INFRASTRUCTURE AND AGRICULTURAL GROWTH IN NIGERIA[1]

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Abstract

The study considered infrastructure and agricultural growth in Nigeria using a time series data for over four decades and the Parsimonious Error Correction Model estimation technique. It was found that various performance indicators with respect to physical infrastructure used for the study have not been encouraging in Nigeria. The provision of infrastructure in Nigeria, particularly physical infrastructure is characterized by the predominance of public enterprises except for telecommunications sector in recent time. The empirical part of the study revealed different relative response rates of the different component of infrastructure used in the study to the growth of the agricultural sector in Nigeria. There was unidirectional causality between telecommunication facilities and agricultural production. The same result was found between labour and agricultural production. It was recommended that the sectoral specific effects of the various forms of infrastructure should be taken into consideration when designing policy for promoting agricultural growth in Nigeria.

Key Words: Infrastructure, Growth of Agriculture and VAR
JEL: H54, O13

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1. Introduction

The major focus of infrastructure investment has been on irrigation, transportation, electric power, agricultural markets etc. These not only contribute to agricultural growth at macro level but also to the wide disparity between different regions with respect to the growth of agriculture (Venkatachalam, 2003). World Bank (1994) in the 1994 World Development Report defined infrastructure in a narrow way as long lived engineered structures, equipment and facilities as well as the services they provide that are used in economic production and by households. The agricultural sector plays a dominant role in alleviating poverty and overall growth of the economy. In other words, the level of infrastructure in agricultural sector is one of the major factors that could explain regional imbalances in the growth of the agricultural sector (Venkatachalam, 2003). Agricultural related infrastructures are expected to reduce farmers' costs and accelerate growth in agriculture (e.g., Antle, 1983).

The growth of agriculture in Nigeria has not been encouraging because of falling labour input, particularly because of high rural – urban labour force migration. Another reason is deficient transport infrastructure like road which is a vital determinant of low technological adoption, cropping choices and of low agricultural productivity in developing countries (Antle, 1983; Zeller, Diagne and Mataya, 1998). On the other hand, price policies, with respect to transport pricing might create distorting signals. For example, Ahmed and Hussein (1990) showed that the fertilizer use in agriculture sector increases with the improvement in the quality of the roads.

At macro level, the relationship between infrastructure and the growth of agriculture is still not clear for Nigeria. For example, it is natural to expect that aggregate agricultural growth is positively related to infrastructure development. However, how to strengthen such a relationship at the operational level remains debatable. A conventional approach in this regard is to estimate an aggregate production function of agriculture as done in (Mundlak *et al*., 2004; Bravo-Ortega and Lederman, 2004).

This paper therefore aims to empirically determine the impact of infrastructure on the growth of the agricultural sector in Nigeria using the parsimonious error correction estimate. Since it is not only infrastructure that may affect agricultural production, the effect of labour was also tested jointly with the infrastructure variables in order to test if labour exhibits decreasing returns to scale in agricultural production contrary to previous studies for Nigeria. Section two dwells on literature review on infrastructure and agricultural growth, section three discussed infrastructure development in Nigeria while section four considers agricultural sector in the Nigerian economy. Section five explains the model and results while section six explains the policy implication of results and conclusion.

2. Literature on infrastructure and agricultural growth

Generally, evidences showed that public investment in infrastructure- specifically, in the rehabilitation of rural roads, improves local community and market development. For example, rehabilitation of rural roads raises male agricultural wages and aggregate crop indices in poor villages of Bangladesh (Khandker et al. 2006). Also, in Vietnam, the result is an increase in the availability of food and the wages of agricultural workers (Mu and van de Walle, 2007). Furthermore, other studies found that access to new and improved roads in rural areas enhance opportunities in non-agricultural activities in Peru (Escobal and Ponce, 2002) and in non-farm activities among women in Georgia (Lokshin and Yemtsov, 2005). In Nigeria, Egbetokun (2009) used infrastructural index on the sampled village level data in Oyo State by summing the individual cost of access (TCi) to the some eight basic infrastructure elements in the study area. It was found that provision of infrastructures served as incentives for increased economic efficiency and productivity of the rural dwellers. The study further showed that rural infrastructures are very crucial to the growth of agriculture in the study area. Poor access to infrastructural facilities like health centers, educational institutions, communication gadget, and water supply all leads to a low agricultural production.

Jacoby (2000) using data from Nepal showed that there is a negative relationship between farmland value and its distance to agricultural markets. As indicated by this author, if farmland behaves like any asset, its price would equal the net present value of the benefits its cultivation generates and therefore this relationship - between farmland value and distance to agricultural markets – is an indicator of the capital gains generated by the improvement of road infrastructure.

As cited by Pinstrup – Andersen and Slimokama (2006), in one of the technical background documents for the World Food Summit held about a decade ago, it was concluded that "Roads, electricity supplies, telecommunications and other infrastructure services are limited in all rural areas, although they are of key importance to stimulate agricultural investment and growth" (Food and Agriculture Organization of the United Nations, 1996). The document further put forward that "Better communications are a key requirement. They reduce transportation cost, increase competition, reduce marketing margins and in this way can directly improve farm incomes and private investment opportunities". This conclusion is supported by several studies of infrastructure in developing countries like Antle 1984; Binswanger, Khandker, and Rosenzweig 1993; Fan, Hazell, and Thorat 2000; as well as Fan and Zhang, 2004). These studies showed that investment in infrastructure is essential to increase farmers' access to input and output markets to stimulate the rural non-farm economy. It also facilitates the integration of less-favoured rural areas into national and international economies.

Fan, Hazell, and Thorat (2000) found that public investment in rural roads has a large positive impact on agricultural productivity growth in India. Fan and Zhang (2004) presented one of the most careful econometric analyses in this area. They controlled for the reverse causality problem by employing a dynamic GMM method. According to their estimates, investments in roads and irrigation significantly contribute to agricultural growth. At the same time, agricultural growth induces a much larger demand effect on irrigation than on roads. This may be because irrigation is sector-specific infrastructure and thus its demand is more directly influenced by agricultural growth while the demand on roads depends on several other factors besides agricultural growth.

