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THE SENSITIVITIES OF FARE TO FREQUENCY AND DISTANCE ELASTICITIES OF NIGERIAN AIRLINES

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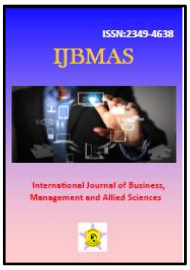

ABSTRACT

The paper ponders on the influence of fares, flight frequency and flight distance. The aggregated level fare elasticity of all airlines in Nigeria was computed as -0.319. The results confirm that the minimum frequency is more critical to the connecting service. In short- to medium-haul markets, the distance effects reflect declining competition from competing airlines, which causes air demand to increase with distance; in long-haul markets, the effect is reversed, presumably due to decreasing propensity to travel. While the majority of the distance elasticities from the estimates are positive, certain markets have negative demand elasticities with respect to market distance.

Keywords: Airlines, elasticity, fare, frequency, distance and demand

1.0 STUDY BACKGROUND

There are conscious efforts by the providers in Nigerian aviation industry to expand capacity and accommodate future traffic growth. While overrating future traffic leads to overinvestment, underestimating future traffic distorts system operations and causes poor system performance, thereby increasing user (e.g. airlines and travelers) costs. Tsekeri (2009) has estimated short and long-term response of air passengers to change in relative air-sea travel cost components in competitive markets using a dynamic demand model. The model proved the importance of considering past volumes of air passengers and relative travel cost components to explain current air travel demand (see also Postotino, 2003). Multiple regression models are however the most reliable method for estimating air travel demands (Uddin et al, 1986). The model relates variations in air traffic to variables of different socio-economic factors of residents and seeks to derive equation for demand in terms of price and other relevant variables. Multiple regression methods are designed to account also for variables in non-price factors.

Demand for public transport, road freight facilities or airline services are usually derived from some other functions (Cole 1998). The demand level for transport is related directly to demand level for product or service. In Nigeria, demand for air transport services has been on increase within the past three decades. There has been growth in passenger, aircraft and freight traffic as a result of physical and economic development of cities in different parts of the country. The creation of states and need to develop state capitals for them to perform their socio-economic responsibilities has fuelled the tempo of physical development in the country. Fast connections between diverse economic spaces of Nigeria are better achieved through air transportation. Ogunbodede (2006) states that diversity in resource endowment between the North and the South is an important factor in the growth of air transport in Nigeria. Also, new civilian administration regards air transport subsector as critical focal point in the effort to open up the country to foreign investors and thereby narrow the gap between available and required levels of domestic investment capital (Adeyemi, 2001).

Although air mode is recent in Nigeria when compared with road and railway modes, its contribution to development of transportation in Nigeria, is very significant. For instance, domestic passenger traffic stood at 3,093,000 in 1988. It rose to 4,618,000 in 1998 and 6,424,000 in 2004 (Adebayo, 2006a). Likewise, both cargo and mail transportation by air had been on regular demand (FMT, 2004). These shows increasing demand for air transport services in the country. The long run success of any organisation is related to how management is able to foresee future and develop appropriate strategies. The objective of this study is to survey demand pattern for air transport in Nigeria and show its consequences for air transport planning.

Jorge-Calderon (1997) presents a demand model for scheduled airline services for entire network of international European routes in 1989. The model covers variables describing both geo-economic characteristics of the area where transportation took place and patterns of airline services. Flight data are divided in three sub-samples by distance of end-points. Results suggest that demand is inelastic respect to fares on shortest sectors and price elasticity increases with distance. In addition, short haul markets seem more sensitive to frequency of flights.

Abed, Ba-Fail and Jasimuddin, (2001) provide an econometric analysis of international air travel demand in Saudi Arabia. They consider only macro-economic and demographic indicators and a detailed description of the steps followed for development of the model given. Results suggest that population size and total expenditures are main determinants of international demand in Saudi Arabia. Brons, Pels, Nijkamp and Rietveld (2002) present a meta-analysis of price elasticity estimates of demand for passenger air travel. After a description of determinants of demand for passenger air transport, they carry out a comparative re-evaluation of previous research on price elasticities for passenger air transport. They find overall demand mean price elasticity of -1.146 with passengers becoming price sensitive over time. Business passengers show lower price sensitivity, with an average price elasticity of -0.8.

