Road transport infrastructure and rural agricultural productivity in Nigeria

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Abstract. *Objective: Rural road network play a pivotal role in raising productivity and alleviating poverty in the rural areas; This study explores the contribution of road transport infrastructure to rural agricultural productivity in Nigeria; Method: In the study data which were collected from World Bank Development Indicators and African Development Indicators covering the period of 1999 to 2023 was analysed using the Autoregressive Distributed Lag (ARDL) bound testing to account for both the short and long run relationship; Results: The result shows that, while the effect of road transport infrastructure is not statically significant in the short run, in the long run, road transport infrastructure and interest rates emerge as significant determinants of rural productivity. However, inflation rate does not show significant effects on rural productivity in either the short run or long run. Originality: The study shows that road transport infrastructure plays a crucial role in facilitating long-term rural productivity growth in Nigeria. The study recommends the need to prioritise and execute extensive rural road construction and maintenance efforts to improve connectivity and facilitate economic activities in rural areas.*

Keywords*: infrastructure, rural economy, agricultural productivity, road transport, Autoregressive Distributed Lag*
JEL classification*: O13, Q12, R42, R53.*

1. Introduction

Rural economies exhibit a broad spectrum of both agricultural and non-agricultural sectors, surpassing the conventional emphasis on agricultural economics predominantly centered on food systems. Agricultural endeavors assume a pivotal role in the economic dynamics of rural areas, constituting a fundamental pillar supporting the livelihoods of rural inhabitants. The productivity of agriculture serves as the bedrock of rural economic vigour, furnishing indispensable resources like raw materials, sustenance, and employment avenues. Additionally, agriculture assumes a crucial role as a social welfare infrastructure within rural settings, facilitating economic prospects and nurturing communal well-being. Rural road networks serve as a cornerstone in bolstering rural productivity and nurturing diverse socio-economic, cultural, and political dynamics within rural communities (Aderamo & Magaji, 2010; Kakwagh, 2018; Ajiboye & Afolayan, 2019). These networks play a pivotal role in promoting the equitable distribution of facilities within rural areas, presenting a promising avenue for poverty alleviation.

Investments in rural road infrastructure consistently correlate with the expansion of non-agricultural employment opportunities (Stifel, Minten & Koro, 2012). By facilitating the movement of raw materials from rural to urban areas and ensuring the efficient distribution of finished goods to consumers, improved transport helps mitigate waste resulting from overproduction and fosters price

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stability (Adedeji et al., 2014; Kakwagh, 2018; Olorunfemi, 2018). Moreover, the productivity of agriculture contributes significantly to infrastructural development, notably in the establishment of road networks. These networks, in turn, facilitate the movement of goods, food items, and raw materials between rural and urban locales, fostering connectivity that amplifies rural economic performance and generates supplementary income streams for rural populations. Furthermore, agriculture sustains a multitude of subsistence occupations for millions of rural denizens, enabling the production and equitable distribution of essential commodities such as food, apparel, and housing materials.

Despite its crucial role in supporting the rural economy, the state of rural transportation infrastructure in numerous states across Nigeria is notably deficient and unsustainable. These transportation networks lack the necessary capacity to consistently support agricultural productivity. The condition of most rural roads in Nigeria sharply contrasts with the quality of inter-urban and intra-urban roads in the country. Especially during the rainy season, the majority of rural roads deteriorate significantly, becoming impassable. This deterioration presents a considerable threat to the sustainability of rural socio-economic development. Nonetheless, the central objectives of road transport and their pivotal role in the agricultural sector serve as the driving force behind this study. The focus of this study is to explore the effect of road transport conditions on rural productivity in Nigeria. The specific objectives of the study are to:

i. examine the short run effects of road transport condition on rural productivity in Nigeria
ii. examine the long run effects of road transport condition on rural productivity in Nigeria.

The focus on Nigeria is justified because this is one of the countries with the largest rural populations in Sub-Saharan Africa, with a significant portion of the economy relying on agriculture. Despite this, the country's rural road infrastructure remains underdeveloped and poorly maintained, posing a substantial barrier to rural productivity. Furthermore, Nigeria's agricultural sector is a key driver of employment, food security, and economic growth, yet it is hampered by inadequate transportation networks. Given the country's heavy reliance on agriculture and the widespread challenges of rural road deterioration, Nigeria serves as a representative case for understanding the broader implications of rural infrastructure on productivity in developing economies.

