Infrastructure and Agricultural Value Chain in Nigeria: 1981-2019, Vector Error Correction Mechanism (VECM) Approach

Femi Augustine Akomolafe[1], Joseph Acheneje Atabo[2], Olabode Agunbiade[3], and Jibril Ebenezer Landu[4]

[1]Federal University of Kashere, Gombe State

[2,3,4]University of Abuja, Abuja

Email: austinesq@yahoo.com, atabojoseph5@gmail.com, bodeagun@gmail.com, and ebenezer.landu@gmail.com

***Abstract*—** Mechanism (VECM). The data were collected from CBN and World Development Indictor on agricultural Value chain, infrastructure, exchange rate and trade openness. The Augmented Dickey Fuller (ADF) and Phillip Peron (PP) unit root test results confirmed that all the variables were stationary at first level difference, i. e I (1) and Johansen Co-integration test established long-run relationship among the variables. The Toda-Yamamoto test established a two-way or bi-directional causality between agricultural value chain and infrastructure in Nigeria. The results of VECM) showed that infrastructure and trade openness had significant and direct effect on agricultural value chain, while exchange rate had an inverse and significant effect on it. This implies that 1% increases in infrastructure and trade openness increase agricultural value chain by 52.6% and 6.1 units respectively. While, 1% increase in exchange rate decrease agricultural value chain by 11.7% on the average. Also, broad money supply was not statistically significant thus, implying that broad money supply had zero effect agricultural value chain over the period investigated. Hence, the study recommended that governments at federal, state and grass-root levels must declare state of emergency on infrastructure deficiency in the country by taking holistic approach through continuous and productive spending on infrastructural development. The holistic approach must include provision of some certain infrastructural facilities such as motorable roads for agricultural products, storage facilities at all levels of government, provision of farm equipment and communication that would encourage agricultural value chain in Nigeria.

***Keywords*—** Infrastructure, Agricultural Value Chain, Vector Error Correction Mechanism (VECM).

1.0 INTRODUCTION

Value chain is a series of activities or processes that aims at creating and adding value to an article (product) within it, analyzing the opportunity cost of the new sequence along the product worth (Lee, Szapiro, and Mao, 2018). Importantly, agricultural value chain reduces poverty to the large extent whereby majority of the population directly or indirectly depends on agriculture and connection between urban consumption and rural production is achieved through agricultural value chains thereby impact marketing and production systems (Mango, Mapemba, Tchale, Makate, Dunjana and Lundy; 2015). This is very critical in Nigeria, particularly for rural farmers who seek to extract more local value from agricultural products.

In a developing nation like Nigeria, public investment is one of the sharpest instruments through which the government can achieve its development objectives. Infrastructure investment both social infrastructure such as education and health and physical infrastructure such as roads, electrification, irrigation and research and development contribute significantly to agricultural productivity. Agricultural infrastructural investment has majorly focused on irrigation, transportation, electric power and agricultural markets. However, following the World Bank Report (1994), the definition of agricultural infrastructure was narrowed down to comprise long-lived engineered facilities and other services which include roads, electricity supplies and telecommunication. The relationship between infrastructural development and agricultural productivity can be seen in the fact that Agricultural related infrastructures are expected to reduce farmers cost in the course of value added and accelerate output and produce more employment opportunities in the agricultural sector with improvement in the quality of the roads (Adesina, 2017).

Furthermore, World Bank (2018) argued that roads, electricity supplies, telecommunication and other infrastructure are important stimulant to agricultural value chain and output, especially in rural areas. Literature indicate that rural infrastructure fosters physical connectivity and promotes better integration of rural and agriculture areas with growing urban markets, which, in turn are linked to the global trading markets, thereby stimulating economic growth and creating

poverty reduction opportunities in those areas (Andersen and Shimokawa 2007; World Bank 2005).
The inability of government to invest massively in infrastructure and ill-maintained irrigation systems, costly electricity, and rural roads in extremely bad condition, all of which have taken their toll in terms of lower productivity and lower level of welfare in agricultural value chain process in the rural areas (Chakwizira, Nhemachena, and Mashiri, 2010). Many studies have been conducted in Nigeria that focused on infrastructure, agricultural production and economic growth, however, the impact of infrastructure on agricultural value chain has not been given much attention. It is on this note this paper tends to examine infrastructure and agricultural value chain in Nigeria and to contribute to existing literature on the subject matter. Then the paper divided into five sections; section is the introduction, section two, three and four contain literature review, methodology and empirical results respectively. Finally, section five contains conclusion and recommendations.

2.0 LITERATURE REVIEW

In economic terms infrastructure often involves the production of public goods or production processes that support natural monopolies. Infrastructure means those basic facilities and services which facilitate different economic activities and thereby help in economic development of the country, education, health, transport and communication, banking and insurance, irrigation and power and science and technology are good examples of infrastructure. They do not directly produce goods and services but induce production in agriculture, industry and trade by generating external economies. Krishna and Ankita (2020) identified basic physical systems of business such as transportation, communication, sewage, water, and electric systems as basic examples of infrastructure.

Dempsey (2006) defined value chain approach as "a value chain is a supply chain or consisting of the input suppliers, producers, processors and buyers that bring a product from its conception to its end use". An effective value chain approach to development seeks to address the major constraints at each level of the supply chain rather than concentrating on just one group (e.g. producers) or on one geographical location (De Marchi., Giuliani and Rabellotti, 2018). Value is added along the chain which gives such product a competitive advantage in terms of quality and attracting a higher price at the market (Gereffi, 2018).

Aggregate theory of demand was propounded by Keynes (1936). The theory advocates a huge public spending is a national asset rather than a liability and continuous deficit spending is an essential tool to increase capital accumulation and steady state level of output per capita in an economy. In the Keynesian perspective the availability of the factors of production such capital, labour, land (agricultural) determines a nation's potential GDP, the amount of goods and services actually being produced and sold (real GDP) depends on how much demand exists across the economy. Hence, increase in public spending through more provision of infrastructural facilities is a national asset rather than a liability and the failure to invest in rural infrastructure would be a critical bottleneck for future growth in agricultural and economic output in developing countries. The theory is adopted for this study by reiterate the need for government intervention in provision of basic infrastructure to boost productive capacity of the economy.