Fan and Chan-Kang (2005) documented that the quality of infrastructure is an important determinant of agricultural growth and poverty reduction in China. Market integration over space and time requires good infrastructure and effective market institutions. Where spatial market integration is poor, favourable local growing conditions, improved production practices or adoption of modern technologies that result in increasing marketable surpluses may result in drastic drops in local prices while other areas may suffer from deficits and rapidly increasing prices. For example, according to Pinstrup-Andersen (2002), maize prices in Ethiopia tripled from 1997-1998 to 1999- 2000 followed by an 80 % drop from 1999-2000 to 2000-2001. In Malawi, the price of maize quadrupled between April 2001 and April 2002. The supply response by small farmers is also seriously affected by the state of infrastructure and market. Chhibber (1988) found that a one percent increase in output prices would result in a supply response of 0.3% - 0.5% in areas with poor infrastructure and 0.7% - 0.9% in areas with good infrastructure.

The farmers' willingness to adopt productivity-enhancing technology depends very significantly on the infrastructure and market situation with which they are faced. Hazarica and Alwang (2003) documented that credit constraint negatively influence plot size while Groppenstedt, Demeke and Meschi (2003) documented that it negatively affected fertilizer use. On the other hand, Freeman, Ekhin, and Jabbar (1998) concluded that it negatively affect total productivity. Binswanger, Khandker and Rosenzweig (1993) showed that private banks are more likely to be located in areas with better road infrastructure and marketing systems.

Temel and Maru (2007) assessed infrastructure and use of Information and Communication Technology (ICT), such as radio, television, printing press, telephony, fax, computers, and the internet in national agricultural research organizations in Georgia. It also identified their needs to improve information flow and management. The study concluded that Georgia has a well-established radio and television broadcasting network, but its linkage with agricultural development, especially with extension, is extremely weak. ICT infrastructure in Georgian agricultural organizations and agricultural research system is extremely poor compared to that of their Western counterparts. Lalli (2007) study evaluated the importance of infrastructure in agricultural development in Haryana, the spatial dimensions in its distribution over time as well as the interlinkages in agricultural facilities available in the state. It was found that agricultural infrastructure is a necessary but not a sufficient condition for development in agriculture, implying the role of some other factors in the process of development. It was found that disparities in the distribution of agricultural infrastructure tended to result in inequalities in the agricultural productivity. Furthermore, a decline in disparities in its distribution tended to narrow down inequalities in agricultural productivity among the districts and delineated productivity regions.

Limi and Smith (2007) in their study concluded that aggregate agricultural growth is expected to be accelerated by public infrastructure provision. Though, the potential infrastructure impact may vary across commodities. The estimation results indicated that agricultural production could be promoted by different infrastructures, depending on commodity. For example, according to them, roads and irrigation facilities could strengthen production efficiency in the coffee and cocoa industries. Telecommunications infrastructures are also important for branding these commodities. Conversely, dairy production requires more water in rural areas.

3. Stylized fact on some infrastructure development in Nigeria

The state of infrastructure in Nigeria has remained a matter of concern given its importance in the growth of agriculture and in the overall economic well being of the populace. However, various performance indicators with respect to these physical infrastructure facilities point to the fact that their performance has not been encouraging. The provision of infrastructure in Nigeria is characterized by the predominance of public enterprises (Central Bank of Nigeria, 2003).

The Nigeria road system is classified into four broad categories. These are; the Federal Trunk 'A' Roads; these are under federal government ownership and they are developed and maintained by the federal government. The Federal Trunk 'F' Roads were formerly under state ownership but were taken over by the Federal Government with a view to upgrading them to federal highway standards. The Trunk 'B' Roads are under the ownership and management of the component states. The Trunk 'C' Roads are under the local government ownership and management. Each tier of government has the responsibility for planning, construction and maintenance of the network of roads under its jurisdiction. While the federal government controls 17% of the total roads network in Nigeria, the state government controls 16% while the local government authority controls 67% (Central Bank of Nigeria 2003).

Until the early 1980s, the telecommunications sector was viewed as quintessential public utility. Economies of scale combined with political sensitivity created large entry barriers and externalities (Jerome, 2003). Beginning from the 1980s however, policy makers gradually began to recognize that telecommunications system is an essential infrastructure for the growth of the agriculture and the entire economy. As the economy broadens and becomes critically dependent on vastly expanded flows of information, telecommunications acquires strategic importance for agricultural growth hence, overall economic growth and development. Following the commercialization of Nigeria Telecommunications Limited in 1992 which was quickly followed by deregulation, the federal government of Nigeria through the promulgation of Nigerian Communications Commission (NCC) Decree No.75 of 1992 introduced private participation in the provision of telecommunication services in Nigeria.

According to the Federal Republic of Nigeria (2006), by 2005, the transmission network consisted of 5000 km of 330 kV lines and 6000 km of 132 kV lines. The 330 kV lines fed 23 substations of 330/132 kV rating with a combined capacity of 6,000 MVA at utilizing factor of 80%. In turn, the 132 kV lines fed 91 sub - stations of 132/133 kV rating with a combined capacity of 7,800 MVA or 5,800 MVA at utilization factor of 75%. The distribution grid consisted of 23,753 km of 33 kV lines and 19,226 km of 11 kV lines. These in turn fed 679 sub – stations of 33/11 kV rating and 20,543 sub stations of 33/0.415 kV ratings. Also, there were 1,790 distributed transformers and 680 injection transformers.

Federal Republic of Nigeria (2006) further documented that Power Holdings Company of Nigeria's business operations are inefficient. The system suffers from chronic under - investment, poor maintenance, un-recorded connections and under - billing arising from a preponderance of un-metered connections (this has been presently reduced as a result of the introduction of pre-paid meter by the federal government of Nigeria).