This investigation is imperative because it addresses a critical yet under-explored aspect of rural development: the condition of rural road transport and its effect on productivity. It contributes to academic literature by offering empirical insights into the relationship between rural road conditions and rural economic performance, particularly in Nigeria. The findings of this study will be useful for policymakers, development agencies, and stakeholders in rural planning and infrastructure development. By highlighting the importance of well-maintained rural roads in boosting agricultural output and creating non-agricultural employment opportunities, the study underscores the potential for rural infrastructure investments to foster sustainable economic growth. Furthermore, the research offers actionable recommendations that can guide future infrastructural development, ultimately benefiting rural populations by improving access to markets, reducing poverty, and enhancing overall rural welfare.

2. Literature review

The transportation infrastructure in rural regions encompasses a myriad of activities at the levels of local government, community, and household. Efficient transportation systems enhance market accessibility and bolster production capacities, thereby reducing unit costs and enhancing competitiveness. The importance of rural roads is further underscored by their role in expediting the transportation of vital inputs such as fertilizers and agricultural produce between rural areas and major transportation hubs, thereby catalyzing agricultural production and trimming production costs, particularly within the agricultural sector. Consequently, a robust road transport infrastructure is indispensable for enhancing productivity and reducing costs in rural regions. Additionally, these roads contribute to economic progress in previously marginalized areas (Lokesha & Mahesha 2016; Tunde & Adeniyi, 2012).

In addition, Obademi, Nwokobia, and Onuh (2023) examined the relationship between rural road infrastructure and agricultural food production, with a specific focus on the local government areas of Otukpo and Agatu in Benue State. The study encompassed 400 participants from varied backgrounds,

including farmers, traders, and students, selected from these two regions. Grounded in the time-geography theory, the researchers employed a comprehensive methodology that integrated questionnaires and interviews to collect data, followed by the utilization of descriptive statistics for analysis. Their findings uncovered a significant deficiency in well-constructed road access in rural areas, posing a substantial obstacle to agricultural advancement in Otukpo and Agatu LGAs. Consequently, the authors advocate for collaborative efforts to improve rural road infrastructure, acknowledging its potential to positively influence the livelihoods of rural residents and the broader national context. They suggest governmental intervention, potentially in partnership with private entities, to address the infrastructural gap in these areas. They argue that such endeavors hold promise for promoting rural development, encouraging the retention of young farmers in rural environments, thereby strengthening food security, curbing rural-urban migration, and mitigating crime rates.

The study by Akinpelu (2015) concentrated on evaluating the transportation needs and demand in rural regions encompassed by the Ayedire Local Government, Osun State, Nigeria. Employing a survey research methodology, the author administered a meticulously structured questionnaire to gather data. Following data collection, thorough analysis utilizing descriptive statistics ensued. Out of the 150 distributed questionnaires, a total of 123 were successfully retrieved. The study's outcomes uncovered correlation between the enhancement of road accessibility and socioeconomic activities. Various challenges prevalent in the area were discerned, with specific attention drawn to the adverse repercussions of subpar road conditions on socioeconomic activities and travel patterns. Moreover, deficiencies in road-network connectivity were accentuated, posing obstacles to efficient transportation and communication among different locales.

Olorunfemi's (2020) study centered on addressing critical concerns regarding rural road infrastructure and its significant impact on agricultural food production in the Local Government Area of Idanre, situated in Ondo State, Nigeria. Employing a randomized methodology, data collection involved administering a structured questionnaire to a sample of 200 farmers across 20 villages within the specified research domain. Descriptive statistics was used to analyze the collected data to reveal relevant insights, supplemented by hypothesis testing through stepwise regression analysis. The study's findings underscored a notable correlation between the inadequate state of roads in the research area and the subsequent escalation in transportation costs and inconsistency in transport services, thereby impeding the effective progression of agricultural activities. Additionally, the research shed light on motorcycles as the primary mode of transportation within the Local Government Area (LGA), attributing their limited capacity and associated high costs to the increasing rate of post-harvest losses. Consequently, urgent measures, such as the construction and rehabilitation of deteriorating road infrastructure, were advocated to address these challenges and stimulate agricultural development within the study area.