Empirically, Obot, Osuafor, Nwigwe and Ositanwosu (2021) investigated agricultural policy on catfish value chain in Akwa Ibom State, Nigeria. The study adopted Policy Analysis Matrix (PAM) and Nominal Protection Coefficient (NPC) on tradable outputs and input technique. The findings from the result revealed that NPC on tradable outputs (NPCOs) were less than unity indicating that the catfish value chain industry in the study area was undervalued by ₦0.8/kg. Also NPC on tradable inputs were less than unity which showed that government support or subsidy maybe reducing tradable inputs cost for the catfish value chain industry by ₦0.8/kg and Effective Protection Coefficients (EPCs) were equally less than unity and faced taxation of ₦0.8/kg on value added resulting from employing domestic factors of production. This implied that value addition processes in the catfish value chain industry were not protected through policy intervention and that they faced a net tax of 0.92%.

Abdulkadir, Ibrahim, Hassan and Nasir (2020) analysed the effect of development of a web application on agricultural product value chain in Nigeria. The study found out that a web application coupled with other communication infrastructural facilities directly and significant influenced agricultural product value chain in Nigeria. The study concluded a web application has contributed significantly to growth of agricultural value chain in Nigeria.

In a related development, Eno, Michael and Irenonsen (2019) examined infrastructural and linkage in agricultural value chain in Cross River. The study used a proportionate sampling technique to analyzed hundred and thirteen (113) respondents that involved in agricultural activities within the area of study. The finding confirmed that infrastructures and building of

storage facilities had a direct and significant effect on agricultural value chain with each of them contributing 71.8 % and 62.7 % respectively. On the aspect of linkage in agricultural value chain, it was discovered that inadequate equipment and poor feedback mechanisms was identified.

Richardson, Johnson and Abah (2019) carried out a study on optimizing agricultural value chain in Nigeria. The study discovered that there has been under-utilization of agricultural value chain in the country which was attributed to poor infrastructural facilities in area like storage facility, poor road and poor communication system. Udemezue, Chinaka and Okoye (2019) investigated cassava value chain on economic growth and food security in Nigeria. The study revealed that cassava value chain had a direct and significant effect on economic growth with employment capacity of 70% of the nation's labour force; therefore, reducing poverty and ensure food security.

Martins, Samuel and Musa-Pedro **(2018) studied** the agricultural value chain and macroeconomic policy in Nigeria from 1981–2016. The study used Error Correction Model (ECM) technique. The ECM revealed that government expenditure and broad money supply had a significant and direct effect on the agricultural value chain as well as energy infrastructure. The study concluded that infrastructural facility such as energy, government expenditure on infrastructural facilities and money supply jointly influence agricultural value chain while Evbuomwan and Okoye (2018) analyzed effect of agricultural value chain financing on small scale farmers in Nigeria with Analyze of Variance (ANOVA) technique. The result revealed that accessibility to loan and other farm implement positively impact agricultural value chain. The study concluded that accessibility to small loan without too much interest rate couple with provision of other farm implement promotes agricultural value chain.

Abula and Ben (2016) examined the effect of public agricultural expenditure on agricultural output in Nigeria 1981–2014. The study used co-integration, granger causality tests and parsimonious error correction. The Johansen co-integration test established a long-run relationship between agricultural output, public agricultural expenditure, commercial bank loans to the agricultural sector, and interest rates in Nigeria. The results of the parsimonious error correction model displayed that public agricultural expenditure had a significant indirect effect on agricultural output, while that commercial bank loans to the agricultural sector and interest rate were non-significant.

Finally, Siyan and Adegoriola (2017) investigated the nexus between infrastructural development and Nigerian economic growth using data from 1981 to 2014. Vector Error Correction Model (VECM) was employed for the analysis and the results of their findings shows that, there is long run relationship between infrastructure development and Nigerian economic growth. VECM have the expected negative sign, and is between the accepted regions which is less than unity. It also shows a low speed adjustment towards equilibrium. Hence specifically, infrastructural development of road and communication show a positive relationship with the Nigerian economic growth for the period under review, while private investment, degree of openness and education produced negative relationship with economic growth.

3.0 METHODOLOGY

The study is fundamentally analytical and employed econometric technique to analyse the impact of infrastructure on agricultural value chain in Nigeria. The first step in the analysis of the study is to test for the stationarity of the variables with Augmented Dickey Fuller (ADF) and Phillip Perron (PP), long run relationship was determined with Johansen co-integration and Vector Error Correction Model (VECM) was employed. The basis for adopting the model is because it enables the investigation of dynamic interaction among endogenous variables in a stationary multivariate system without imposing a priori structural restrictions. The study used secondary data that were collected from CBN Statistical Bulletin (2019) and Word Bank Development Indicator, (2019).

Model Specification

The model for this study was built on Martins *et.al.* (2018) model and their paper examined macroeconomic policy and agricultural value chain in Nigeria. Therefore, the basic model for Martins *et al.* (2018) is given as;

$AVC = \beta 0 + \beta 1GE + \beta 2M\ 2 + \beta 3EN + \mu t$ ... . …… (1)

Where:

AVC = Agricultural value chain

GE = Government expenditure (Fiscal policy);

M2 = Broad money supply (monetary policy)

EN = Energy infrastructure (a control variable);

μ = Error term, respectively.