4. Agricultural sector in the Nigerian economy

Agricultural sector in Nigeria covers the main fields of primary production in terms of crops, livestock, forestry, wildlife and fisheries. During the 1980s, the sector employed on the average, about 80% of the country's working population. It has constituted a significant but declining proportion of gross national product. In the 1950s and 1960s in Nigeria, agriculture was the leading sector in terms of contribution to gross domestic product. In 1960, the country was still largely an agricultural country with the sector accounting for approximately 64% of output as well as employing over 73% of the total labour force. It was the major foreign exchange earner used to pay for imported capital/ manufactured goods. However, the discovery of crude oil in commercial quantity brought about reduction in agricultural share of gross domestic product; from a gross domestic product share of almost 64% in 1960 to about 49% in 1969. Between 1980 and 1989 it fell to an average of 33.4%.

Agriculture's contribution to gross domestic product between 1990 and 1997 averaged 29.34% (Iyoha, 2003). This clearly shows that agriculture contribution's to gross domestic product has been on the downward trend particularly since the early 1970s. Generally, there had been a lack of consistency in the growth performance of the agricultural sector in the 1981-2000 periods, with some evidence of unstable or fluctuating trends, probably due to inconsistencies in policies and policy implementation in the period.

Also, overall food supply has been on the downward trend, probably because of low productivity. To make up for the shortfall in food supply, Nigeria resorted to massive importation of some food items. For example, while Nigeria spent about N400.05 million between 1962 and 1970, it spent about N11,288.532 million between 1971 and 1985 on food importation. In 1981, the nation's food import bill rose to N2,115 million. It decreased to N843.2 million in 1984. The overall consequence of this was that huge amount of foreign exchange that would have been used for accumulating capital was used for food importation.

In terms of export earnings, agricultural exports accounted for 86% of total exports in 1955 - 59, 80% in 1960 - 64 and 57% between 1965 - 69. Part of the decline in 1965 - 69 may have been due to destructions in production caused by civil war of 1967 - 70 (Aigbokhan, 2001). Aigbokhan further observed that from 1970, the decline became very dramatic and this coincided with the evolution of the petroleum sector as the country's main export commodity. In the 1970 - 74 periods, agriculture accounted for 26% of total exports, thereafter, it accounted for less than 10%, being 5.7% in 1975 - 79, 2.7% and 5.6% in `1980 - 84 and 1985 - 89 respectively. In 1990, it fell to the lowest level at 1.8% before some recovery in 1994 - 98 to 8.6%.

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6. Theoretical framework model estimation, results and analysis

The study adopted the Barro (1990) framework with slight modification by assuming the production function has the Cobb - Douglas technology form as:

$$Y_t = A_t K_t^{\alpha} G_t^{\beta} L_t^{1-\alpha-\beta} \quad (1)$$

Where: t is time trend chronologically.
Y = Aggregate output from agricultural sector,
A = Technical progress,
K = Capital stock,
G = Infrastructure,
L = Labour force.

Being constant returns to scale means that capital has to grow along with one type of infrastructure. From (1), the respective marginal products of G and K are given as;

$$\frac{\partial Y_t}{\partial G_t} = \beta A_t K_t^{\alpha} G_t^{\beta-1} L_t^{1-\alpha-\beta} \succ 0 \quad (2)$$

$$\frac{\partial Y_t}{\partial K_t} = \alpha A_t K_t^{\alpha-1} G_t^{\beta} L^{1-\alpha-\beta} \succ 0 \quad (3)$$

The respective marginal products from (2) and (3) show that K is enhanced by infrastructure (G), just as the productivity of G is enhanced by capital stock (K). Given the assumption that infrastructure provision is financed by a flat rate tax on total output (Y) from agricultural sector in (1), the budget constraint can be represented as:

$$G_t = \tau_t Y \quad (4)$$

Where τ is tax rate, G_t and Y_t are as earlier defined. Equation (4) constraints the government to run a balanced budget which is not likely to hold for a developing country like Nigeria. That is the government can neither finance deficits by issuing debt nor run surpluses by accumulating assets. Theoretically, a proportional tax on output affects Given the assumption that infrastructure provision is financed by a flat rate tax on total output (Y) from agricultural sector Let the capital accumulation identity be specified as:

$$K_t = (1-\delta)K_{t-1} + I \quad (5)$$

where δ represents depreciation of capital and assuming depreciation of capital is zero, (5) can be re – arranged to get:

$$\Delta k = k_t - k_{t-1} = I \quad (6)$$

For simplicity, assume a constant savings rate and that capital fully depreciates each period, infrastructure for the next period is a proportion of total savings so that:

$$G_{t+1} = \tau Y_{t+1} \quad (7)$$

Therefore from (7), investment in capital stock is determined by:

$$K_{t+1} = (1-\tau_t)sY \qquad (8)$$

Substituting capital accumulation equations (7) and (8) into equation (1) produces a difference equation for the evolution of growth rate of output from the agricultural sector:

$$(Y)_{t+1} = A_{t+1}s^{\alpha+\beta}(1-\tau_t)^{\alpha}\tau_t^{\beta}(Y)_t^{\alpha+\beta}(L_{t+1})^{\alpha+\beta} \qquad (9)$$

Assuming the evolution of technical progress is A_t, the share of investment going to infrastructure is τ_t, and size of labour force is L_t and assuming that each of these is determined by an exogenous stochastic process, total agricultural productivity can be modeled as:

$$a_t = a_0 + \sigma_t + \varepsilon_t \qquad \textbf{(10)}$$

where $\varepsilon_t = \delta\varepsilon_{t-1} + \omega_t$ for some $0 \leq \delta \geq 1$, and ω_t is a stationary random variable with $W[\omega_t] = 0$. Equation (10) implies that total agricultural productivity depends on a constant a_0, a trend growth rate of growth σ and a random term that is stationary if $\delta \prec 1$ and non – stationary if $\delta = 1$. While the driving force in the exogenous growth model is technical process, in the endogenous growth model, there is possibility that shocks to infrastructure have permanent effect on the level of growth of the agricultural sector. Furthermore, the sign of this permanent effect may be positive or negative depending on whether $\bar{\tau}$ has been set above or below the tax rate that maximizes expected growth from agriculture.