2.0 EMPIRICAL FRAMEWORK

Assuming that potential travelers are homogeneous in the observed characteristics-no individual deviations $\mu_{irt} = 0$ except for the stochastic terms ε_{irt}, the equations to estimate the determinants of demand of domestic traffic in sample of Nigerian airports within the period under study are as follows:

Using analytical specification, it identifies the following equation for estimation in semi-logarithmic form:

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

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 travelling public)

We take log of those independent variables for which logarithmic interpretations are meaningful. Second, log-linearity of demand function implies that underlying root function is of Cobb-Douglas (C-D) type. This may be ambiguous. We make this assumption for two reasons: estimated coefficients of a demand function have interesting interpretations and can be easily compared with a vast number of other studies for which similar functions have been estimated; and, these functions are computationally less expensive. In a larger context, however, appropriateness of functional form can be empirically tested.

This paper chooses aggregate demand forms for market share (total number of passengers carried per quarter) function, and also estimates aggregate demand model for another demand proxy (passenger-kilometer done per quarter) for comparisons. Routes are grouped in a city-pair by assuming that the routes with more common characteristics are more likely to be competitors, i.e. higher correlations among these routes. The common characteristics used in the empirical analysis include (1) air routes and (2) origin-destination (O-D) airport pair.

The coefficient of the fare sensitivity of demand is expected to be negative since higher prices usually result in lower demand. Demand should increase with distance due to substantial differences in travel time between air travel and other transport modes. If, however, the socioeconomic effects of distance predominate, demand will have a negative relationship with distance. Demand should increase in a liberalized industry due to lower fares and more departures as a result of competition. The frequency variable is expected to respond positively to passenger traffic. Following previous literature all continuous variables in the model are expressed in natural logarithms so that their coefficients can be interpreted as elasticities.

This study focuses on exploring the effect of aggregate information on the accuracy of aggregate air travel demand models. This study considers the case of Nigeria commercial air travel demand. The data available from the NCAA are the quarterly flight information departing from all airports between 2009 and 2013. Individual route level data was used for 117 flight routes during the period under study, with aggregate level data.

The contributions of this study to the existing literature can be, applying the two approaches to quarterly air passenger data over the period 2009 to 2013. The results provide further empirical evidence on advantages of using approaches in modelling aggregate variables of interest. For example, Giacomini and Granger (2004) illustrate that modeling performance can be improved by imposing a priori constraints on the VAR process for disaggregate variables. They also show that ignoring the impact of spatial correlation, even when it is weak, can lead to highly inaccurate models. Furthermore, Hendry and Hubrich (2006) state that exploiting a common factor structure model in disaggregate variables might provide better out-of-sample models for aggregate variable.

In most aggregate or macroscopic models, some measure of air travel demand, such as total number of passengers or flights, or revenue per mile, is modeled as a linear function of various explanatory variables, including, but not limited to, some measure of price, some measure of an alternative mode of traveling, control variables such as GDP of region, some measure of tourism, measure of foreign trade, etc. (Ejem, 2014). Among others, studies analyzing macroscopic models of air travel demand include Abed, Ba-Fail, and Jasimuddin (2001), Cline, Ruhl, Gosling, and Gillen (1998). These models treat air travel demand as a homogenous commodity, and do not consider differences between air travel demand functions in different regions.

3.0 STUDY MODEL STATISTICS

Nigeria domestic market in this study is divided into 117 origin-destination (OD) pairs due to data compilation needs. Markets are specified as directional OD pairs such that from route 1 to route 2 is a different market, from route 2 to route 1. Air travel choices include multiple products which are unique combinations of airport (there can be multiple airports in a zone. e.g. Warri in Delta States has two airports QRW (Osubi) and ASA (Asaba)) (see Table 1 for the airlines examined in the study), ticket class (first, business, full, premium coach, and discount coach), and connection (non-stop flight and connecting flight). Pels, Nijkamp and Ritveld (2000, 2001) suggest that air travelers may prefer particular airports, or treat airline-airport combinations as a travel choice. Study specification captures these important service attributes of air services.

Recent studies such as Li, Hensher and Rose (2010), Hensher, Greene and Li (2011), Hensher and Li (2012), Chorus and Dellaert (2012) point it is important to incorporate travel time reliability/variability in model specification (hence the need to include on-time performance of flights in model). Summarily, our data consist of 117 directional O-D markets and total number of travel products on 117 markets filtered is 2954.

