Determination of Structural Changes of Domestic Air Travel Demand in Nigeria

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Abstract: This article investigates structural changes throughout time. Air demand is heavily influenced by fare and frequency. The focus of this research is primarily on structural alterations connected to these two elements. The idea that fare sensitivity has grown and frequency sensitivity has (roughly) reduced is explored in particular. It is critical to investigate the stability of the structure of air travel demand. Demand elasticities with these variables, as well as coefficient ratios, can be utilized to depict structural changes over time. While no particular temporal trends for scheduled flight time and fare impacts have been discovered, no structural changes relating to other factors have been discovered. From 2009 and 2013, we conducted paired sample t-tests for the important operational and economic factors of air travel demand, and there was no statistically significant variation in the parameter estimates. The ratios of frequency of flight and airline fares change over time, and all ratios of airlines have identical patterns- they rise or drop concurrently because frequency coefficients are more stable than pricing coefficients. Furthermore, changes in fare elasticities follow patterns comparable to changes in fare-to-frequency coefficient ratios. These adjustments are thus mostly driven by increases in fare sensitivity. This research provides a framework for airlines to evaluate demand on domestic routes and place their services by constructing a service positioning matrix to guarantee commercial sustainability.

Keywords: Air Travel, Demand, Structural Changes, Elasticities, Fare and Frequency
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1. Introduction

Air transport is of tremendous significance for tourism growth and visitor flow since it provides reduced journey time and is an important routine platform in tourism global engagement. It has remained the quickest mode of transportation on a worldwide scale, impacting the tourist sector. When compared to other modes of transportation, air travel allows people to travel large distances throughout the world in a short amount of time. Today, the sector offers a variety of flying services, including both short- and long-distance transit. The primary benefit of this technology is the significant amount of time saved due to the high speed of the flight [1].

Deregulation is the act or process of removing rules and limits from a certain industry, or, to put it another way, "the decrease or elimination of centralized control in a specific industry generally implemented to increase competition within the business" [2]. According to the descriptions above, the primary goal of airline deregulation was to foster competition among airline carriers, resulting in price reductions. In 1978, the United States initiated airline deregulation in an attempt to promote competition in the airline business. It was, and continues to be, a part of a large-scale experiment to dramatically lower ticket costs and abolish entrance control for new airline hopefuls. That solitary move ushered in a new era in the industry, as well as a new business climate. This business model prospered, spreading to other industries in the United States and eventually being imitated in Europe and the rest of the globe [1].

Airlines have used new techniques since the beginning of deregulation, and customers are in for a new market experience. The air travel market is currently highly competitive, with several airlines operating various routes, making long-haul and short-haul flights more inexpensive and allowing for shorter travel times. Domestic and foreign markets are booming. Even though state-supported airlines continue to exist across the world, exercising control over ticket prices and route entries, numerous nations have long deregulated their domestic airline markets. Deregulation has provided some financial benefits to the typical airline passenger. Since deregulation, fares have continuously been cut. It is important to note that deregulation did not affect industrial safety in any way; rather, it increased safety on flights and at airport terminals [1].

Airlines have developed a set of business models to increase their market share and gain competitive advantage against each other. One of the business models that have recently captured attention is the low-cost business model [3]. The business model of the corporation indicated how it produces money and competes in its industry [4]. The profit margin of a company is affected by the business plan it chooses [5]. There are two primary business models in the airline industry: network (full-service) and low-cost (discount) carriers. The network carrier model implements a diversification strategy by expanding domestic destinations, covering international routes, offering a variety of seating arrangements (business, economy, and first-class), managing a complex network of hubs, and delivering high-quality service. Low-cost (discount) airlines, on the other hand, are concerned with reduced airfares. To save operational expenses, inexpensive airlines offer shorter routes, and point-to-point destinations rather than through complex hubs, and flights are mostly domestic.

Discount airlines use a similar model aircraft fleet, a minimal infrastructure, a single seating layout, and fewer amenities and flight services than network airlines [6].