Empirical model

In reality, the relationship between infrastructure and the growth of the agricultural sector is likely to be more complex than the simple production function modeled. In line with our theoretical model and the studies of Canning and Pedroni (1999), Esfahani and Ramirez (2003) as well as Fedderke, Perkins and Luiz (2005), an equation for the empirical part of the study is specified in error correction form as:

$$\Delta LAGR_t = C_o + \sum_{j=1}^{M} \beta_i \Delta LG_{t-i} + \beta_i \Delta LLBR_{t-i} + ECM_{t-i} + \varepsilon_t \qquad \textbf{(11)}$$

Where L before a variable is the log of that variable and sub – script t is time trend in chronological order and Δ before a variable is the first difference of that variable, M is the lag length;

AGR = Growth rate of agricultural GDP (Proxy for growth of the agricultural sector)

C_o = constant term

G = Vector of physical infrastructure variables

LBR = labour force

ECM = Error correction term

ε = error term

The data were obtained from, Olayide (1976) and Central Bank of Nigeria Statistical Bulletin (2004), Vol. 15. Road infrastructures proxied by total length of roads in Nigeria were obtained from Olayide (1976), Canning David World Infrastructure Data Base (2005) and World Bank African Data Base (2005).

Stationarity test

The Augmented Dickey Fuller (ADF) [Dickey and Fuller, 1979] test was used to test for the stationarity of the variables. The ADF test is of the form:

$$\Delta \lambda_t = \delta \lambda_{t-i} + \beta_i \sum_{i=1}^{n} \delta_i \Delta \lambda_{t-i} + \varepsilon_t \qquad \textbf{(12)}$$

Where: λ_t is our variable of interest; Δ is the difference operator; t is the time trend and ε_t is the white noise residual of zero mean and constant variance; $(\delta_1, \delta_2, \beta_1, ..., \beta_m)$ is a set of parameter to be estimated.

Table 1: ADF test for stationarity

Variable	ADF Test-Statistic	Critical Value 1%	Remark
$LAGR$	-2.238356	-4.1837	Non-stationary
$\Delta LAGR$	-5.467513	-4.1896	I(1)
$LELEC$	-0.826020	-4.1837	Non-stationary
$\Delta LELEC$	-4.836835	-4.1896	I(1)
$LLRAD$	-2.2960613	-4.1837	Non-stationary
$\Delta LLRAD$	-4.136460	-3.5189 (5%)	I(1)
$LTELFAC$	-1.914396	-3.5889	Non-stationary
$\Delta LTELFAC$	-4.537138	-3.5930	I(1)
$LLBR$	-1.958253	-3.5889	Non-stationary
$\Delta LLBR$	-4.751795	-4.1896	I(1)

Note: The entire statistic is individually significant at 1% except LLRAD

The ADF result shows that all the variables were not stationary at their levels but stationary at first difference.

Cointegration test and result

The Johansen and Juselius (1990) multivariate Cointegration test was used by formulating the VAR model below:

$$\lambda_t = \Gamma_i(L)\lambda_{t-i} + \ldots + \Gamma_p(L)\lambda_{t-p} + \varepsilon_{t-p} \qquad \textbf{(13)}$$

Where λ_t is also our variable of interest; a column vector and $\Gamma_i(L)$ with $i = 1,\ldots,p$ is a lag operator; ε is the white noise residual of zero mean and constant variance. The order of lag of the model p is determined by Akaike Information Criterion (AIC).

Table 2: Cointegration results

Sample: 1960 2004

Included observations: 43

Series: LAGR LELEC LLRAD LTELFAC LLBR

Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.638466	104.3197	87.31	96.58	None **
0.468135	60.57153	62.99	70.05	At most 1
0.274216	33.42278	42.44	48.45	At most 2
0.233523	19.64116	25.32	30.45	At most 3
0.173719	8.205264	12.25	16.26	At most 4

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 1 cointegrating equation(s) at 5% significance level

The result revealed one cointegrating vector. Since it has been ascertained that the variables are non-stationary at level but stationary after differencing ones, and they are cointegrated, we can formulate an error correction model. Error correction is necessary because, it helps to recover the long run information lost by differencing the variables.

Parsimonious error correction estimation

From Table 3 below, adopting the general to specific framework, an over parametized error correction model of equation twelve is estimated. Following Hendry's (1995) general to specific modeling using four lags for each of the explanatory variable, the insignificant variables were gradually eliminated from the general form of the ECM equation. The parsimonious error correction estimation was obtained as below given this process.

Table 3: Result from the Error Correction Model

Dependent Variable: D(LAGR)
Method: Least Squares
Sample(adjusted): 1965 2004
Included observations: 40 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.886441	2.930324	2.008802	0.0564
D(LELEC(-3))	-0.933139	0.376964	-2.475407	0.0211
LLRAD	-0.754374	0.369194	-2.043299	0.0526
D(LLRAD)	0.595613	0.529621	1.124602	0.2724
D(LLRAD(-4))	1.606691	0.670444	2.396460	0.0251
D(LTELFAC)	0.583900	0.675834	0.863969	0.3965
D(LTELFAC(-1))	-2.982692	0.831854	-3.585595	0.0016
D(LTELFAC(-3))	2.180013	0.656681	3.319743	0.0030
D(LTELFAC(-4))	1.861727	0.684435	2.720095	0.0122
LLBR	-1.521884	0.906169	-1.679472	0.1066
D(LLBR)	-0.318334	0.349126	-0.911803	0.3713
D(LLBR(-1))	1.611959	0.434370	3.711026	0.0011
D(LLBR(-3))	-1.112958	0.341987	-3.254390	0.0035
D(LLBR(-4))	-0.974677	0.356600	-2.733252	0.0118
LLBR^2	0.176929	0.104696	1.689936	0.1046
LAGR(-1)	-0.143913	0.112747	-1.276418	0.2145
ECM(-1)	-0.600759	0.141410	-4.248338	0.0003