TABLE 1: SUMMARY OF AIRLINES FLIGHT DATA PER QUARTER

Airline	**Number of Observations**	**Percentage of quarterly route share**
AERO	**488**	**16.5**
AFRIJET	**17**	**0.6**
AIR NIGERIA	**235**	**8.0**
ARIK	**1147**	**38.8**
ASSOCIATED	**160**	**5.4**
BELLVIEW	**16**	**0.5**
CAPITAL	**13**	**0.4**
CHANCHANGI	**112**	**3.8**
DANA AIR	**173**	**5.9**
FIRST NATION	**13**	**0.4**
IRS	**325**	**11.0**
MEDVIEW	**37**	**1.3**
OVERLAND	218	**7.4**
Total	**2954**	**100**

After the data were filtered based on criterion of retaining routes with at least 6 quarterly flights, 2954 route-quarter observations- including direct route-quarters and connecting route-quarters remained to estimate the model. Sample statistics are in Table 1.

The statistics for variables are computed using data of different time periods from 2004 to 2013. Market level variables, which are used to explain total demand of air routes, are identical for all similar city-pair of a market. The statistics for these variables, therefore, are presented in terms of routes. The data used for estimating the model is filtered, in order to simplify the empirical work and ensure reliable data. This research uses Nigeria domestic itineraries with non-zero fares. These itineraries account for about 95% of all Nigeria domestic itineraries. Itineraries served exclusively by commuter carriers are discarded since commuter carriers did not completely report their activities to NCAA. Only itineraries between all origin and destination airports in Nigeria are included in the sample. The airports account for all the total airport traffic, while maintaining a reasonable computational burden.

4.1 AIRLINE DEMAND ELASTICITY WITH RESPECT TO FARE

Fare elasticities of route demand are summarized in Table 2. Since potential travelers have more choices at route, fare elasticities of route demand are expected to be larger (in absolute values). While fare elasticities calculated from OLS estimates, are consistent with expectation. In addition, when market size (measured by number of passengers) is taken into account, the elasticities generally become smaller in absolute values. Details of these elasticities are shown below.

TABLE 2: FARE ELASTICITY OF VARIOUS AIRLINES

Airline	Fare Elasticity	Remark
ARIK	-0.151	inelastic
AERO	-0.240	inelastic
ASSOCIATED	-0.097	inelastic
CHANGCHANGI	-0.387	inelastic
DANA	-1.159	elastic
IRS	-0.357	inelastic
OVERLAND	-0.280	inelastic
AIR NIGERIA	-1.740	elastic
Aggregate (panel)	-0.319	inelastic

The fare elasticities can be investigated by their distributions and compared with other estimates in the literature. The fare elasticities from OLS estimates indicate inelastic market demand except for Dana and Air Nigeria which showed elastic values. This indicates that fare elasticities of low traffic markets are higher than those of high traffic markets. A possible reason is that current fares in the low traffic markets are relatively high. Thus, a proportional fare increase reduces more service attractiveness in these markets. Direct comparisons of estimates from literature and this research cannot be made because most fare elasticities available in the literature are estimates for air market demand or for airline demand. However, some guidelines for ranges of fare elasticities are available. Summarizing from the literature on air market demand, Gillen et al (2002) reported that the medians of fare elasticities for different trip lengths and trip purposes range from -0.70 to -1.52. The fare elasticities of route demand from OLS estimates are, like those of market demand, too low- most of them are smaller (in absolute values) than those of market demand from Gillen et al (2002).

Fare elasticities of route demand are comparable to elasticities of airline demand reported in the literature. First, monopolistic routes, route demands are equivalent to airline demands. For example, airlines serving same market offer competing routes each connecting at their respective hubs, so that each route corresponds to one airline. When airlines compete with each other on the same routes, elasticities of airline demand should be higher than those of route demand. This may be offset, however, by airline brand loyalty (e.g. due to frequent flyer programme or low carrier model operated by airline such as Aero Contractor in Nigeria), which reduces airline demand elasticities.

The fare elasticities of route demand from the OLS estimates from various airlines in Nigeria shown in Table 2 are consistent with these expectations. For Dana and Air Nigeria airlines, the estimated absolute fare elasticity is larger than those of market demand, and close to smaller than those of airline demand, compared with estimates of Oum et al (1993). Oum et al (1993) estimated fare elasticities of market demand and computed airline specific fare elasticities using estimated conduct parameters. The medians of their fare elasticities are -1.54 for market demand and -2.99 for airline demand.