Adeniyi, Akinrinmade, and Abiodun (2018) assess the impact of rural road transportation on agricultural food production in the Local Government Area of Akure North in Ondo State, Nigeria. Employing a simple random sampling method, eight settlements were chosen from the research area, totaling 2,651 inhabitants. Subsequently, 240 questionnaires were distributed using a systematic sampling approach. The study revealed the inadequate state of rural road infrastructure, which significantly increased transportation costs for agricultural produce and adversely affected the local economy. To mitigate these challenges, the authors recommended providing the local government council with sufficient human and financial resources to effectively maintain rural roads, thereby enabling smoother transportation. Additionally, they advocated for the implementation of various policies by federal and state governments, as well as projects aimed at enhancing rural infrastructure. These measures are proposed to bolster rural development efforts across Nigeria.

In their 2020 study, Olagunju and Akinbile explored farmers' perspectives regarding the impact of rural road transportation on their standard of living in Ondo State. Employing structured interviews, the authors gathered data by administering a structured questionnaire to a sample of 120 farmers across two local governments in Ondo State, as part of their research endeavor. To ensure the sample's representativeness, multi-stage techniques were employed. The study's findings unveiled a correlation between farmers' perspectives and the quality of the road transport system, leading to a decline in their standard of living. Additionally, variables such as gender and marital status which represent and respectively, were discovered to significantly influence the standard of living, with statistical

significance at $p<0.05$. Drawing from these findings, the study suggests that enhancing transport infrastructure has the potential to enhance farmers' productivity, thereby addressing poverty issues in rural areas. Consequently, the authors advocate for the maintenance of rural roads and the provision of adequate infrastructure. Moreover, they recommend establishing an agency or board responsible for overseeing rural infrastructure, particularly in the transportation sector, to facilitate smoother mobility and improve access to essential services such as medical facilities within the region.

3. Data and methodology

This study explores the effect of road transport on rural agricultural productivity in Nigeria. Previous scholarly investigations have acknowledged the correlation between road transport and agricultural advancement. However, this study aims to validate this relationship specifically within the rural economic context, considering the inconsistent findings from prior research endeavors. By integrating insights from growth and financial frontier theories, this study seeks to evaluate the role of road transport in fostering rural economic development. Growth theory, as endorsed by various scholars (Howitt & Aghion, 1998; Barro & Sala-i-Martin, 2004) furnishes the theoretical groundwork for comprehending the impact of infrastructure on growth and developmental outcomes.

Financial Frontier Theory, first introduced by Adams and von Pischke (1992), offers a market-driven conceptual framework that explores the intricate interplay between the formal and informal sectors of an economy. Central to this theory is the notion of a defined boundary known as the "frontier," within which formal financial institutions operate under regulation and supervision. Inside this frontier lie the regulated and supervised intermediaries that constitute the formal sector. Conversely, the informal sector extends beyond this frontier, encompassing various entities such as rural small-scale farmers, small businesses, and traders. Transactions occurring beyond the frontier are often characterized by personalized interactions, particularly prevalent among rural-based participants engaged in subsistence activities, thereby reflecting the rural economy's heavy reliance on agricultural output.

The theory advocates for the expansion of this financial frontier, aiming to integrate participants and activities from the informal sector into the formal economy. This expansion entails the growth of the formal sector, accompanied by a corresponding reduction in the scope of the informal sector. Ultimately, such a process signifies the assimilation of the informal sector into the broader framework of both national and international financial systems. In essence, Financial Frontier Theory proposes that by extending the boundaries of the formal financial sector to encompass informal sector participants, the economy can achieve enhanced integration and efficiency within both domestic and global financial landscapes. In summary, the core premise of Financial Frontier Theory is outlined as follows:

$$RE = f(RB) \quad 3.1$$

where RE is rural economy, RBE represents rural based economic activities encompassing rural farmers, rural small traders and rural small businessmen.

