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Transportation and Economic Growth in Nigeria: Cointegration and Hsiao's Causality Analysis

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Abstract

This paper investigates the causal relationship between transportation and economic growth and transportation and employment in Nigeria. By applying techniques of co-integration and Hsiao's version of Granger causality, the results infer that economic growth causes total transportation. Economic growth also leads to growth in road transportation, while on the other hand; neither economic growth nor rail transportation affects each other. However, air transportation leads to economic growth. The implications of the study are that transportation development policy regarding road transportation would not lead to any side-effects on economic growth in Nigeria. However, transportation policy in the case of rail and air transportation should be adopted in such a way that it stimulates growth in the economy and thus expands employment opportunities.

***Key Words**: Transport; Economic growth; Employment, Co-integration and Hsiao's Causality*

INTRODUCTION

Transport is an important sector of economic activity, especially in developing countries, where it plays an essential role in marketing agricultural products and providing access to health, education and agricultural inputs and extension services.It isthe frame of a country's economic growth and development. Transportation sector support growth and open corridors, port links and tourism areas, and connect each region to the rest of the country (Rudra, 2010).

According to Olomola (2003), inadequate provision of transport infrastructure and services provide a basis for explaining the incidence of poverty across various Nigerian communities in both urban and rural areas. The categories of transport problems that can be identified are: bad roads, fuel problem (high fuel price, shortage of fuel supply and consequential high transport cost), traffic congestion (long waiting time, bad driving habits, hold-ups), inadequate high passenger capacity/mass transit vehicles and overloading, high cost and shortage of spare parts, poor vehicle maintenance and old vehicles. It is clearly established that inadequate transport facilities and services as well as the constraints imposed on the mobility and accessibility of people to facilities such as markets, hospitals and water sourceshave grave implications on deepening poverty levels.

An efficient transportation system gives a country a competitive edge in moving goods economically. Conversely, lack of accessibility or poor transport conditions are barriers to agriculture, industry and trade and may hinder the entire development effort. Nevertheless, the contributions of transport to national development may be difficult to quantify in economic terms. Unfortunately our roads have been overwhelmed by myriads of problems which have substantially minimized their value. The road system is largely in disrepair and is not useable in any value-adding way. Traumatic traffic congestions are commonplace in the populous cities of the country. Aside long delays in the movement of goods, highway accidents and deaths are frequent. These are caused by faulty designs, absence of drainage systems, washing away of pavements, fallen bridges, gullies/potholes as well as non-existent culture of maintenance.

Collectively, these undesirable road characteristics have clogged the stream of exchange of goods and services across the country as it has become expensive and more difficult to move products and services from producers to consumers, farm produce from rural to urban centers with lots of man-hour losses. Consequently, this weakens the purpose of desirable time bound; destination bound, cost bound and purpose bound operational efficiencies which should underscore effective transportation. Generally the conditions of our roads substantially affect the cost of production and overall national productivity.

Nigeria road transportation system is severely deficient due to underinvestment. Road transport investment takes a considerable share in public expenditure, yet there are still many unanswered, unsettled questions about transport infrastructure: what is the causation between transport investment and growth? What priority in transport investment should be chosen in different areas if we try to reduce difference in growth and alleviate poverty nationwide?

For Nigeria to be able to reverse the current consequences of economic recession, it is necessary to improve on its Gross Domestic Product (GDP). However, the achievement of higher GDP (measure of economic growth) is threatened by inadequate and diminishing connections to national and global markets by air, sea, rail and road. The relationship between transport and economic growth is now well established in the literature, yet the direction of causation of this relationship remains controversial. That is, whether economic growth leads to transport growth or that transport growth is the engine of economic growth. The direction of causality has significant policy implications. Empirical results to find the direction of causality between transport growths are, however mixed.

The objective of this paper therefore, is to investigate the causal relationship between transport growth and economic growth in Nigeria. The rest of the paper is structured as follows: section 2 presents a brief literature review and theoretical framework. Section 3 discusses the methodology and model. Empirical analysis is presented in section 4. Section 5 concludes the paper.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Literature Review

The analysis of the nexus between transport and economic growth has a long history. This paper provides a very brief literature review on the considerations of what might explain the linkages between transportation and economic growth. According to (Litman, 2010), economic development refers to progress toward a community's economic goals such as increased employment, income, productivity, property values and tax revenues. For economic development to occur there must be sustained quantitative and qualitative improvements in almost all the sectors of the economy growth.