4.2 SENSITIVITIES TO FARE AND FREQUENCY

The hypothesis that fare sensitivity has increased relative to frequency sensitivity is tested first, and then structural changes related to individual variables are discussed. The ratios of fare coefficient to frequency coefficients shown in Table 3. Using panel as the base, a coefficient ratio of specific airline is tested against its counterpart. When the ratio is significantly (p-value<0.05) different from its counterpart, it is presented with a larger marker. For instance, the coefficient ratio of fare to frequency of ARIK and Air Nigeria are about 0.15 and 1.64, they are not statistically different from its ratio of panel.

As shown in Table 3, ratios fluctuate over time, and all the ratios of airlines have similar patterns- they increase or decrease concurrently, mainly because the coefficients of frequency are stable than those of fare. The OLS estimates indicate that (1) the ratios increase first and then decrease; (2) the ratios of Aero, Overland are close to that of aggregate model.

TABLE 3: SENSITIVITY TEST FOR FARE AND FLIGHT FREQUENCY ON VARIOUS AIRLINES

Airline	Frequency Elasticity	Fare Elasticity	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	

The fare elasticities suggest that potential travelers became more sensitive to fare for Air Nigeria. The changes of the fare elasticities have patterns similar to changes in coefficient ratios of fare to frequency. These changes are thus driven largely by increases in fare sensitivity.

4.3 SENSITIVITIES TO FARE AND MARKET DISTANCE

As shown in Table 4, OLS estimation yields the elasticities of market demand with some sensitivity with distance. Distance effects from the OLS estimates for markets with similar distance may vary, since they depend on inclusive values, which represent service levels of air routes.

TABLE 4: PANEL DATA ESTIMATION RESULTS FOR AGGREGATE AIR TRAVEL DEMAND WITH DISTANCE BIAS

Variable	0-300KM	301-600KM	601-900KM	>900KM	Panel
Frequency (flights per quarter)	**1.357*** [0.030]**	**1.351*** [0.013]**	**1.296*** [0.045]**	**0.832*** [0.140]**	**1.337*** [0.013]**
Fare (in Naira)	**0.419* [0.188]**	**0.212^a [0.118]**	**0.649^a [0.361]**	**-0.299 [1.182]**	**-0.319*** [0.048]**
R^2	0.810	0.877	0.676	0.620	*0.806*
Adjusted R^2	0.806	0.876	0.667	0.579	*0.805*
F	204.886	974.309	81.073	12.401	*871.302*

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 $p < 0.100$

Demand elasticities with respect to market distance can help to understand the distance effects of individual markets. Three main generalizations emerge from the Table 4. First, markets with distance less than 900 km have positive fare elasticities. That is, for two markets with distance less than 900 km, the longer distance market is expected to have higher sensitivities with air travel demand with respect to fare, all else being equal. Second, for markets with distance longer than 900 km fare elasticities are negative in line with theoretical construct. This indicates that the influence of propensity to travel, as opposed to mode shift, is likely to be observed in longer-haul markets. Third, within each distance category the percentage of passengers with positive fare elasticities is higher than percentage of markets with negative fare elasticities. This implies that higher fare elasticities are more likely to be found in markets with long-haul. All else being equal, while the influence of declining propensity to travel is more pronounced in better served markets, the influence of mode competition is stronger in minor markets.

5.0 CONCLUSION

The paper focuses on the findings regarding the influence of fares, flight frequency and flight distance. At market level, the fare elasticities from OLS estimates indicate inelastic market demand Fare elasticities are likely to be in markets with long-haul with distances more than 900km. Market demand elasticities with respect to market distance help understand the distance effects of individual markets. While the majority of the distance elasticities from the estimates are positive, certain markets have negative demand elasticities with respect to market distance. Although all estimated frequency coefficients indicate that potential travelers prefer routes with high flight frequency, marginal effects of different frequency variables are different. The results confirm that minimum frequency is more critical to the connecting service, thus a proportional flight frequency increase on the segment with lower frequency increases service attractiveness more than an equivalent change on higher frequency segment.

The model employed in this paper can handle activities at a low aggregation level, and can be applied to large network system. The model is applied to domestic air transport network of Nigeria, and serves as bottom-up policy analysis tool for different scenarios. System impacts of changes in specific route elements, such as airports or segments, can be evaluated.

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