Based on the insights from the theoretical framework, the empirical model was formulated to examine the impact of the road transport system on agricultural productivity. This empirical analysis employs a single equation model, drawing on insights from growth theory (Adams & von Pischke, 1992) and the financial frontier model. Furthermore, the model incorporates elements from previous research by Egbetunde (2012) and Brana and Jégourel (2011), with adjustments made to include variables such as the inflation rate and interest rate. The equation is further specified as:

$$RT = f(RP, IR, IF) \quad 3.2$$

Based on the conceptual framework, the theoretical argument and empirical evidence, the study expanded the equation by adopting and modifying works of Egbetunde (2012) as follows:

$$RPt = \beta 0 + \beta 1 RTt\text{-}1 + \beta 2 IRt\text{-}1 + \beta 3 IFt\text{-}1 + \mu t\text{-}1 \quad 3.3$$

Where $\beta 0$ = Coefficients

$\beta 1$, $\beta 2$ and β n = are the coefficients

RP = Rural Productivity is proxy by Agricultural Output

RT = Road Transport

IR = Interest Rate

IF = Inflation Rate

μ = Error term

Using ARDL model, the equation can be written as follows:

$$yt = \sum_{i=1}^{k} \alpha_1 \, \Delta y_{t-1} + \sum_{i=0}^{p} c_1 \, \Delta x_{t-1} + \varepsilon_t \qquad 3.4$$

Where Δ represent the first difference of the variable (RT, RP, IR, IF), α, C are the parameters of the model, K and q are the lag lengths and the ε is a scalar mean error term. The ARDL framework for equation.

$$\Delta RP_t = \delta_0 + \sum_{i=0}^{p_1} \emptyset i \Delta RT_{t-1} + \sum_{i=0}^{p_2} \emptyset i \Delta IR_{t-1} + \sum_{i=0}^{p_3} \emptyset i \Delta IF_{t-1} + \varepsilon \qquad 3.5$$

In Equation (3.4), the summation symbol represents the error correction adjustment. The inclusion of interest rate and inflation rate in the study is crucial for analyzing how financial conditions affect rural agricultural productivity in Nigeria. Interest rates influence farmers' access to credit, impacting their ability to invest in inputs and technologies, while inflation affects both input costs and agricultural product prices. These variables align with Growth and Financial Frontier theories, highlighting how macroeconomic factors shape rural economic activities. In Nigeria, where rural areas heavily rely on agriculture, understanding the impact of these financial variables helps assess the effectiveness of road transport improvements in boosting rural productivity.

In this research, data were collected from World Bank Development Indicators and African Development Indicators available at the World Bank Development Indicators database covering the period of 1999 to 2023. Road transport (RT) was measured by roads total network in kilometers, while rural productivity proxy by agricultural output was measured by agricultural, forestry and fishing value added as a percentage of Gross Domestic Product (GDP). Interest rate was measured by lending interest rate in percentage and inflation rate was measured by consumer price in percentage. The missing values for road transport were calculated using the five-year moving average.

The study employed the Autoregressive Distributed Lag (ARDL) bound testing estimation technique to analyze secondary data. The ARDL model is renowned for its robustness and adaptability in empirical investigations. Emeka and Aham (2016) highlighted the resilience and effectiveness of the ARDL technique, particularly in cases where the F-statistic indicates a single long-run relationship, especially with small sample sizes (n < 30) or finite datasets.

4. Research results and comments

The result of the analysis is segmented into three parts. This first part covers the preliminary tests, the trend analysis was presented in the second part, while the third part is on the empirical analysis of the model.

4.1 Preliminary Analysis

Table 1. Descriptive Statistics

	RP	RT	IR	IF
Mean	24.21117	186474.0	18.45261	17.89404
Median	23.69187	192837.8	17.58500	13.00697
Maximum	36.96508	194394.0	31.65000	72.83550
Minimum	19.99025	122000.0	11.48313	5.388008
Std. Dev.	3.612098	17264.71	4.059448	15.64683
Skewness	1.696695	-2.652495	1.020578	2.292538

	RP	RT	IR	IF
Kurtosis	6.573369	8.880842	4.699756	7.316063
Jarque-Bera	35.41425	91.47721	10.28925	57.82483
Probability	0.000000	0.000000	0.005831	0.000000
Observations	35	35	35	35

Note: RT: road transport; RP: rural productivity; IR: interest rate and IF: inflation rate.
Source*:* Author, 2024.

As illustrated in Table 1, the mean value of rural productivity (RP) is 24.21, with a minimum of 19.99 and a maximum of 36.97. This indicates a moderate level of productivity, leaning slightly towards the higher end of the spectrum. The standard deviation of 3.61 suggests a relatively low dispersion around the mean, implying that productivity values are relatively consistent over time. However, the skewness of 1.70 indicates a positive skew, suggesting that there may be more instances of higher productivity values compared to lower ones. The kurtosis of 6.57 indicates heavy-tailedness, meaning there may be outliers or extreme values in the data, potentially indicating significant variations in productivity. The Jarque-Bera statistic of 35.41, with a probability close to zero, suggests that the data for RP is not normally distributed at the 5% significance level.