In this study, trade openness, exchange rate and capital expenditure on infrastructure by government and private were introduced. Thus, the model for this study is given as:

$AVC = \partial_o + \partial_1 INFE + \partial_2$ BMS $+\partial_3 EXC + \partial_4 TOP + \mu_t$……..... (2)

Where:
AVC = Agricultural Value Chain (Proxy as agriculture value added as a share of GDP %)
INFE = Infrastructure (Proxy as Capital Expenditure on infrastructure by Government and Private)
EXC= Exchange Rate (Yearly average official exchange rate of naira relative to US dollar (₦/$))
BMS= Broad money supply (It is measured as M_3/GDP %)
TOP = Trade openness (The sum of imports and exports of goods and services divided by GDP at constant prices)
The related *a priori* expectations are: $\partial_1 > 0, \partial_2 > 0, \partial_3 < 0$ *and* $\partial_4 > 0$

Justification of the Variables in the model, measurements and Sources

- ***Agricultural Value Chain (AVC):*** Agricultural value chain was included in the model as the dependent variable and also serves as the target variable. AVC is defined as value added to agricultural product like maize, cassava, vegetables, cotton etcetera or vegetables or cotton from obtaining inputs and production in the field to the consumer, through stages such as processing, packaging, and distribution. It is measured as agriculture value added as a share of GDP. The data was sourced from World Bank Development Indicator, 2019.
- ***Infrastructure (INFE):*** This involves total expenditure incurred by government and private organization in providing infrastructural facilities that include energy, communication, road transportation, water transportation, air way transportation and utilities. It entered our model as a policy variable. It is measured as capital expenditure on infrastructure by Government and Private Bodies as a share of GDP percentage and sourced from World Bank Development Indicator, 2019.
- ***Exchange rate (EXC):*** Infrastructural investment is not only carried out by government, in some instance foreign aids and foreign investments are directed towards infrastructural development. Foreign aids and foreign investment are majorly in foreign currency and they are converted into local currency (Naira). Therefore, exchange rate was included in the model to capture the average official exchange rate of naira relative to US dollar or other foreign currency. The variable was measured in yearly average official exchange rate of naira relative to US dollar (₦/$) and sourced from CBN Statistical Bulletin 2019.
- ***Broad money supply (BMS):*** Broad money supply was included in the model based on Martins et *al* (2012) model. In this study, Broad money supply acts as proxy for monetary policy. It is measured as M_3/GDP % and CBN Statistical Bulletin 2019.
- ***Trade Openness (OPEN):*** This variable was included in the model because of the theory assumption of the neo-classical growth theory that assumes free-trade. Since foreign investor also involved in infrastructure; therefore, they must open their economy to receive investment in that area. It was measured by sum up imports and exports of goods and services divided by GDP in constant prices and sourced from CBN Statistical Bulletin 2019.

4.0 EMPIRICAL RESULTS

Summary Statistics

Table 1: *Summary Statistics*

	AVC	INFE	BMS	EXC	TOP
Mean	23.16857	3.174943	15.18527	94.25879	0.160513
Median	22.12331	2.603608	12.73591	102.1052	0.110000
Maximum	37.51699	9.383714	25.15527	306.9206	0.480000
Minimum	11.77383	0.644016	9.151674	0.610025	0.000000
Std. Dev.	5.163881	1.891597	5.227400	92.86518	0.156238
Skewness	0.319831	1.084427	0.692518	0.806529	0.555627
Kurtosis	3.804570	4.318879	1.837442	2.846208	1.926327
Jarque-Bera	1.716814	10.47048	5.313533	4.266618	3.879946
Probability	0.423837	0.005326	0.070175	0.118445	0.143708
Sum	903.5744	123.8228	592.2254	3676.093	6.260000
Sum Sq. Dev.	1013.295	135.9693	1038.377	327709.8	0.927590
Observations	39	39	39	39	39

Source: Researcher's Compilation from E-view-9

The Table1 presents summary statistics for the data used in the study. The average values for AVC, INFE, BMS, EXC and TOP are given as 23.16857, 3.174943, 15.18527, 94.25879 and 0. 160513 respectively.The table also shows minimum and maximum value for each of the variable. All the variables are positively skewed and the value of Jarque Bera revealed that all the variables are normally distributed except INFE but central limit theorem rule out normally distributed assumption when average value is involved.

Covariance Analysis

Table 2: *Correlation Matrix*

Probability	***AVC***	***INFE***	***BMS***	***EXC***	***TOP***
AVC	1.000000				
INFE	0.130309	1.000000			
	0.0429				
BMS	-0.027629	-0.671147	1.000000		
	0.8674	0.0000			
EXC	0.178063	-0.597609	0.867432	1.000000	
	0.0278	0.0001	0.0000		
TOP	0.165705	-0.618824	0.837463	0.844973	1.000000
	0.0313	0.0000	0.0000	0.0000	

Source: Researcher's Compilation from E-view-9

Table 2 revealed that the agricultural value chain coefficient was in line years with the Pearson's correlation assumption that states that there must be a perfect and strong relationship between a variable and against itself (i.e. X1 against X1). The implication of this is that continuous increase in agricultural product is perfectly proportional to factors inputs. For infrastructure, it had a positive and low relationship with agricultural value chain with a coefficient value approximately to 0.1303 and *p*-value of 0.0429 statistically significant; this implies that increase in infrastructure brought about increase in agricultural value chain with a moderate degree level of association. By implication, increase in the basic infrastructural facilities within the environment influence stage of agricultural value chain such as processing, packaging, and distribution which all jointly contribute positively to agricultural products. Also, on broad money supply the *p*-value was greater than 0.05 & 0.1 significance level with a coefficient value approximate to 0.0276, implying a low level degree of association. The finding confirmed that broad money supply has no influence on agricultural value chain. The non-significance of the relationship may be as a result of low levels of financial development in developing countries Nigeria inclusive. In term of the degree of association between exchange rate and agricultural value chain, finding confirmed a moderate relationship between the duo with a coefficient value of 0.1781 and *p*-value less than 5%. This therefore, confirmed a direct relationship between the pair with exchange rate having greater effect on it. The finding implies that exchange rate appreciation in term of naira relative to US dollar (₦/$) encourages investment in agricultural sector which have a multiplier effect on agricultural product. Furthermore, a direct relationship was confirmed between trade openness and agricultural value chain with a low degree association with a *p*-value less than 5%. This established a positive relationship between them. From the correlation matrix above it was confirmed that relationship between the variables identified was not strong.