R-squared	0.736982	Mean dependent var	0.038755
Adjusted R-squared	0.554013	S.D. dependent var	0.135843
S.E. of regression	0.090719	Akaike info criterion	-1.665478
Sum squared resid	0.189290	Schwarz criterion	-0.947704
Log likelihood	50.30955	F-statistic	4.027903
Durbin-Watson stat	2.095665	Prob(F-statistic)	0.001254

From Table 3, the R-squared value revealed that about 74% variation in agricultural production is explained infrastructural variables and labour while the F-statistic shows that the all the variables put together jointly significant at 1% level of significance in the determination of agricultural output in Nigeria. This implies that components of infrastructure used for the study have joint effect on the growth of the agricultural sector in Nigeria. The result further reveals that the error correction coefficient is statistically significant and it has the expected negative sign. It suggests a high speed of adjustment to long run equilibrium and therefore confirms the validity of long run equilibrium relationship between agricultural growth and the selected infrastructure and labour in Nigeria.

Table 4: Granger causality result

Pairwise Granger Causality Tests
Sample: 1960 2004

Null Hypothesis:	Obs	F-Statistic	Probability
LLRAD does not Granger Cause LAGR	44	0.86796	0.35697
LAGR does not Granger Cause LLRAD		1.05124	0.31123
LTELFAC does not Granger Cause LAGR	44	4.56785	0.03859
LAGR does not Granger Cause LTELFAC		0.00886	0.92545
LLBR does not Granger Cause LAGR	44	4.16880	0.04764
LAGR does not Granger Cause LLBR		0.01231	0.91221
LTELFAC does not Granger Cause LLRAD	44	0.03322	0.85627
LLRAD does not Granger Cause LTELFAC		0.64489	0.42658
LLBR does not Granger Cause LLRAD	44	0.05992	0.80784
LLRAD does not Granger Cause LLBR		0.69831	0.40819
LLBR does not Granger Cause LTELFAC	44	0.05928	0.80886
LTELFAC does not Granger Cause LLBR		0.04148	0.83963

Specifically, the lag value of electricity supply though significant had contrary sign. It shows that it has an inverse relationship with agricultural output. This may result from non usage of agricultural specific infrastructure for the estimation. As expected, telecommunication infrastructure has a positive relationship and significant, though with a delayed effect. The third and fourth lag values of labour are significant with a delayed effect in the determination of agricultural production, though, with a negative sign. The one period lag value of agriculture was not significant and also with a contrary sign. This may imply that the previous year had poor harvest and this would seriously discourage people from farming in the current period. Surprisingly, the result further shows that labour is subject to increasing returns to scale rather than decreasing returns to scale. The recursive residual, Cusum and Cusum of square plots show that the estimation is stable and can therefore be used for prediction purposes.

The result shows that there is unidirectional causality between telecommunication facilities and agricultural production with causality from telecommunication facilities to agricultural production. Causality also runs from labour to agricultural production but not the other way round.

7. Conclusion and policy implications of results

The result shows different relative response rates of the different infrastructure to the growth of the agricultural sector in Nigeria. A useful policy implication of the result is that in designing agricultural sector's policy, emphasis should be placed on the provision of roads, and telecommunications facilities; though, both will only impact on the agricultural sector after some time.

In conclusion, without efficient provision and maintenance of these infrastructures, the agricultural sector in Nigeria may be unable to contribute significantly to overall economic growth; a large portion of the population will be relegated to poverty, hunger and human misery. Even if there has been mixed empirical results on the relationship between infrastructure and the growth of the agricultural sector, the usefulness of infrastructure to the growth and development of the agricultural sector cannot be overemphasized.

References

Ahmed, R. and M. Hossain. 1990. Developmental Impact of Rural Infrastructure in Bangladesh. *International Foods Policy Research Institute, IFPRI. Research Report 83*. Washington D.C.

Aigbokhan B. E. 2001. *Resuscitating Agricultural Production (Cocoa, Cotton, Ground nut, Palm oil, Rubber etc) for Export.* A Paper Presented at the 10th Annual Conference of Zonal Research Unit of the Central Bank of Nigeria on the theme Resource Endowment, Growth and Macro-economic Management, Owerri June 4th – 8th

Antle, J. M. 1983. Infrastructure and Aggregate Agricultural Productivity: International Evidence *Economic Development and Cultural Change.*

Antle, J. M. 1984. Human Capital, Infrastructure and the Productivity of Indian Rice Farmers. *Journal of Development Economics.* No. 14. pp 163 – 181.

Barro, R. J. 1990. Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy* Vol. 98, No.5, pp 5103 - 5125. October.

Bravo-Ortega, C. and D. Lederman. 2004. Agricultural Productivity and its Determinants: Revisiting International Experiences. *Estudios de Economía*, Vol. 31, pp. 133-163.

Binswanger, H. P., S. R. Khandker, M. R. Rosenzweig. 1993. How Infrastructure and Financial Institutions Affect Agricultural Output and Investment in India. *Journal of Development Economics*. No. 41. pp 337- 366.

Calderon, C and L. Serven. 2008. Infrastructure and Economic Development in Sub – Saharan Africa. *World Bank Policy Research Working Paper* No. 4712. The World Bank Development Research Group Macro-economics and Group Team, September

Canning, D and P. Pedroni. 1999. *Infrastructure and Long Run Economic Growth* CAER II Discussion Paper No. 57. Harvard Institute of International Studies. December

Central Bank of Nigeria. 2003. *Highway Maintenance in Nigeria: Lessons from other Countries.* Research Department; Occasional Paper No. 27.