For road transport (RT), the mean value is 186,474, with a minimum of 122,000 and a maximum of 194,394. This indicates a high level of road transport activity. The standard deviation of 17,264.71 suggests relatively low variability around the mean. The negative skewness (-2.65) indicates a left-skewed distribution, suggesting more instances of higher transport values compared to lower ones. The kurtosis of 8.88 indicates heavy-tailedness, with potential outliers or extreme values. The Jarque-Bera statistic of 91.48, with a probability close to zero, suggests that the data for RT is not normally distributed at the 5% significance level.

Interest rate (IR) has a mean value of 18.45, with a minimum of 11.48 and a maximum of 31.65. This suggests a moderate level of interest rates, with potential variability. The standard deviation of 4.06 indicates moderate dispersion around the mean. The positive skewness of 1.02 suggests a slightly right-skewed distribution, indicating more instances of lower interest rates compared to higher ones. The kurtosis of 4.70 suggests a moderate degree of peakedness or tail thickness. The Jarque-Bera statistic of 10.29, with a probability of 0.0058, suggests that the data for IR may not be normally distributed at the 5% significance level.

Inflation rate (IF) has a mean value of 17.89, with a minimum of 5.39 and a maximum of 72.84. This indicates a relatively moderate level of inflation, with potential for high variability. The standard deviation of 15.65 suggests considerable dispersion around the mean. The positive skewness of 2.29 indicates a right-skewed distribution, suggesting more instances of lower inflation rates compared to higher ones. The kurtosis of 7.32 indicates heavy-tailedness, with potential outliers or extreme values. The Jarque-Bera statistic of 57.82, with a probability close to zero, suggests that the data for IF is not normally distributed at the 5% significance level.

Overall, these statistics suggest that while rural productivity and interest rates demonstrate moderate levels with some variability, road transport and inflation rates exhibit higher levels with potentially greater variability and skewness, highlighting the complexities and challenges within rural areas in Nigeria, potentially impacting economic activities and policy decisions

Table 2. Pairwise Correlation Coefficients

	RP	RT	IR	IF
RP	1.000000	0.261126	0.225153	0.020857
RT	0.261126	1.000000	-0.543394	-0.233409
IR	0.225153	-0.543394	1.000000	0.433951
IF	0.020857	-0.233409	0.433951	1.000000

Note: RT: road transport; RP: rural productivity; IR: interest rate and IF: inflation rate.
Source*:* Author, 2024.

As depicted in Table 2, the correlation coefficient between rural productivity (RP) and road transport (RT) is 0.261, indicating a weak positive correlation. This suggests that there is a slight tendency for higher levels of rural productivity to be associated with higher levels of road transport activity. In the context of rural areas in Nigeria, this implies that improved productivity in rural sectors leads to increased demand for transportation services to move goods and people, albeit to a limited extent. The correlation coefficient between rural productivity RP and interest rate (IR) is 0.225, indicating another weak positive correlation. This suggests that there is a slight association between higher rural productivity and higher interest rates. This implies that as productivity increases, there is increased borrowing and investment activities, leading to higher demand for credit and potentially driving interest rates up, though the effect is not substantial. The correlation coefficient between rural productivity RP and inflation rate (IF) is 0.021, indicating a very weak positive correlation. This suggests that there is almost no association between rural productivity and inflation rate. This implies that changes in productivity levels does not significantly impact inflation rates, as rural areas may have limited influence on broader inflationary trends.

The correlation coefficient between road transport RT and interest rate is -0.543, indicating a moderate negative correlation. This suggests that there is a significant negative relationship between road transport activity and interest rates. This implies that higher interest rates may discourage borrowing for transportation-related investments, leading to decreased road transport activity. The correlation coefficient between road transport and inflation is -0.233, indicating a weak negative correlation. This suggests a slight negative relationship between road transport activity and inflation rate. This imply that higher inflation rates lead to increased operating costs for transportation services, potentially dampening road transport activity to some extent. The correlation coefficient between interest rate and inflation IF is 0.434, indicating a moderate positive correlation. This suggests a significant positive relationship between interest rates and inflation rate. The result implies that changes in interest rates influence inflationary pressures, potentially affecting the cost of living and economic activities in rural areas.