The Trend Analysis

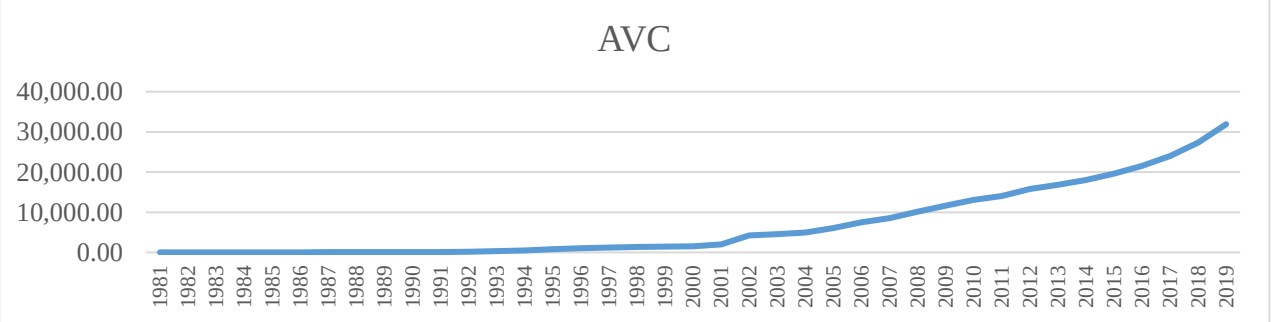

Figure 1A: *Trend of Agricultural Value Chain*
Source: Researcher's Compilation from Excel

Figure 1A shows the trend analysis of agricultural value chain from 1981- 2019. Nigeria's agricultural value chain in 1981 was 17.05 billion naira, in 1982 (20.13 billion naira) and 23.80 billion naira in 1983. This implies that from the initial value of 17.05 billion naira in 1981, it increased by an additional 6.75 billion naira within two years. This increase may be attributed to awareness on the need to encourage local production, controls and regulations of price and band of some certain imported goods. Nigeria's agricultural value chains kept maintain a stable increasing till 1986. As at 1986, it stood at 35.70 billion naira. Despite a new government in power in 1985 with a policies changed towards a desire to combine austerity with adjustment, it keep increasing. Between 1987 and 1995, agricultural value chain was increasing in a geometric progressive manner. As at 1987, 1989, 1990 and 1991 it was 50.29 billion naira, 73.76 billion naira, 88.26 billion naira, 106.63 billion naira, and 123.24 billion naira respectively. The geometric progressive in agricultural value chain could be attributed to acceptance of the IMF loan in 1986. For instance, one of the conditions for Structural Adjustment Programme (SAP) then was trade liberalization, deregulation, and liberalization of market which all together jointly influence productivity in agricultural policies.

Furthermore, from 1996 there was an upward surge in agricultural value chain. As at this period Nigerian agricultural value chain has started operating within the range of thousand. For instance, from initial value of 1,211.46 billion naira in 1996, it increased to 1,341.04 billion naira, 1,426.97 billion naira, 1,508.41 billion naira, 2,015.42 billion naira and 4,251.52 billion naira in 1997-2002. Also, from 2002-2007, agricultural value chain maintained a thousand unit and was 8,551.98 billion naira in 2007. In 2008, it entered tenth thousand units. As at 2008, it stood at 10,100.33 billion naira. This increase could be attributed to debt relief worth of $18 billion granted to Nigeria then by Paris Club on October 2005. Ever since then till 2019, agricultural value chain has maintained tenth thousand units with a stable increase. As at 2019, it stood as 31,904.14 billion naira.

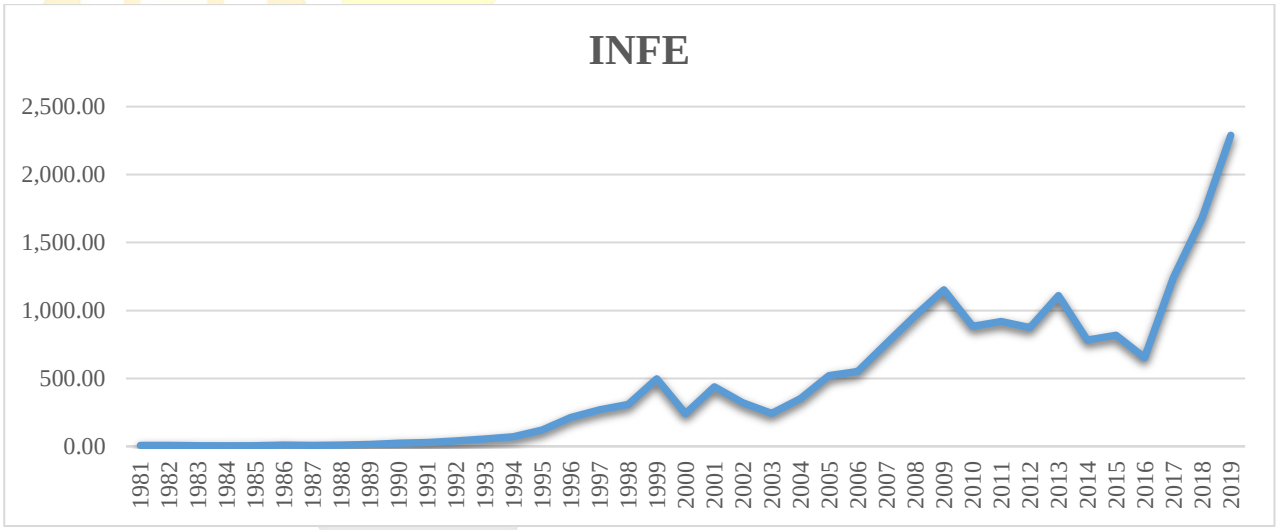

Figure 4.1.3B: *Trend of Infrastructure*
Source: Researcher's Compilation from Excel