Amaechi et al infer that performance measurement is critical for every enterprise involved in air transportation. With these measurements, airlines are able to establish an understanding of their internal systems which then informs their understanding of the competition [7]. Potter investigated the relationship between profitability and airline business models as proposed by Collins and discovered that network airlines had a higher long-term consistent profit margin than low-cost competitors [6], [8]. Potter also noted that, although retaining high operational expenses, the old network (full-service) business model provides enough service differentiation, resulting in larger profit margins in the long term. As a competitive advantage, Flamholtz and Randle proposed that airlines include corporate culture in their business models [9]. Given the airline industry's severe rivalry, the choice of a business model remains important to the airline's profit margin [5].

Certain research has been conducted in the literature of academia, business, and government to better comprehend the nature of the rapidly developing air transport industry with economic progress. Because of the diverse data sets, methodological approaches, economic development level of the studied location, and examining different periods, the results are substantially different. Additional research on the fundamental link between the air transport business and economic growth in the defined region is also required. Because, according to Doganis, the airline sector has been paradoxically defined by continuing and fast expansion of its service while remaining only modestly profitable over the previous five decades [10].

In the words of Kiraci & Yasar, four features are required for systems to work appropriately; 1) robustness, 2) self-organization, 3) hierarchy, and 4) efficiency. These crescendos must be in sync to have a beneficial impact on airline productivity [11]. When a system can recover from an obstacle caused by internal or external adverse influences, it reveals flexibility. It is generally documented that there is a substantial relationship between air traffic and economic growth; however, the direction of causation is uncertain, and only a few causal analyses in the field of air transportation have been conducted thus far. The link between air passenger demand and economic growth (GDP) was discovered to be cointegrated in research done in Brazil [12]. They demonstrated that in a middle-income scenario, a positive change in GDP has a large positive influence on air passenger numbers, as does the impact of air passenger growth on GDP. Similarly, Fernandes et al used the Granger causality test to investigate the link between economic development and national airline passenger travel in Brazil [13]. In the analysis, GDP was used as an indication of economic growth, and total national passenger-kilometre data were used to calculate airline access demand. The analysis spans the years 1966 to 2006 and yields results that support the notion that there is a single directional Granger causation link between economic growth and the national airline.

Dharmawan explored the association between aircraft traffic frequency and economic growth in Indonesia. For the analysis, data from the years 2000 to 2010 were used [14]. Following the research, the results might show that, due to the contribution of tourism-related industries to airline utilization, there is a favourable association between airline transportation and economic growth. Furthermore, Van De Vijver et al explored the relationship between trade and air passenger travel by using heterogeneous Granger causality tests on a variety of Asia-Pacific nation pairings [15]. Notably, they discovered all four types of causal relationships (independent, air traffic to trade, and trade to air traffic bi-directional) across all nation pairs. However, contrary to this finding, studies on the same topic in Italy [16] and Nigeria [17] found unidirectional causality from air transport to economic growth for countries with varying levels of economic growth and regional configuration.

Changes in the structure of air travel demand through time are of interest but rarely investigated. Changes in distribution networks and the arrival of low-cost carriers are two possible causes for the structure. The rapid growth of the Internet and its usage to purchase air travel may have an impact on the structure of airline service demand by increasing the availability of travel information and decreasing the role of travel agents [18]. The entry of low-cost carriers may raise consumer expectations for cheaper rates and their proclivity to look for them. Examining patterns in air travel demand structure can show whether and to what degree such shifts have happened, as well as the potential for similar trends in the future.

Possible reasons for the structural changes seen throughout the data period (2009-2013) include the expansion of e-commerce and the development of low-cost carriers. Because of the increased availability of travel information and changes in ticket distribution, the rapid growth of the Internet and its applications may have an impact on the structure of airline service demand. The simple availability of travel information broadens potential passengers' options while also assisting potential travellers in making more informed judgments. Prospective passengers, for example, may easily evaluate several choices (different routes, airlines, fares, travel times, and so on) side by side via a single website. Potential passengers may see less information and consequently evaluate fewer choices through traditional distribution methods, such as travel agents. For example, potential passengers may not request lower-cost tickets if their travel agencies currently provide reasonable rates. Furthermore, travel firms' compensation arrangements occasionally provided incentives for agents to promote more costly flights.

Because potential passengers may explore bigger choice sets and do so more knowledgeably than previously, internet impacts may lead to changes in observed travellers' sensitivity to route features. The bulk of potential passengers look for affordable fares online, and most internet-based channels present options arranged by fare—from low to high—from low to high. In contrast, frequency is more relevant in traditional channels, as passengers choose greater frequency alternatives to save search expenses than in internet-based channels. As a result, we anticipate that fare sensitivity will grow while frequency sensitivity will decrease across the data period.