Chhibber, A. 1988. Raising Agricultural Output: Price and Non Price Factors. *Finance and Development*. Vol. 25. No. 2. pp 44 – 47.

Dickey, D. A. and W. A. Fuller. 1979. Distribution of the Estimators for Autoregressive Times Series with a Unit Root. *Journal of American Statistical Association* Vol. 74, pp 427 – 431.

Egbetokun, O. A. 2009. Provision of Rural Infrastructure Oyo State, Nigeria. Agricultura – Ştiinţă şi practică nr. 1-2 (69-70]/2009

Escobal, J. and C. Ponce. 2000. *The Benefits of Rural Roads: Enhancing Income Opportunities for the Rural Poor* Group of Analysis for Development (GRADE) Working Paper No. 40, November.

Esfahani, H. and M. T. Ramirez. 2003. Institutions, Infrastructure and Economic Growth. *Journal of Development Economics.* No.70 pp 443 – 477.

Fan, S. P., P. Hazell, S. Thorat. 2000. Government Spending, Growth and Poverty in Rural India. *American Journal of Agricultural Economics.* Vol. 82, No. 4. pp 1038 – 1051

Fan, S. and X. Zhang. 2004. Infrastructure and Regional Economic Development in Rural China. *China Economic Review.* No. 15. pp 203 – 214.

Fan, S. and C. Chan – Kang. 2005. *Road Development, Economic Growth and Poverty Reduction in China.* International Food Policy Research Institute Report 138.

Fedderke, J. W., P. Perkins and J. M. Luiz. 2005. *Infrastructure Investment in Long – Run Economic Growth: South Africa: 1875 - 2001*. Paper presented at the 10th African Econometric Society in South Africa. July

Federal Republic of Nigeria. 2000. *National Telecommunications Policy*.

Federal Republic of Nigeria. 2006. *Federal Ministry of Power and Steel: Renewable Electricity Policy Guidelines* www.iccednigeria.org

Food and Agricultural Organization of the United Nations. 1996. *Technical Background Documents 6 – 11, Vol. 2*. World Food Summit; FAO, Rome.

Freeman, H. A., S. K. Ekhin, M. A. Jabbar. 1998. Credit Constraints and Smallholder Daily Production in the East African Highlands: Application of Switching Regression Model. *Agricultural Economics.* No. 19. pp 33 – 44.

Groppenstedt, A., M. Demeke, M. M. Meschi. 2003. Technology Adoption in the Presence of Constraints: The Case of Fertilizer Demand in Ethiopia. *Review of Development Economics.* Vol. 7. No. 1: pp 58 – 70.

Hazarica, G. and J. Alwang. 2003. Access to Credit, Plot Size and Cost Efficiency among Small Holders Tobacco Cultivators in Malawi. *Agricultural Economics* No. 29: pp 99 – 109.

Hendry, D. F. 1995. *Dynamic Econometrics* Oxford University Press, Oxford.

Iyoha, M. A. 2003. An Overview of Leading Issues in the Structure and Development of Nigerian Economy since 1960. In Iyoha, M.A. and G.O. Itsede (ed) *Nigerian Economy, Structure, Growth and Development* pp 3 - 28.

Jacoby, H. C. 2000. Access to Markets and the Benefits of Rural Roads, *Economic Journal*, No.110, pp. 713 - 737.

Jerome, A. 2003. *Public Enterprise Reform in Nigeria Evidence from the Telecommunications Industry* African Economic Research Consortium (AERC) Research paper 129, AERC, Nairobi, Kenya, March.

Johansen, S. and K. Juselius. 1990. Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics* Vol. 521, pp 169 -210.

Khandker, S. R., Z. Bahkt and G. B. Koowal. 2006. The Poverty Impact of Rural Roads: Evidence from Bangladesh. *World Bank Policy Research Working Paper* No 3875, April.

Lalli, S. A. 2007. *Infrastructure and Agricultural Development in Haryana--Policy Implications* New Delhi, Research India

Limi, A. and J. W. Smith. 2007. What is missing between Agricultural Growth in Infrastructure Development? Cases of Dairy in Africa. *World Bank Policy Research Working Paper No. 4411*. November.

Lokshin, M. and R. Yemtsov. 2005. Has Rural Infrastructure Rehabilitation in Georgia Helped the Poor? *The World Bank Economic Review* No. 19 Vol. 2, pp 311-333

Mu, R. and D. van de Walle. 2007. Rural Roads and Poor Area Development in Vietnam. *World Bank Policy Research Working Paper* No. 4340, August.

Olayide, S. O. 1976. *Economic Survey of Nigeria (1960-1975).* Aromolaran Publishing Company Ltd, Ibadan, Nigeria.

Pinstrup – Andersen, P. and S. Shimokawa. 2006. *Rural Infrastructure and Agricultural Development.* Paper Prepared for Presentation at the Annual Bank Conference on Development Economics, Tokyo, Japan. May 29th – 30th.

Pinstrup – Andersen, P. 2002. Food and Agricultural Policy for Globalizing World: Preparing for the Future. *American Journal of Agricultural Economics*. Vol. 25, No. 2. pp 1201 – 1214.

Temel, T. and A. Maru. 2007. Georgia ICT Infrastructure and Use in Agriculture Agricultural Policy, Research and Education Organizations *http//srn.com/abstract=986496*

World Bank. 1994. *World Development Report 1994: Infrastructure for Development: Word Development Indicators* Washington D.C. The World Bank.

Zeller, M., A. Diagne and C. Mataya. 1998. Market Access by Small Holder Farmers in Malawi. Implication for Technological Adoption, Agricultural Productivity and Crop Income. *Agricultural Economics. Special Issue*.