Figure 1B shows the trend analysis of Nigeria's infrastructure from 1981- 2019. In 1981, it was 6.57 billion naira, from 1982-1985, there was a decline in Nigeria's infrastructure facility. For instance, it was 6.42 billion naira, 4.89 billion naira, 4.10 billion naira, 5.46 billion naira in 1982-1985. The continuous decline in it could be attributed to austerity measures taken by Nigerian government in 1982 and 1983, by relying heavily on controls and regulations rather than correcting the structural distortions; therefore, worsened the situation. With a new government in power in 1985, policies changed towards a desire to combine austerity with adjustment. Between 1985 and 1986, infrastructure increased by about 30.5% and stood as 8.53 billion naira. From 1987-1988, it was unstable, until 1989 when it started experiencing a stable increase. From 1989-1994, infrastructure was within the range of tenth unit. For instance, it was 70.92 billion naira in 1994. Also, 1995-2008, it was within the range of hundred units and remained stable during this period. In 2009, it stood as 1,152.80 billion naira fell back to 883.87 billion naira in year 2010. From 2010-2016 Nigeria's infrastructure remained unstable. In 2017, there was an improved in infrastructure spending within the country, in that year it was 1,242.30 billion naira. Also, 2018 and 2019, it was 1,682.10 billion naira and 2,289.00 billion naira respectively.

Unit Root Test

- ***Augmented Dickey Fuller (ADF) Unit Root Test***

Table 3A: *Results of Unit Root Test*

Test at Level					***Test at first level difference***			
Variable	*Test Statistic*	*5% critical value*	*Level*	*S/NS*	*Test Statistic*	*5% critical value*	*Level*	*S/NS*
AVC	/2.334002/	/2.945842/	I(0)	NS	/6.408627/	/2.945842/	I(1)	S
INFE	/1.418592/	/2.943427/	I (0)	NS	/9.103813/	/2.943427/	I(1)	S
BMS	/0.603556/	/2.941145/	I (0)	NS	/5.897836/	/2.943427/	I(1)	S
EXC	/1.393597/	/2.941145/	1(0)	NS	/4.263488/	/2.943427/	I(1)	S
TOP	/1.458310/	/2.941145/	I (0)	NS	/7.513553/	/2.943427/	I(1)	S
Where; S indicates Stationary; NS non Stationary								

Source: Researcher's Compilation from E-view-9

Table 3A shows the Augmented Dickey Fuller (ADF) result of test at level and test at first differences. The findings infered that all the five variables identified in the model that include agricultural value chain, infrastructure, broad money supply, exchange rate and trade openness were not stationary at level, i.e., I (0). Also, it was confirmed that all the variables were stationary at first level difference, i. e I (1). The economic implication of this finding is that at integrated of order (Δ = 1), other economics variables do not cause change among the variables identified in the model; therefore, become independent of themselves.

- ***Phillip Perron (PP) Unit Root Test***

Table 3B: *Results of Phillip Peron (PP) unit root test*

Test at Level					***Test at first level difference***			
Variable	*Test Statistic*	*5% critical value*	*Level*	*S/NS*	*Test Statistic*	*5% critical value*	*Level*	*S/NS*
AVC	/2.541187/	/2.941145/	I(0)	NS	/5.561380/	/2.943427/	I(1)	S
INFE	/2.220995/	/2.941145/	I (0)	NS	/9.103813/	/2.943427/	I(1)	S
BMS	/0.258145/	/2.941145/	I (0)	NS	/6.157350/	/2.943427/	I(1)	S
EXC	/1.336387/	/2.941145/	1(0)	NS	/4.165247/	/2.943427/	I(1)	S
TOP	/1.199248/	/2.941145/	I (0)	NS	/8.735068/	/2.943427/	I(1)	S
S indicates Stationary; while NS non Stationary								

Source: Researcher's Compilation from E-view-9

Table 3B shows the results of Phillip Peron (PP) unit root test. The Phillips-Perron test differs from ADF unit root because it provides a more robust test for serial correlation and time dependent heteroskedasticities of the stochastic process.

The PP was used because it uses the automatic bandwidth selection technique of Newey-West. The same conclusion was reached for all the variables, implying that all the variables that include agricultural value chain, infrastructure, broad money supply, exchange rate and trade openness were integrated of order one (Δ = 1).

However, since all the variables were integrated of the same order (Δ = 1), this established a prerequisite for the presence of long-run linear combination among them, and the need to examine a co-integration test for the variables.

Lag Order Selection

Table 4: *Lag Order Selection (Max 2)*

Lag	***LogL***	***LR***	***FPE***	***AIC***	***SC***	***HQ***
0	-433.4113	NA	13474.95	23.69791	23.91560	23.77465
1	-307.8048	210.4758	59.42857	18.25972	19.56587*	18.72020*
2	-278.7716	40.80332*	51.66986*	18.04171*	20.43632	18.88592
**** indicates lag order selected by the criterion***						

Source: Researcher's Compilation from E-view-9

In Table 4 above, majority of the criteria selector selected the maximum lag order of 2. Therefore, the study selected maximum lag order of 2 for the VECM

Toda-Yamamoto (TY) Causality Test

Table 5: *Toda-Yamamoto Result*

Dependent variable : AVC			
Variable	Chi-Sq	Df	Prob.
INFE	1.032620	2	0.0597*
All	1.032620	2	0.0597*
Dependent variable: INFE			
AVC	0.549573	2	0.0760*
All	0.549573	2	0.07560*
**** indicates statistically significant and rejection of the null hypothesis at 0.1 level***			

Source: Researcher's Compilation from E-view-9

The Toda-Yamamoto Test Table 5 reveals that agricultural value chain as dependent variable did granger cause infrastructure with a *p*-value less than 0.1 significance level.

This implies that the null hypothesis that states 'agricultural value chain does not granger because infrastructure was rejected at 0.1 significance level.

The economic implication of this finding is that contribution of agriculture sector to gross domestic product coupled with revenue from the sector jointly facilitate provision of infrastructure facilities.