The introduction of low-cost carriers may also have resulted in structural changes. Potential travellers may be encouraged to look for reduced costs if they are aware that low-cost carrier services are available. They may, for example, examine the alternate origin and/or destination airports provided by low-cost carriers. Because of decreased search costs, the impacts of low-cost carriers are amplified when paired with the effects of the internet.

2. Methodology

The purpose of this research is to investigate the impact of aggregate information on the accuracy of aggregate air travel demand models. This study looks at the commercial air travel demand in Nigeria. The NCAA data we have is quarterly flight information departing from all airports between 2009 and 2013. During the research period, we used individual route level data for 117 aircraft routes, as well as aggregate level data. To estimate the models, this research gathers a panel data set that comprises variables for all 117 directed Nigerian domestic routes throughout 2954 route quarters between 2009 and 2013.

Using our conceptual specification, we specify the semi-logarithmic estimation equation:

Log-linear Model: $$InD_{pax-km} = \beta_1 InFreq + \beta_2 InFare + \beta_3 Rtyp + \beta_4 InOntp + In\beta_5 Scft + In\beta_6 Inco + \varepsilon_{irt}$$

The explanatory variables are defined as follows:

Freq = represents the frequency of flight at route r;

Fare = available airline fare of route r, which is the same for all routes of the O-D airport pair at time t served by the same airline;

Rtyp = is the binary indicator variable for the direct route; 1 if a route is a direct route, 0 if otherwise

Ontp = on-time performance of flights of respective airlines

Dist = distance between origin and destination

Scft = scheduled flight time of respective route-specific flight

Inco = Gross domestic product per capita (income determinant of the travelling public)

We compute the log of those predictor variables that have relevant logarithmic meanings. The demand function's log-linearity indicates that the underlying root function is of the Cobb-Douglas (C-D) type. This might be correct or incorrect. This assumption is made for two reasons: computed coefficients of a demand function have intriguing meanings and can be readily compared to a large number of other studies for which comparable functions have been estimated, and these functions are less costly to compute.

Table 1. *Summary of Statistics of Variable of Airline Demand.*

Variables	Mean	Std. Deviation	Number of Observations
Frequency (flights per quarter)	115.91	126.986	2954
Scheduled Fight Time (minutes)	54.45	16.368	2954
On-time Performance (minutes per flight)	78.00	21.572	2954
Fare (in Naira)	22525.22	5779.088	2954
Income (measured in GDP per capita in Naira)	2.4932	.68306	2954
Route Distance (Kilometres)	475.73	210.686	2954
Number of Passengers (per quarter)	8083.40	11552.990	2954
Passenger kilometres (per quarter)	3775744.89	5722846.117	2954

Source: Authors' Compilation (2022)

After filtering the data based on the condition of preserving routes with at least 6 quarterly flights, 2954 route-quarter observations remained to estimate the model, including direct route-quarters and connecting route-quarters. Table 1 displays the sample statistics. Variable statistics are generated using data from several periods ranging from 2009 to 2013. To ease empirical work and assure accurate data, the data used to estimate the model is filtered. This study makes use of domestic Nigeria routes with non-zero fares. These itineraries account for about 95% of all domestic itineraries in Nigeria. Itineraries supplied solely by commuter airlines have been eliminated because commuter carriers did not fully disclose their activity to NCAA. The sample includes only routes between all Nigerian origin and destination airports. While maintaining a suitable computing load, the airports account for all overall airport traffic.

3. Results and Discussions

The Nigerian airline industry has been so unstable over the years. The airline industry contributes to the reduction of unemployment and increases growth and development. The value of the market share of a specific airline, although a rough parameter, could be very valuable information for the airline's top management who, at every moment, has to be aware of the airline's position against its competitors in certain segments of the market or even in the overall market. By gaining higher portions of markets, airlines have a chance to maximize their revenue [19].