Although a number of empirical studies report evidence supporting the significant contribution of infrastructure to economic development, it is a puzzling and disputing question of whether transport is the cause of growth or vice versa. The research on transport infrastructure and its relation with economic growth did not emerge until late 1980s. The move to measure quantitative relationship between growth in infrastructure and total economic growth using macroeconomic model began with Mera (1973), Ratner (1983) and Biehi (1986). Though the early analytical explorations of the contributions of public infrastructure to economic productivity started with Mera (1973), Ratner (1983) and Biehi (1986), it was the study carried out by Aschauer (1989) on the economic contribution of public investment, of which transport capital forms part for the G7 countries using panel data for the period 1966-1985 that drew the attention of mainstream economics and policy personnel.

Following the seminal work of Aschauer, interest in the relationship between economic growth and infrastructure had been rekindled and, as a consequence, a large body of mainly empirical studies to support the conclusion that infrastructure is important to the economy emerged. Many of these studies, based on the production function approach assume public capital as one of the direct input factors. Pereira (2000), cited in Zou et al (2008), applied sophisticated production function on time series data of the US in 1970-1983. His finding is that among core infrastructure, the investment return on electricity and transport is the highest, 16.1% and 9.7% respectively; both are higher than that of education and Medicare.

Onakoya, et al. (2012) utilized a multivariate model of simultaneous equation on time series data in Nigeria 1970-2010. Their finding showed that infrastructural investment has a significant impact on output of the economy directly through its industrial output and indirectly through the output of other sectors such as manufacturing, oil and other services. The agricultural sector is however not affected by infrastructure. The results also revealed a bi-directional causal relationship between infrastructure and economic growth.

In his contribution to empirical analysis of transport - economy linkage, Zhu (2009), applied a simple Cobb Douglas production function approach on panel data covering the period between 1992 and 2004 to compare transport-economy linkage of developed countries and developing countries. His results indicated that physical units of transport infrastructure are positively and significantly related to economic growth and the output elasticity with respect to physical units for developed countries is higher than developing countries

In another study, Rudra and Tapan (2013) using Vector Error Correction Model (VECM),examined the effect of transportation (road and rail) infrastructure on economic growth in India over the period 1970 to 2010.The paper found bidirectional causality between road transportation and economic growth. It also found bidirectional causality between road transportation and capital formation, bidirectional causality between gross domestic capital formation and economic growth, unidirectional causality from rail transportation to economic growth and unidirectional causality from rail transportation to gross capital formation.

Amadi and Amadi, (2013) examined public spending on transport infrastructure and economic growth in Nigeria. The study employed the Ordinary Least Square (OLS) regression method to analyze the data collected. The data analyzed showed that public spending on transport infrastructure is negatively related to growth and insignificant.

In Nigeria, Imobighe and Awogbemi (2006) regressed private capital stock, non-military, net investment, time to capture the effects of the technical changes in economic growth, one year lag GDP and electricity supplied against Gross Domestic Product to assess the impact of capital stock in Nigeria's economic growth from 1980-1998. The paper found gross domestic product to be positively related to private capital stock by one year lag GDP_{t-1} and electricity supply was negatively related to recurrent and capital expenditure, except expenditure on defense and technical change. They further found that while lagged value of gross domestic product significantly increases output in Nigeria, other explanatory variables were, individually insignificant in explaining output in Nigeria.

Loto (2006) studied the impact of infrastructure on economic growth using co-integration and error correction model also found that infrastructure, when measured in physical sense, impacts positively on economicNational development encompasses social, political as well as economic development which is defined as the attainment of a number of ideals of modernization such as a rise in productivity, social and economic equity, improved institutions and values. Economic development is thus an important aspect of general development in any nation (Falodun*et al*, 2010).

Theoretical Framework

The relationship between infrastructure and economic growth has attracted attention in economics research. The theoretical basis of this paper centers on endogenous growth theory, the endogenous growth theory is an extension of some other growth theories before it. Harrod and Domar (1947) observed that investment plays a key role in the process of economic growth. Investment has a dual character: first, it creates income and secondly it augments the productive capacity of the economy by increasing the capital stock. The former is the 'demand effect' and the latter is the 'supply effect' of investment. Thus, so long as net investment is taking place, real income and output will, ceteris paribus, continue to expand. Endogenous growth models postulates that the economy's output is conditioned not only on the level of physical capital and labour stock but also on additional production factors which may enter the production function with constant returns to scale alone (Afonso and Furceri, 2007).

This theoretical position was followed by Edame (2014), and Appahettal (2013) in their separate analysis of the public spending on transport infrastructure and economic growth in Nigeria. There is the believe that following this line of thought offers appropriate analysis of the relationship between road transport infrastructure and economic growth in Nigeria, hence, the adoption of this model.