Evidence of this may be seen from the graph in figure 1A from 2008-2019 when the aggregate agricultural value chain maintained tenth thousand units with a stable increase.

Also, Table 5 shows that infrastructure as dependent variable did granger cause agricultural value chain in the model at conventional level of 0.1 significance.

This implies that the alternative hypothesis that states that infrastructure does granger cause agricultural value chain was accepted.

This is possible because the *p*-value (*p*= 0.0597) was less than 0.1 significance level. The economic implication of this finding is that more spending on infrastructure facilities such as road, electricity, water, etc. by government coupled with corporate social responsibility of private institution jointly influence processing, packaging, and distribution of farm products. This implies a two-way or bi-directional causality between agricultural value chain and infrastructure in Nigeria.

Co-integration Result

Table 6: *Johansen Co-Integration Test*

Traces Statistics				
r = 0	*r = 1*	*r = 2*	*r = 3*	*r = 4*
90.78957 **(69.81889)** **{0.0005*}**	49.85691 (47.85613) {0.0320*}	26.60809 (29.79707) {0.1116}	7.495772 (15.49471) {0.5208}	0.027163 (3.841466) { 0.8690}
Max-Eingen Statistics				
r = 0	*r = 1*	*r = 2*	*r = 3*	*r = 4*
40.93266 **(33.87687)** **{0.0061*}**	23.24882 (27.58434) { 0.1631}	19.11232 (21.13162) {0.0936}	7.468609 (14.26460) {0.4353}	0.027163 (3.841466) {0.8690}
**** denotes rejection of the null hypothesis at the 0.05 level, Critical value at 5% level in ( ) , & Prob in { }***				

Source: Researcher's Compilation from E-view-9

The results from both Traces and Max-Eingen statistics established the presence of two co-integrating equation using the Traces statistics and one using Max-Eingen statistics.

Therefore, confirmed long-run relationship between the variables and the use of VEC. This implies that the set of identified co-integrated time series in the model have an error-correction that indicates the presence of the long run adjustment mechanism.

Given this, Dalina and Liviu (2015) reveal that VECM is a suitable technique for a model if there is the presence of co-integrating vectors among the set of variables in a model.

Vector Error Correction Estimates

Table 7: *Vector Error Correction Estimates*

CointEq1:	-0.093938 (0.04799) [-1.95745]	R^2 : 0.614511		
		Adj R^2squared: 0.437829		
		F-statistic : 3.478059		
Δ(AVC(-1))	**Δ (INFE(-1))**	**Δ (BMS(-1))**	**Δ (EXC(-1))**	**Δ (TOP(-1))**
0.183076 (0.08884) [2.06075**]	0.526846 (0.27446) [1.91957*]	-0.048068 (0.24323) [-0.19762]	-0.117677 (0.04044) [-2.90997**]	6.054298 (1.00301) [6.03613]
Standard errors in ( ) & t-statistics in [ ], t-value ($t_{0.05}$= 2.042, & $t_{0.1}$ = 1.697				
***** & * indicate statistically significant at the 0.05 and 0.1 level***				

Source: Researcher's Compilation from E-view

The findings from Table 7 shows that the lagged error correction ECM $_{(-1)}$ included in the model to capture the long run dynamics between the co-integrating series were correctly signed (negative) and statistically significant judging from the *t*-value.

The absolute estimated coefficient value of the lagged error correction ECM $_{(-1)}$ was 0.093938 with the absolute *t*-statistic (1.95745) greater than the *t*-value ($t_{0.1}$= 1.697) at 10 % level.

This finding implies that long run causality ruined from infrastructure, broad money supply, exchange rate and trade openness to agricultural value chain.

Hence, the term error relates to the fact that last period deviation from long-run equilibrium (the error) influences the short-run dynamics of the dependent variable.

In economic terms, the finding implies that the independent variables in the model jointly moved at the constant rate of 9.4% annually from disequilibrium that occurred from the short-run to long-run.

The result for agricultural value chain for one lagged period was significant with a direct effect. The *t*-statistic (2.06075) was greater than the *t*-value ($t_{0.05}$= *2.042*) at 5% significance level with a co-efficient value of 0.183076.

In economic term, this implies that increase in processing, packaging, and distribution of agricultural product within an economy in previous year, to a large extent influenced its increase in current year. Udemezue, *et al.* (2019) confirmed that cassava value chain had a direct and significant effect on economic growth with employment capacity of 70% of the nation's labour force; therefore, reducing poverty and ensure food security.

For the infrastructure, the finding confirmed a direct and statistically significant effect on agricultural value chain with *t*-statistic of 1.91957 and *t*-value of $t_{0.1}$= 1.697. The finding was in support of the formulated *a priori* expectations.

The estimated coefficient result of broad money supply was -0.048068 with the t-statistic (0.19762) which was less than the student t-test ($t_{0.05}$= 2.042 and $t_{0.1}$= 1.697) in absolute value.

This shows that broad money supply was not statistically significant at conventional level of 5% and 10% significance.

The exchange rate took on negatively signed co-efficient (-0.117677) and was statistically significant with table *t*-value ($t_{0.05}$= 2.042) less than the absolute *t*-statistic (2.90997) at 5% level.

The negative sign of the exchange rate was in line with the *a priori* expectation formulated for this study. Furthermore, trade openness was directly related to agricultural chain value and significance at 5% significance level.

From the finding, it was established that table *t*-value ($t_{0.05}$= 2.042, was less than the absolute *t*-statistic (6.03613).