Considering the pairwise correlation coefficients across all the pairs of variables in the model, none of the correlation coefficients exceed the 0.8 threshold commonly used as a rule of thumb for multicollinearity. Therefore, based on these coefficients, multicollinearity does not appear to be a significant problem in the dataset.

Augmented Dickey-Fuller test statistic

Table 3. Unit Root Statistics

Variables	Level		Firs Difference		Order
	t-Statistic	Prob.*	t-Statistic	Prob.*	
RP	-1.969835	0.2979	-78.16350	0.0001	I(1)
RT	-78.16350	0.0001	-44.29981	0.0001	I(0)
IR	-2.454805	0.1352	-7.246874	0.0000	I(1)
IF	-2.223785	0.2019	-4.477738	0.0012	I(1)
Test critical values:	1% level	-3.711457	-3.724070		
	5% level	-2.981038	-2.986225		
	10% level	-2.629906	-2.632604		
	*MacKinnon (1996) one-sided p-values.				

Note: RT: road transport; RP: rural productivity; IR: interest rate and IF: inflation rate.
Source*:* Author, 2024.

As illustrated in Table 3, for rural productivity (RP), the unit root test statistic at the level is -1.9698, with a probability value of 0.2979, indicating that at the 1% significance level, we fail to reject the null hypothesis of a unit root. However, after taking the first difference, the test statistic becomes -78.1635 with a probability value close to zero. This implies that the series becomes stationary after differencing once, suggesting that RP is integrated of order 1, or I(1). For road transport (RT), the unit root test statistic at the level is -78.1635, with a probability value close to zero, indicating rejection of

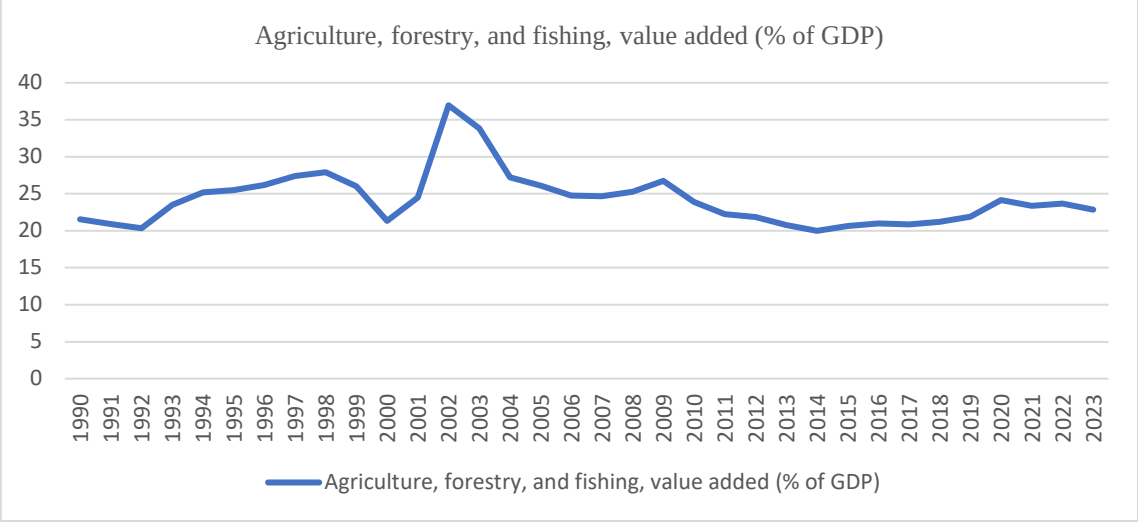
the null hypothesis of a unit root at any conventional significance level. Therefore, RT is stationary at the level, or integrated of order 0, I(0).

For interest rate (IR), the unit root test statistic at the level is -2.4548, with a probability value of 0.1352, indicating failure to reject the null hypothesis of a unit root at the 1% significance level. However, after differencing once, the test statistic becomes -7.2469 with a probability value close to zero, suggesting stationarity of the series. Therefore, IR is integrated of order 1, or I(1). The unit root test statistic of inflation rate (IF) at the level is -2.2238, with a probability value of 0.2019, indicating failure to reject the null hypothesis of a unit root at the 1% significance level. However, after differencing once, the test statistic becomes -4.4777 with a probability value of 0.0012, suggesting stationarity of the series.