Appendices

Table A1: Cointegration result

Sample: 1960 2004

Included observations: 43

Series: LAGR LELEC LLRAD LTELFAC LLBR

Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.638466	104.3197	87.31	96.58	None **
0.468135	60.57153	62.99	70.05	At most 1
0.274216	33.42278	42.44	48.45	At most 2
0.233523	19.64116	25.32	30.45	At most 3
0.173719	8.205264	12.25	16.26	At most 4

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Unnormalized Cointegrating Coefficients:

LAGR	LELEC	LLRAD	LTELFAC	LLBR	@TREND(61)
-1.325731	-0.596990	-0.223951	3.879140	-1.977223	0.040815
-0.681456	0.368422	1.909520	3.533008	-1.886071	-0.014284
-0.021857	-1.929884	0.703494	4.004075	-2.050792	0.031263
0.436122	-0.240564	2.759573	0.434534	-0.135693	-0.056426
0.005989	-0.036350	-3.094463	-1.404249	0.787033	0.040119

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

LAGR	LELEC	LLRAD	LTELFAC	LLBR	@TREND(61)	C
1.000000	0.450310	0.168927	-2.926039	1.491421	-0.030787	-7.154748
	(0.18241)	(0.40490)	(0.45694)	(0.23645)	(0.00752)	
Log likelihood	264.8527					

Normalized Cointegrating Coefficients: 2 Cointegrating Equation(s)

LAGR	LELEC	LLRAD	LTELFAC	LLBR	@TREND(61)	C
1.000000	0.000000	-1.181183	-3.952335	2.071395	-0.007272	-0.001096
		(0.96560)	(1.06070)	(0.56837)	(0.01260)	
0.000000	1.000000	2.998179	2.279087	-1.287944	-0.052220	-15.88606
		(2.09126)	(2.29723)	(1.23096)	(0.02729)	
Log likelihood	278.4271					

Normalized Cointegrating Coefficients: 3 Cointegrating Equation(s)

LAGR	LELEC	LLRAD	LTELFAC	LLBR	@TREND(61)	C
1.000000	0.000000	0.000000	-2.432676	1.250701	-0.020004	-4.717659
			(0.37277)	(0.20410)	(0.00354)	
0.000000	1.000000	0.000000	-1.578240	0.795211	-0.019902	-3.914084
			(0.47181)	(0.25832)	(0.00448)	
0.000000	0.000000	1.000000	1.286557	-0.694807	-0.010779	-3.993084
			(0.33994)	(0.18612)	(0.00323)	
Log likelihood	285.3179					

Normalized Cointegrating Coefficients: 4 Cointegrating Equation(s)

LAGR	LELEC	LLRAD	LTELFAC	LLBR	@TREND(61)	C
1.000000	0.000000	0.000000	0.000000	-0.175724	0.002722	-2.992376
				(0.08411)	(0.02096)	
0.000000	1.000000	0.000000	0.000000	-0.130207	-0.005158	-2.794777
				(0.04893)	(0.01220)	
0.000000	0.000000	1.000000	0.000000	0.059579	-0.022798	-4.905526
				(0.03164)	(0.00789)	
0.000000	0.000000	0.000000	1.000000	-0.586360	0.009342	0.709212
				(0.03141)	(0.00783)	
Log likelihood	291.0359					