Impulse Response Result

Figure 8: Impulse Response

Impulse response result is shown in the figure 8 to explain shock from one variable to others. The method of impulse response adopted in this study was multiple bar charts and the decomposition employed is Cholesky –SD adjusted method for five (5) years period. The impulse response result table shows the response of agricultural value chain, infrastructure, broad money supply, exchange rate and trade openness for the period of five (5) years. The response of agricultural value chain to broad money supply over five (5) year was largely positive; while, that of infrastructure, exchange rate and trade openness exhibited both negative and positive. Over five (5) years, exchange rate have a negative reaction on agricultural value chain and

positive in the fifth year; while, trade openness is largely negative throughout the five years. The economic implication of this finding is that over five years, total additional change to agricultural product would depend on volume of money in circulation couple with increase in infrastructural facility over five (5) year; while, its reduction over five years would be attributed to continuous decrease in exchange rate appreciation and trade openness holding all other variables constant.

The impulse response of infrastructure to agricultural value chain, broad money supply, exchange rate and trade openness over five (5) years exhibited both positive and negative. In the graph above, exchange rate and trade openness exhibited both negative and positive effect on infrastructure; while, broad money supply is in negative region throughout the five years. At the initial stage, both the exchange rate and trade openness exhibited negative sign but move to positive region after two and three years respectively. The implication of this finding is that both exchange rate and trade openness have the tendency to improve and cause decline in infrastructural spending. Impulse response result table shows the response of broad money supply over five (5) years. The response of agricultural value chain to broad money supply over five (5) years will operate majorly on negative region; while that of trade openness exhibited positive. The implication of this finding on broad money supply is that liberation of the economy by allowing free movement of goods and services increase the volume of money in circulation; while, others jointly increase or decrease it.

Impulse response result table shows the response of exchange rate over five (5) years. The response of exchange rate over five (5) years to agricultural value chain, and trade openness operate majorly on negative region; while that of infrastructure, broad money supply, and trade openness exhibited positive. The implication of this finding on exchange rate is that agricultural value chain, and trade openness jointly cause depreciation to exchange rate appreciation in Nigeria; while infrastructure and broad money supply contribute to its appreciation.

In addition, over five (5) years, agricultural value chain, infrastructure, broad money supply, and exchange rate exhibited both positive and negative effect on trade openness. In the first two years, agricultural value chain contributes positively to trade openness before moving to negative region; while, exchange rate starts to contribute positively in the second year. From the impulse response result, the contributions of all the selected variables positively and negatively influence trade openness.

Discussion of Results

This study examined the effect of infrastructure on agricultural value chain in Nigeria from 1981-2019 using Vector Error Correction Model (VECM).The coefficient of infrastructure (0.526846) was directly related to agricultural value chain and statistically significant at 10% significance level, judging from the absolute *t*-statistic of 1.91957 that was greater than *t*-value of $t_{0.1}$= 1.697. Statistically, this implies that 1% increase in infrastructure brought about 52.6% increases in agricultural value chain holding other variables constant. From the finding, it could be deduced that effect of infrastructure under the years in view was high judging from the obtained co-efficient, implying that such effect is strong. This finding corroborates the *a priori* expectations. The economic implication of this finding is that improvement on physical structures carried out by both public and private increase product of agricultural production through the connection of chain producing and delivering of goods to consumers in a sequence of activities. In Nigeria, studies conducted by Abdulkadir, *et al.* (2020), Eno, *et al.* (2019), and Udemezue, *et al.* (2019) confirmed our finding. In their separate studies, they found positive and significant relationship exist between infrastructure and agricultural value chain through increase in agricultural productivity. Accordingly, Nigeria's agricultural sector, a multifaceted approached is needed such as a comprehensive spending on infrastructural facility, innovation, cooperation and market power, in order to promote agricultural value chain.

The result of broad money supply showed an indirect coefficient (-0.048068) and non-significance effect on agricultural value chain judging from the *t*-statistic (0.19762) which was less than the student *t*-test ($t_{0.05}$= 2.042 and $t_{0.1}$= 1.697) in absolute value. This implies that total volume of money in circulation within Nigeria for period under investigation do not influence productivity of range of goods and services product in agricultural sector. This finding negated the formulated *a priori* expectation. The exchange rate had an inversely co-efficient (-0.117677) and statistically significant with *t*-value ($t_{0.05}$= 2.042) less than the absolute *t*-statistic (2.90997) at 5% level. Statistically, the finding implies that holding other variables constant, 1% increase in exchange rate led to 11.7% decrease in agricultural value chain. The negative sign of the exchange rate conformed with the *a priori* expectation formulated for this study. From the finding, the estimated coefficient of trade openness was 6.054298 and statistically significance at 5% conventional level. This finding was in line with the formulated *a priori* expectation. The economic implication of this finding was that change in

import of goods and services couple with export of oil and non-oil had a significance influenced on agricultural products.

5.0 CONCLUSION AND RECOMMENDATIONS

This study examined the effect of infrastructure on agricultural value chain in Nigeria from 1981-2019. The results of VECM) showed that infrastructure and trade openness had significant and direct impact on agricultural value chain in Nigeria over the period investigated, while exchange rate had an inverse and significant effect on agricultural value chain in Nigeria over the period investigated and trade broad money supply was not statistically significant and had zero effect on agricultural value chain in Nigeria chain over the period investigated. Based on the summary of the findings, it was concluded that output of agricultural value chain was greater than expenditure on infrastructure, infrastructure and trade openness stimulated agricultural value chain and exchange rate appreciation depressed agricultural value chain in the country over the years. Hence, governments at both federal, state and grass-root level must declare state of emergency on infrastructure deficiency in the country by taking holistic approach through continuous spending on infrastructural deficiency. The holistic approach must include provision of some certain infrastructural facility such as motorable road for agricultural product, storage facilities at all level of government, provision of farm equipment and communication that would encourage agricultural value chain in Nigeria. Nigerian government should continuously adopt floating exchange rate system so that the determination of exchange rate would be allowed by market forces: The continuous use of this system would encourage agricultural production especially the consumable product which in turn reduces the severity cause by foods insecurity. Since the higher the level of exchange rate, the lower the plantation of consumable goods for the citizens. Government should encourage both agricultural capital investment and agricultural import substitution policy. This could be achieved by domestic savings, foreign private loan, share capital, foreign direct investment and development stocks through continuity in government policy and building a strong institution. Finally, private institutions should set aside some certain amount from their yearly profit known as agricultural expansion funds for agricultural sector accompany by strict enforcement by government.