Overall, the unit root tests suggest that while road transport activity remains stable over time (I(0)), rural productivity, interest rates, and inflation rates exhibit tendencies for long-term trends or persistence (I(1)).

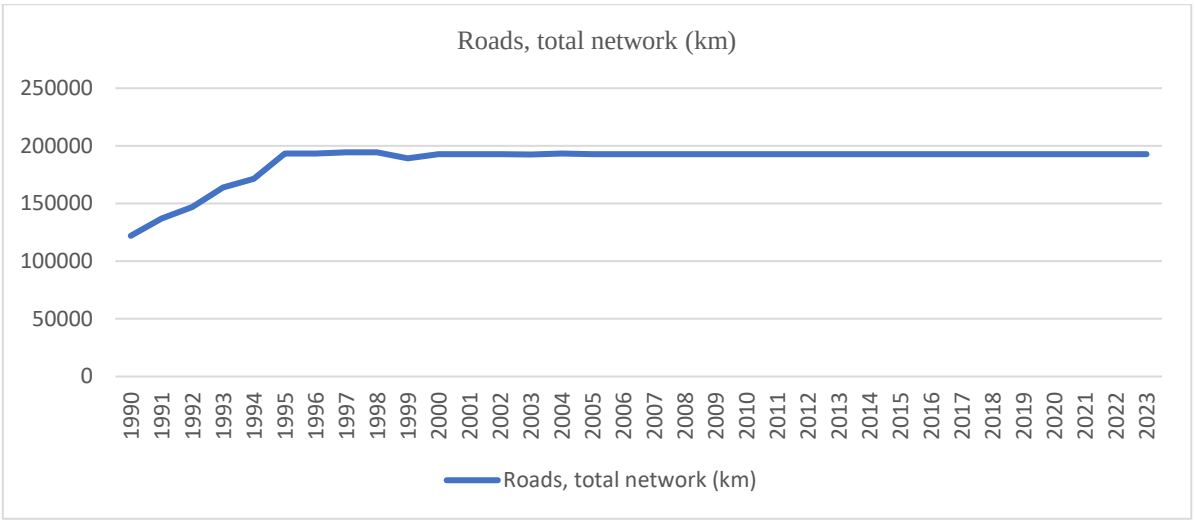
4.2 Trend analysis

Figure 1. Trend of Agricultural Productivity in Nigeria (1990-2023)



Source*:* Author, 2024.

Figure 2. Trend of Road Transport Infrastructure in Nigeria (1990-2023)



Source*:* Author, 2024.

As shown in Figure 1 and 2, over the period from 1990 to 2023, there are observable trends in both agricultural productivity (RP) and road transport infrastructure (RT). Looking at the trend of RP, we see fluctuations over the years, starting at 21.56 in 1990, declining to 19.99 in 2014, and then gradually increasing to 23.19 in 2023. This suggests that there have been periods of both growth and decline in rural productivity within this timeframe. The fluctuations may be influenced by various factors such as changes in weather patterns, technological advancements, government policies, and socioeconomic conditions. The increase towards the latter years could imply efforts to improve rural agricultural investments in the sector, potentially driven by the recognition of the importance of agriculture in rural development.

In contrast, the trend of RT shows a relatively stable pattern over the years, with minor fluctuations but no clear upward trend. The values hover around the range of 192,000 to 194,000 throughout the entire period, indicating little progress in level and condition of road transport infrastructure.