To investigate the structural changes in air demand, the preferred model (log-linear) is estimated periodically using different yearly data sets that are subsets of the original panel data set and are shorter panel data sets (just four quarters). Tables 2 and 3 exhibits the yearly estimation results for the log-linear model and the log-linear model with routing bias, respectively. As a consequence, each table has five yearly prediction performances, from column (1) to column (5). Estimation results for the entire panel data set are likewise replicated from Table 3 and placed in column (6) of both tables for comparison. It is worth noting that the yearly estimates (are comparable to the two complete panel estimates. The OLS approach produces smaller (in absolute value) fare coefficient (s) and bigger frequency coefficients for both yearly and panel estimations. The OLS approach estimates implausibly high-frequency coefficients, low (absolute value) fare elasticities, and low correlations between air routes.

The yearly coefficients of the model are quite constant over time, as seen in Tables 2 and 3. Direct comparisons between these coefficients, however, may be improper since their values may be influenced by scale parameters that change over time. Demand elasticities concerning these variables, as well as coefficient ratios, can be utilized to depict structural changes over time. While no particular temporal trends for scheduled flight time and fare impacts have been discovered, no structural changes relating to other factors have been discovered. While there are no distinct temporal trends for income coefficients and elasticities, yearly estimates have larger income coefficients and elasticities than panel estimates. Because yearly data sets are dominated by cross-sectional variation, this shows that time-series variation in income has a smaller influence on air demand than cross-sectional variation in income.

Whereas the majority of the income coefficients exhibit anticipated signs (positive), those for 2012 are not substantially different from zero. This suggests that markets with higher income levels create more air travel throughout the majority of periods, but the income effect becomes insignificant in 2012. The dark time in Nigerian aviation history caused by frequent crashes might be an explanation for the temporally diminished income impact, possibly because it dampened demand for discretionary travel affordable to the more wealthy.

Table 2. *Log-Linear Model Estimates.*

Variable	2009	2010	2011	2012	2013	Panel
Frequency (flights per quarter)	1.282*** [0.029]	1.412*** [0.029]	1.313*** [0.026]	1.363*** [0.030]	1.290*** [0.036]	1.337*** [0.013]
Scheduled Fight Time (minutes)	3.175*** [0.378]	2.768*** [0.332]	2.372*** [0.291]	1.917*** [0.287]	1.825*** [0.328]	2.375*** [0.145]
On-time Performance (minutes per flight)	-2.122*** [0.418]	-1.733*** [0.410]	-1.534*** [0.403]	-0.308 [0.359]	0.126 [0.393]	-1.146*** [0.178]
Fare (in Naira)	0.166 [0.234]	-0.592** [0.237]	-0.322 [0.198]	-0.367[a] [0.202]	-0.571* [0.235]	-0.319*** [0.048]
Income (measured in GDP per capita in Naira)	0.259[a] [0.138]	0.456*** [0.123]	0.421*** [0.113]	-0.099 [0.133]	-0.318* [0.133]	0.193*** [0.057]
Routing Type (=1, if direct route)	0.223 [0.148]	0.248*** [0.178]	0.155 [0.153]	0.386* [0.186]	0.076 [0.212]	0.220** [0.076]
Constant	3.100[a] [1.840]	9.835*** [1.812]	8.572*** [1.506]	7.913*** [1.792]	6.950*** [2.053]	9.551*** [1.061]
R^2	*0.797*	*0.825*	*0.832*	*0.830*	*0.767*	*0.806*
Adjusted R^2	*0.794*	*0.822*	*0.829*	*0.827*	*0.763*	*0.805*
F	*260.451*	*323.407*	*351.770*	*240.953*	*185.323*	*871.302*

1. Log-linear model: Dependent variable = In (Passenger-Kilometers); 2. Standard errors in brackets are robust to heteroskedasticity and serial correlation; 3. * p < 0.05, ** p < 0.01, *** p < 0.001; Statistics of the first stage. [a]Parameters estimates for the income variable are significant at p <0.100

Table 3. *Log-Linear Model Estimates with Routing Bias.*

Variable	Direct Flight	Connecting Flight
Frequency (flights per quarter)	1.352*** [0.013]	0.774*** [0.116]
Scheduled Fight Time (minutes)	1.878*** [0.148]	0.495 [3.968]
On-time Performance (minutes per flight)	-0.176 [0.193]	-3.127 [3.172]
Fare (in Naira)	-0.324*** [0.097]	-2.932*** [0.842]
Income (measured in GDP per capita in Naira)	0.147** [0.057]	0.281 [0.285]
Constant	7.360*** [1.045]	-6.829 [6.032]
R^2	0.823	0.384
Adjusted R^2	0.822	0.322
F	1001.840	6.133fd

1. Log-linear Model: Dependent variable = In (Passenger-Kilometers); 2. Standard errors in brackets are robust to heteroskedasticity and serial correlation; 3. * p < 0.05, ** p < 0.01, *** p < 0.001; Statistics of the first stage.