REFERENCES

[1] Abdulkadir, U., Ibrahim, U. K., Hassan, S. K. and Nasir, U. (2020) Development of a web application for agricultural product value chain in Nigeria. International Journal of Scientific Innovations. 8(1), 20-32.

[2] Abula, M. & Ben, D. M. (2016). The impact of public debt on economic development of Nigeria. Asian Research Journal of Arts & Social Sciences, 1(1), 1-16.

[3] Adejumo, A. V., Olomola, P. A. and Adejumo, O. O. (2013). The role of human capital in industrial development: The Nigerian case (1980-2010). Scientific Research Modern Economy, 4, 639-651.

[4] Adesina, A. (2017) Nigeria needs more investment in rural infrastructure to boost agriculture. Daily Trust Newspaper (25th, May, 2017). Retrieved on 20th, June, 2020, from www.dailytrust.com.ng/nigerianeeds-ore-investment-in-rural-infrastructure-to-boost-agriculture-adesina.html

[5] Adetoso, A. J., Akesinro, S. A. and Oladejo, K. S. (2012). Human capital development and economic growth: A lesson from Nigeria. Journal of Economics and Sustainable Development, 3(12), 139-143.

[6] Adeyemo, T. A and Okoruwa, V. O (2018), Value addition and productivity differentials in the Nigerian cassava system, Sustainability, 10, 4770.

[7] Andersen, P. and Shimokowa, S. (2007). Rural infrastructure and agricultural development. Paper presented at the Annual Bank Conference on Development Economics, Tokyo, Japan, and May 29-30.

[8] Central Bank of Nigeria (CBN). (2019). Statistical bulletin. Garki, Abuja: Central bank of Nigeria Annual Publication

[9] Chakwizira, J., Nhemachena, C., and Mashiri, M. (2010). Connecting transport, agriculture and rural development: Experiences from Mhlontlo Local Municipality Integrated Infrastructure Atlas. 29th Annual Southern African Transport Conference, CSIR International Convention Centre, Pretoria, South Africa, 16 - 19 August 2010.

[10] Dalina, M. A. & Liviu, C. A. (2015). Vector error correction model in explaining the association of some macroeconomic variables in Romania. 2nd International Conference 'Economic Scientific Research - Theoretical, Empirical and Practical Approaches', ESPERA, 13-14, Bucharest, Romania

[11] De Marchi, V., Giuliani E. and Rabellotti R. (2018). Do global value chains offer developing countries learning and innovation opportunities?' The European Journal of Development Research, 30(3), 389–407.

[12] Dempsey, J. (2006) A case study of institutional building and value chain strengthening: To link

Ethiopian cooperative coffee producers to international markets. ACDI/VOCA, Addis Ababa, Ethiopia.

[13] Eno, J., Michael, M., C. M. and Irenonsen, O. U. (2019). Infrastructure and linkage challenges in the execution of agricultural programmes in Cross River State, Nigeria. Journal of Path of Science. 5(11),13-23.

[14] Evbuomwan, G. O. and Okoye, L. U. (2018). Agricultural value chain financing and small scale farmers in Nigeria: The pre-requisites. Africa farm management association conference programmed proceedings.

[15] Gereffi, G. (2018). Global Value Chains and Development: Redefining the Contours of 21st Century Capitalism (Development Trajectories in Global Value Chains). Cambridge. Cambridge University Press.

[16] Keynes J. M. (1936). The general theory of employment, interest and money. London: Macmillan.

[17] Krishna S. J. and Ankita S. R. (2020) Role of infrastructure development of rural and urban sector of India. International Journal of Multidisciplinary Research (IJMR)

[18] Lee, K, Szapiro, M. and Mao Z. (2018). From global value chains (GVC) to innovation systems for local value chains and knowledge creation. The European Journal of Development Research, 30(3), 424–441.

[19] Mango, N., Mapemba, L., Tchale, H., Makate, C., Dunjana, H., and Lundy. M. (2015). Comparative analysis of tomato value chain competitiveness in selected areas of Malawi and Mozambique. Cogent Economics and Finance, 3(1), 1-15.

[20] Martins, I., Samuel, F. O. and Musa-Pedro, L. (2018). Macroeconomic policy and agricultural value chain in Nigeria. Journal of Social Sciences, 2(2), 20-28.

[21] Obot, A., Osuafor, O., Nwigwe, C. and Ositanwosu, C. (2021). Analysis of agricultural policy on catfish value chain in Akwa Ibom State. Nigeria International Journal of Research and Innovation in Applied Science (IJRIAS), 6(1), 23-31.

[22] Okafor, S. O. and Jegbefumwen, K. (2016). Public spending for growth induced employment: The Nigerian experience. British Journal of Economics, Management & Trade, 12(1), 1-19.

[23] Richardson, K. E., Johnson, F. and Idongesit, A. J. (2020). Optimizing Value Chain in the Nigeria's Agricultural Sector. Journal of Agricultural Economic, 2(3), 34-45.

[24] Siyan, P. and Adegoriola, W. (2017). An assessment of the nexus between infrastructural development and Nigerian economic growth using data from 1981 to 2014. Research Journal of Business Management. Vol. 11(18), pp. 470-477, 28 September, 2017 DOI: 10.5897/AJBM2016.8079.

[25] Udemezue J. C., Chinaka E. C. and Okoye, B. C. (2019). Cassava value chain as instrument for economic growth and food security in Nigeria. Universal Journal of Agricultural Research 7(6), 197-202.

[26] Word Bank Development Indicator. (2019). Nigerian Data. World Bank National Accounts Data

[27] World Bank (2005). World Investment Report 2004. (Oxford University Press, New York)

[28] World Bank (2018). Migration and development brief 27, migration and remittances: Recent development and Outlook, Special Topic on Global Compact on Migration. The World Bank, Washington, DC.