Figure 1: Stability Test Results

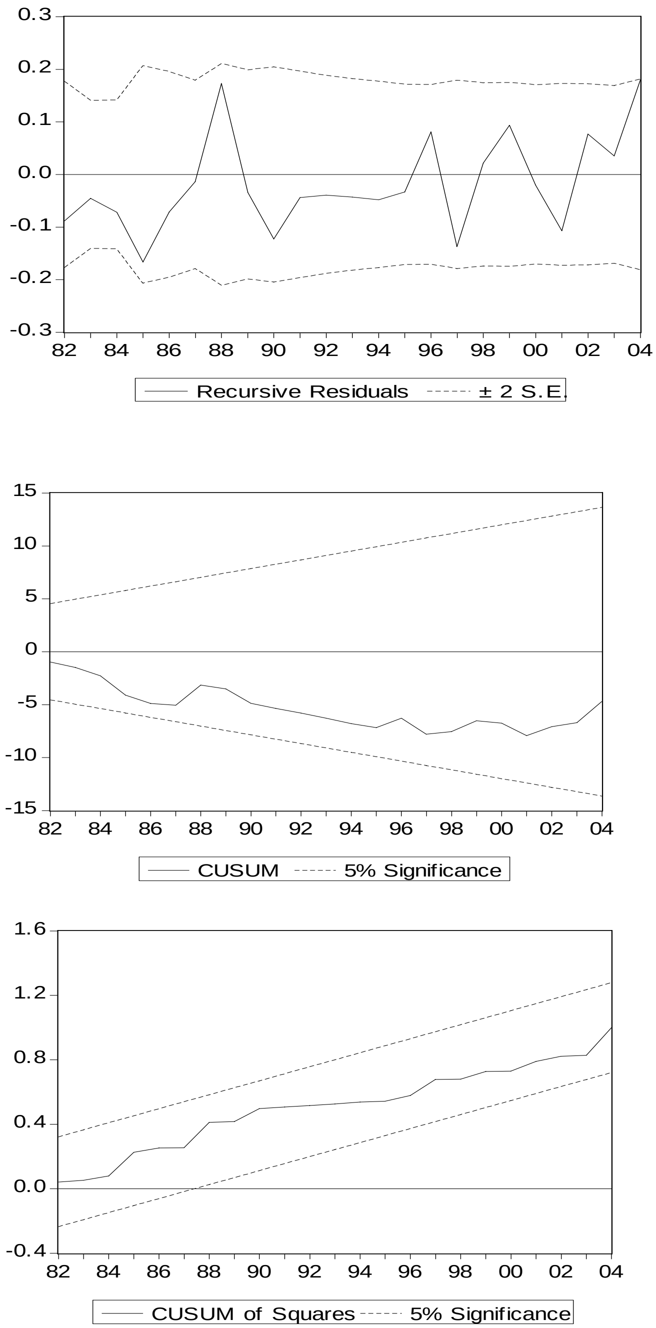

Table A2: General/Overparameterized Error Correction Model

Dependent Variable: D(LAGR)
Method: Least Squares
Date: 10/17/11 Time: 22:34
Sample(adjusted): 1965 2004
Included observations: 40 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.244826	58891.28	-2.11E-05	1.0000
LELEC	0.596467	12106.89	4.93E-05	1.0000
D(LELEC)	0.006702	12106.89	5.54E-07	1.0000
D(LELEC(-1))	0.157965	0.474636	0.332813	0.7446
D(LELEC(-2))	1.980576	0.497840	3.978335	0.0016
D(LELEC(-3))	0.830102	1.061939	0.781685	0.4484
D(LELEC(-4))	0.863225	0.694028	1.243790	0.2355
LLRAD	-0.129676	48147.46	-2.69E-06	1.0000
D(LLRAD)	0.120773	48147.46	2.51E-06	1.0000
D(LLRAD(-1))	-0.497679	0.635225	-0.783468	0.4474
D(LLRAD(-2))	-0.595286	0.565720	-1.052262	0.3118
D(LLRAD(-3))	-0.831627	0.666779	-1.247230	0.2343
D(LLRAD(-4))	2.203179	0.676229	3.258038	0.0062
LTELFAC	0.112845	123309.4	9.15E-07	1.0000
D(LTELFAC)	-0.036138	123309.4	-2.93E-07	1.0000
D(LTELFAC(-1))	-5.180762	1.386048	-3.737794	0.0025
D(LTELFAC(-2))	-0.779193	1.252347	-0.622186	0.5446
D(LTELFAC(-3))	2.383619	0.853498	2.792765	0.0152
D(LTELFAC(-4))	1.652826	0.595307	2.776426	0.0157
LLBR	-0.111172	65150.52	-1.71E-06	1.0000
D(LLBR)	0.072707	65150.52	1.12E-06	1.0000
D(LLBR(-1))	2.883644	0.737651	3.909224	0.0018
D(LLBR(-2))	0.525279	0.687749	0.763767	0.4586
D(LLBR(-3))	-1.143123	0.448733	-2.547445	0.0243
D(LLBR(-4))	-0.838984	0.305037	-2.750434	0.0165
LAGR(-1)	-0.038083	39797.28	-9.57E-07	1.0000
ECM(-1)	-0.915925	39797.28	-2.30E-05	1.0000

R-squared	0.917077	Mean dependent var	0.038755
Adjusted R-squared	0.751231	S.D. dependent var	0.135843
S.E. of regression	0.067754	Akaike info criterion	-2.319790
Sum squared resid	0.059678	Schwarz criterion	-1.179796
Log likelihood	73.39579	F-statistic	5.529699
Durbin-Watson stat	2.423979	Prob(F-statistic)	0.001192

Table A3: Data used in Log Form

obs	LAGR	LELEC	LLRAD	LTELFAC	LLBR
1960	3.153449	2.627067	4.771455	0.000000	1.244277
1961	3.165897	2.743231	4.817565	0.000000	1.255273
1962	3.206718	2.810141	4.820031	0.000000	1.266467
1963	3.224015	2.887210	4.858988	0.000000	1.277838
1964	3.224792	2.962178	4.864547	0.000000	1.289366
1965	3.228349	3.022453	4.900433	0.000000	1.300813
1966	3.251492	3.076560	4.935240	0.000000	1.302114
1967	3.233757	3.114204	4.951129	0.000000	1.313867
1968	3.237192	3.189490	4.964260	0.000000	1.325516
1969	3.241497	3.056306	4.966456	0.000000	1.325516
1970	3.252222	3.125136	4.969574	3.160000	7.354416
1971	3.531402	3.208390	4.972619	3.180000	7.365057
1972	3.553312	3.281013	4.975707	3.230000	7.375755
1973	3.525278	3.365241	4.982416	3.240000	7.386570
1974	3.511415	3.423937	5.009634	3.240000	7.397558
1975	3.527978	3.539515	5.012078	3.240000	7.408732
1976	3.670140	3.613440	5.014508	3.250000	7.419989
1977	3.707288	3.673261	5.021189	3.260000	7.431444
1978	3.645830	3.660780	5.025777	3.340000	7.443122
1979	3.554221	3.794174	5.028876	3.390000	7.455012
1980	3.596017	3.853723	5.033384	3.410000	7.467060
1981	4.388469	3.890779	5.034649	3.450000	7.478855
1982	4.399367	3.931036	5.036749	3.480000	7.490815
1983	4.398100	3.940168	5.036988	3.500000	7.502782
1984	4.376566	3.953450	5.036988	3.510000	7.514534
1985	4.443954	4.009498	5.041314	3.520000	7.525951
1986	4.482252	4.032038	5.042576	3.530000	7.537088
1987	4.468198	4.051747	5.044540	3.550000	7.547996
1988	4.508842	4.066479	5.044540	3.540000	7.558721
1989	4.633198	4.107654	5.046495	3.560000	7.569292
1990	4.547494	4.129139	5.048830	3.560000	7.579784
1991	4.562562	4.151266	5.049761	3.560000	7.592021
1992	4.571393	4.171838	5.050457	3.570000	7.604442
1993	4.577271	4.161506	5.052309	3.560000	7.616948
1994	4.587626	4.191199	5.233681	3.560000	7.629542
1995	4.603197	4.200210	5.286007	3.560000	7.642316
1996	4.620588	4.210661	5.286007	3.490000	7.655167
1997	4.638441	4.207282	5.287018	3.590000	7.667518
1998	4.655657	4.179264	5.287130	3.570000	7.679382
1999	4.676635	4.206521	5.287802	3.580000	7.690754
2000	4.690031	4.168114	5.287802	3.590000	7.701628
2001	4.706389	4.189294	5.287802	3.560000	7.713087
2002	4.729413	4.333326	5.287802	3.570000	7.724571
2003	4.740363	4.304990	5.288987	3.580000	7.736094
2004	4.774984	4.305330	5.288987	3.580000	7.743510