To investigate the structural changes in air demand, the model is estimated iteratively using different yearly data sets that are subsets of the original panel data set and are shorter panel (just four quarters) data sets. The model's annual coefficients are somewhat stable over time. Similarities between these coefficients, however, may be improper since their values may be influenced by scale parameters that change over time. Demand behaviour about these factors and coefficient ratios may be utilized to depict structural changes over time. While there are no particular temporal trends for scheduled flight time and fare impacts, there are no structural changes connected to other factors.

The assumption that fare sensitivity has grown relative to frequency sensitivity is evaluated first, followed by a discussion of structural changes relating to individual factors. Using a panel as the foundation, a certain airline's coefficient ratio is compared to its counterpart. When the ratio is considerably (p-value0.05) different from its equivalent, a bigger marker is given. For example, the coefficient ratios of fare to the frequency of ARIK and Air Nigeria are around 0.15 and 1.64, respectively, and are not significantly different from the panel ratio. The ratios change with time, as shown in table 2, and all of the airlines' ratios have identical patterns- they rise or drop concurrently because frequency coefficients are more stable than fare coefficients. The OLS estimates show that (1) the ratios grow first and subsequently fall; and (2) the Aero and Overland ratios are close to the aggregate model. That is, the relative sensitivities do not differ much among all carriers. As a result, the null hypothesis is rejected.

Table 4. *Sensitivity test for fare and flight frequency on various Airlines.*

Airline	Frequency Elasticity	Fare Elasticity	The ratio of fare to frequency coefficients	p-value
ARIK	1.348	-0.151	-0.15	0.914
AERO	1.150	-0.240	-0.21	0.997
ASSOCIATED	1.212	-0.097	-0.08	0.996
CHANGCHANGI	1.020	-0.387	-0.38	0.997
DANA	1.245	-1.159	-0.93	0.993
IRS	0.943	-0.357	-0.38	0.963
OVERLAND	1.383	-0.280	-0.20	0.929
AIR NIGERIA	1.064	-1.740	-1.64	0.910
Aggregate (panel)	1.337	-0.319	-0.24	

Source: Authors' Compilation (2022)

The fare elasticities indicate that potential travellers have become increasingly price-sensitive to Air Nigeria. Furthermore, changes in fare elasticities follow a pattern comparable to changes in fare-to-frequency coefficient ratios. These shifts are thus mostly driven by increases in fare sensitivity. Between 2009 and 2013, we ran paired sample t-tests on the important operational and economic factors of air travel demand, and there was no statistically significant variation in the parameter estimates. Refer to Table 5 for a summary of the test findings.

Table 5. *Paired Samples Test of Air Travel Demand Parameters between 2009 and 2013.*

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	2009 - 2013	-.47071	1.87284	.70787	-2.20281	1.26138	-.665	6	.531

As a result, the null hypothesis is accepted, meaning that there are no structural changes in air travel demand in Nigeria. As a result, operational and economic factors are not the reasons why the aviation industry in Nigeria is not viable.

4. Conclusion

Since the empirical objective of this paper focuses on the coefficients and ratios of coefficients, the log-linear model can serve this purpose well, and the log-linear model provides a good balance between flexibility and computational complexity, this paper chooses the aggregate log-linear model for the demand proxy in the empirical study. Nonetheless, the full domestic network was analyzed to detect variability among possible travellers and allow for more flexible replacement patterns. Disaggregate data, which may offer information closer to travellers' behaviour, may be provided in some circumstances. Individual fare information, for example, is provided for Nigeria's domestic markets. The model enhances previous models by including desired variables and employing an appropriate estimating approach. The model can manage activities at the route level and can be used in a broad network system. The model is applied to Nigeria's domestic air transport network and serves as a topmost program evaluation tool for various situations.

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