METHODOLOGY

Traditionally to test for the causal relationship between two variables, the standard Granger (1986) test has been employed in the relevant literature. This test states that, if past values of a variable Y significantly contribute to forecast the value of another variable Xt+1 then Y is said to Granger cause X and vice versa. The test is based on the following regressions.

$$Y_t = \beta_0 + \sum_{k=1}^{M} \beta_k Y_{t-k} + \sum_{l=1}^{N} \alpha_l X_{t-1} + U_t \qquad (1)$$

$$X_t = \gamma_0 + \sum_{k=1}^{M} \gamma_k X_{t-k} + \sum_{l=1}^{N} \delta_l X_{t-1} + V_t \qquad (2)$$

Where Y_t and X_t are the variables to be tested, and U_t and V_t are mutually uncorrelated white noise errors, and t denotes the time period and *'k'* an *'l'* are number of lags. The null hypothesis is $\alpha_1 = \delta_1 = 0$ for all i's versus the alternative hypothesis that $\alpha_1 \neq 0$ and $\delta_1 \neq 0$ for at least some i's. If the coefficient α_1i's are statistically significant but δ_1i's are not, then X causes Y and vice versa. But if both α_1i and δ_1i are significant then causality runs both ways (ie bi-directional causality).

Recent developments in the time series analysis have suggested some improvements in the standard Granger test. The first step is to check for the stationarity of the original variables and then test cointegration between them. According to Granger (1986), the test is valid if the variables are not cointegrated. Second, the results of Granger causality are very sensitive to the selection of lag length. If the chosen lag length is less than the true lag length, the omission of relevant lags can cause bias. If the chosen lag length is more, the irrelevant lags in the equation cause the estimates to be inefficient. To deal with this problem Hsiao (1981) has developed a systematic autoregressive method for choosing optimal lag length for each variable in an equation. This method combines Granger causality and Akaike's Final Prediction Error (FPE), defined as the (asymptotic) mean square prediction error1.

Both the cointegration technique and Hsiao's version of Granger causality tests, were employed to determine the causal relationship between GDP and transport, GDP and various components of transport (road, air and rail), and finally between employment and transport. The basic model relates economic growth (or employment) to transport. The model is:

$$\log Y = f(\, log X_i) \qquad (3)$$

Where Y is GDP (or employment) and X is transport. All the variables are in per capita log form. The relevant data were available for the period 1980-2016 from National Bureau of Statistics. The procedures to estimate the model are discussed below.

Cointegration

The concept of cointegration among the variables can be defined in simple words as follows. Two or more variables are said to be cointegrated if they share common trends i.e. they have long run equilibrium relationships. The technique of cointegration involves three steps. The first step requires a determination of the order of integration of the variables of interest. We have for this purpose used two popular tests: namely Dickey – Fuller (DF) and Augmented Dickey Fuller (ADF) test based on Ho: X_T is not I (0) which are given by the following equations.

$$(DF)\Delta X_t = \alpha + \beta X_{t-1} + \varepsilon_t \qquad (4)$$

Where X_t denotes the variables GDP, total transport, employment, road (ROT), air (AIT), rail (RAT). All the variables are real and in log form. Δis the difference operator, α and β are parameters to be estimated.

$$(ADF)\Delta X_t = \alpha + \beta X_{t-1} + \sum_{i=1}^{\gamma} \delta \Delta X_{t-1} + \varepsilon_t \qquad (5)$$

α, β, and δ are the parameters to be estimated and where γ is selected such that ε_t is white noise. The tests are based on the null hypothesis (Ho) is: $X_t$is not I(0), If the calculated DF and ADF statistics are less than their critical values from Fuller's table, then the null hypothesis (Ho) is rejected and the series are stationary or integrated or order one i.e. I(1).

In the second step we estimate cointegration regression using variables having the same order of integration. The cointegration equation estimated by the OLS method is given as:

$$Y_t = \alpha_0 + \alpha_1 X_{ti} + Z_t \qquad (6)$$

Where Y_t is per capita real GDP and X_{ti} is the ith component of transport. For the employment equation Y_t is employment and X_t is transport growth.

In the third step residuals Z_t from the cointegration regression are subjectedto the stationarity test based on the following equations.

$$(DF)\ \Delta Z_t = \alpha + \beta_0 Z_{t-1} + V_t \qquad (7)$$

$$(ADF)\ \Delta Z_t = \alpha + \beta_0 Z_{t-1} + \sum_{i=1}^{K} \beta_1 \Delta Z_{t-1} + V_t \qquad (8)$$

Where, Z_t is the residual from equation 6. The null hypothesis of non-stationarity is rejected if β is negative and the calculated DF or ADF statistics is less than the critical value from Fuller's table. That means there is a long run stable relationship between the two variables and causality between them is tested by the error correlation model. On the other hand, if the null hypothesis of non-stationarity is rejected and the variables are not cointegrated then the standard Granger causality test is appropriate.

Hsiao's granger causality

Studies like Thornton and Batten (1985), Hwang et. al.(1991) and Chang and Lai (1997) have found Hsiao's Granger Causality test more robust than both arbitrary lag length selection and other systematic methods for determining lag length. Hsiao's procedure involves two steps: The first step follows a series of autoregressive regressions on the dependent variables. In the first regression, the dependent variable is lagged once. In each succeeding regression, one more lag on the dependent variable is added. The M regressions we estimated are of the form.

$$d(Y_t) = \alpha + \sum_{i=1}^{m} \beta_1 d(Y_t) + \varepsilon_{1t} \qquad (9)$$

Where, the value of i is from 1 to m, the choice of lag length is based on the sample size and underlying economic process. It is better to select m as large as possible. As the transportation sector has a long gestation period, especially construction and maintenance in Nigeria, we have set maximum m = 10. Then we computed the FPE for each regression in the following way:

$$\mathrm{FPE(m)} = \frac{\mathrm{T+m+1}}{\mathrm{T-m-1}}\, ESS^{(m)}/_{T} \qquad (10)$$

Where T is sample size and FPE and ESS are the final prediction error and the sum of squared errors respectively.

The optimal lag length, m*, is the lag length which produces the lowest FPE. In the second step, once m* has been determined, regressions are estimated with the lags on the other variable added sequentially in the same manner used to determine m*. Thus we estimate ten regressions of the form;

$$d(Y_T) = \alpha + \sum_{i=1}^{m*} \beta\, d(Y_{t-1}) + \sum_{j=1}^{N} \gamma\, d\big(Y_{t-j}\big) + \varepsilon_{2t} \qquad (12)$$

Where, j ranges from 1 to 10. We then compute FPE for each regression as:

$$\mathrm{FPE}(\mathrm{m}*, \mathrm{n}) = \frac{\mathrm{T} + \mathrm{m}* + 1}{\mathrm{T} - \mathrm{m}* - 1}\, ESS^{(m*, n)}/_{T} \qquad (13)$$

We choose the optimal lag length for X, n* as the lag length which produces the lowest FPE.

To test for causality FPE (m*) which excludes the X variable is compared with FPE m*, n* which contains the X variable in the model. If FPE (m*) < FPE (m* n*) Þ transport (X_t) does not Granger cause GDP (Y_t) on the other hand FPE (m*) >F (m*n*) (X_t) Granger causes$Y$. Once the test is performed with GDP (Y_t) as the dependent variable a similar test with transport$X_t$as the dependent variable is done.
To test the causality from GDP to transport, all these regressions are repeated for every component of transport with GDP and also for employment and transport.

RESULTS
The results of our estimations are presented step by step and are as follows:

Test for unit roots
The degree of integration of each variable involved has been determined in our analysis, based on equations 3 and 4 for both DF and the ADF test statistics respectively. The results are reported in table 1. In the level form, both the DF and ADF class of unit root tests are rejected for all the variables except that for employment.
However, both the tests reject the null hypothesis of non-stationarity for all the variables when they are used in the first difference. This shows that, except for employment, all the series are stationary in the first difference, and integrated of order I (1).

Test for cointegration
The variables which have been tested for the order of integration and found to have the same order are used to estimate cointegration regression. Table 2 reports the results of the DF and ADF tests applied to the residuals of the cointegration equations based on equation 5 and given in equations 6 and 7. The absolute values of the calculated test statistics for all the residuals are less than its critical value at the5 per cent level. Neither of the series is cointegrated. Therefore the standard Granger test (Granger, 1969) is appropriate.

Hsiao's version of granger causality test

By following the estimations based on equations 8 to 11, we are able to reach the results of Hsiao's Granger causality test reported in table 3. The results indicate that economic growth causes transport growth as shown by the total transportation, where F (m*) >F(m*, n*).

Table 1. Unit root test Results

	Levels		*First Difference*	
Variables	*DF*	*ADF*	*DF*	*ADF*
GDP	-2.32	-2.61	-5.88*	4.57**
TRN	-2.14	-2.17	-5.61*	-4.14**
ROT	-0.63	-0.43	-6.94*	-4.68*
AIT	-1.82	-1.44	-4.70*	-4.86*
RAT	-1.3	-1.66	-4.54*	-3.81*
EMP	-4.40*	-4.05**	–	–

GDP = Gross Domestic Product
TRN = Total Transportation
ROT = Road Transport
AIT = Air Transport
RAT = Rail Transport
EMP = Employment
All the variables are in per capita log form.
* Significant at 1 per cent
** Significant at 5 per cent

Table 2. Cointegration results

Variables	*DF*	*ADF*
GDP, TRN	-3.84	-3.17
GDP, ROT	-2.56	-2.61
GDP, AIT	-2.77	-2.72
GDP, RAT	-3.26	-3.06

The critical values for DF and ADF for 1 per cent and 5 per cent are -4.74 and -4.03 respectively. The absolute values of the calculated test statistics in the table are less than the critical values which indicates acceptance of the null hypothesis of No-Cointegration.

Also, by observing the road equation we see that economic growth leads to road transport growth and not vice versa. On the other hand, for the rail sector, the results show neither economic growth nor rail sector affecting each other. However, the results reported for total transport and GDP states that total transport leads to economic growth with feedback. The table also indicates that road transport causes employment but not conversely as shown in the employment equation. Where F(m*) > F(m*, n*), the lag of 6 in the employment equation may be indicative of the labour intensity of the road sector especially those of small businesses where demand for employment is high.

Some logical inferences could be drawn from the below results. It seems that increased economic activity causes growth in transportation and since goods and services largely transported is also affected by growth in GDP. While rail transport does not by itself affect GDP and vice versa, but since persons involves in these sector are mostly traders and working class citizens, it may have its effect on GDP through reduction in aggregate output which is stimulating economic growth in

Nigeria. Moreover, as economic growth is boosting transportation the later is also causing generation of employment in the economy as well.

Table 3. Results of Hsiao's version of the causality tests

	F(m*)	F(m*, n*)	
The GDPEquation	0.42978×10^3 (1)	$< 0.44228 \times 10^3$ (1)	Transport does not cause economic growth
The Transport Equation	0.12942×10^2 (1)	$> 0.12450 \times 10^2$ (1)	Economic growth cause transport growth
The GDP Equation	0.42978×10^3 (1)	$< 0.44767 \times 10^3$ (1)	Road transportdoes not cause economic growth
The Road Equation	0.19450×10^2 (1)	$> 0.18264 \times 10^2$ (1)	Economic growth causes Road transport
The GDP Equation	0.42978 x 103 (1)	$< 0.45231 \times 10^3$ (1)	Rail transportdoes not cause economic growth
The Rail Equation	0.44478×10^2 (9)	$< 0.47236 \times 10^2$ (1)	Economic growth does not cause Rail transport
The GDP Equation	0.42978 x 103 (1)	$> 0.41632 \times 10^3$ (1)	Air transport causes economic growth
The Air Equation	0.35503×10^2 (9)	$< 0.37793 \times 10^2$ (1)	Economic growth does not cause Air transport
Employment Equation	0.33001×10^3 (6)	$> 0.32612 \times 10^3$ (1)	Total transport cause employment
Total Road Equation	0.12942 x 102 (1)	$< 0.13415 \times 10^2$ (1)	Employment does not cause transportation

The values in parenthesis are the optimum lags.

CONCLUSION AND POLICY RECOMMENDATIONS

In this paper we attempted to find the direction of the causal relationship between transport and economic activity in Nigeria. More specifically the paper investigated the casual relationship between growth in transportation and growth in GDP. Additionally, to explore the possibility of further information on the direction of causality we disaggregated transportation into its components of road, air and rail transport. Subsequently, causality was sought for employment and transportation. The methodology was based on the Granger causality test which has been found appropriate by using the cointegration technique and finding out that there is no cointegration between the variables concerned. For selection of optimum lag length Hsiao's version of Granger causality tests was used which employ differenced data and the FPE criterion.

The estimated results infer that economic growth causes total transportation growth. Further investigation indicates that economic growth leads to the growth in road transport, while in the case of the rail transport, neither economic growth nor rail transport effect each other. However, in the air transport it has been found that air transportation leads to economic growth with feedback.

Finally, transport growth also directly causes employment. The total transport has a positive and statistically significant relationship with economic growth. This implies that increasing transport network would increase economic growth.

The paper has important policy implications. The implications of the study suggest that transport policy regarding road transport would not lead to any adverse side-effects on economic growth in Nigeria, whereas transport policy in the case of air and rail, should be adopted in such a way that, growth in these sectors stimulates economic growth. Such growth would lead to expansion of employment opportunities in the country. Since Nigeria places a high priority on controlling unemployment and ensuring full employment of economic resources for the growth of the economy.

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