4.3 Empirical Analysis

Table 4. ARDL Estimates

ARDL Bounds Test: Null Hypothesis: No long-run relationships exist			**Critical Value Bounds**		
Test Statistic	**Value**	**K**	**Significance**	**I0 Bound**	**I1 Bound**
F-statistic	5.579628	3	10%	2.72	3.77
			5%	3.23	4.35
			1%	4.29	5.61
Dependent Variable: DLOG(RP)	Short-run Estimates				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
DLOG(RP(-1))	0.344764	0.163649	2.106728	0.0458	
D(RT)	-0.000004	0.000005	-0.658510	0.5165	
D(IR)	0.017705	0.006729	2.631156	0.0146	
DLOG(IF)	0.052105	0.048819	1.067329	0.2964	
CointEq(-1)	-0.519987	0.130846	-3.974048	0.0006	
	Long-Run Estimates				
RT	0.000009		0.000004	2.069162	0.0495
IR	0.030935		0.011063	2.796250	0.0100
LOG(IF)	0.148012		0.093772	1.578429	0.1276
R-squared	0.522455				
F-statistic	3.282135				
Prob(F-statistic)	0.011319				
Durbin-Watson stat	1.711686				
	Post test				
Heteroskedasticity Test: ARCH					
F-statistic Prob. F(1,30)	0.213(0.648)				
Breusch-Godfrey Serial Correlation LM Test:					
F-statistic Prob. F(2,22)	2.080(0.148)				
Histogram-Normality					
Jarque-Bera(Prob.)	6.083(0.048)				

Note: RT: road transport; RP: rural productivity; IR: interest rate and IF: inflation rate.
Source*:* Author, 2024.

The ARDL bounds test indicates the presence of long-run relationships among the variables at the 5% significance level, as the F-statistic (5.58) exceeds the critical value bounds for the 5% significance level, which range from 3.23 to 4.35. This implies that there exist stable long-term relationships among the variables considered, indicating the potential for long-term equilibrium dynamics to exist within the model.

In the short-run, the coefficient for the lagged rural productivity variable (DLOG(RP(-1))) is estimated at 0.345 (t = 2.107; Pr(0.05) = 0.0458), indicating a positive relationship between current and past rural productivity levels. This suggests that an increase in rural productivity in the previous period positively influences current productivity levels. The coefficient for road transport (RT) is estimated at -0.000004 (t = -0.659; Pr(0.05) = 0.5165), which is statistically insignificant at the 5% level. This suggests that changes in road transport infrastructure do not significantly impact short-term changes in rural productivity in the short run.

The coefficient for the interest rate (IR) variable is estimated at 0.018 (t = 2.631; Pr(0.05) = 0.0146), indicating a positive and statistically significant relationship between interest rates and rural productivity changes in the short run. This suggests that increases in interest rates lead to higher rural productivity levels in the short term, potentially due to increased investment incentives or access to credit for rural businesses. The coefficient for the inflation rate (IF) is estimated at 0.052 (t = 1.067; Pr(0.05) = 0.2964), which is statistically insignificant at the 5% level. This suggests that changes in inflation rates do not significantly affect short-term changes in rural productivity.

In the long run, the coefficient for road transport (RT) is estimated at 0.000009 (t = 2.069; Pr(0.05) = 0.0495), indicating a positive and statistically significant relationship between road transport infrastructure and rural productivity in the long run. This suggests that improvements in road transport infrastructure contribute positively to long-term rural productivity growth, potentially by facilitating access to markets, inputs, and services.

The coefficient for the interest rate (IR) variable is estimated at 0.031 (t = 2.796; Pr(0.05) = 0.0100), indicating a positive and statistically significant relationship between interest rates and rural productivity in the long run. This suggests that higher interest rates by encouraging long-term investment in rural sectors, leads to increased rural productivity over time. The coefficient of inflation rate (IF) is estimated at 0.148 (t = 1.578; Pr(0.05) = 0.1276), which is statistically insignificant at the 5% level. This suggests that changes in inflation rates do not significantly impact long-term rural productivity levels.

By and large, the result shows that, in the long run, road transport infrastructure and interest rates emerge as significant determinants of rural productivity, indicating the importance of sustained investments in infrastructure and favourable monetary policies for fostering long-term productivity growth. However, inflation rate does not show significant effects on rural productivity in either the short run or long run.

4.4 Discussion of Findings

The findings presented in the study provide valuable insights into the dynamics of rural productivity, road transport infrastructure, interest rates, and inflation rates in Nigeria. The descriptive statistics reveal important characteristics of the variables under consideration. While rural productivity (RP) demonstrates a moderate level with some variability, road transport (RT) exhibits higher levels with potential for greater variability and skewness. Interest rates (IR) and inflation rates (IF) also display moderate levels with some variability, albeit with different skewness and kurtosis patterns. These statistics underscore the complexities and challenges within rural areas in Nigeria, potentially impacting economic activities and policy decisions. The correlation analysis further illuminates the relationships between the variables. While there is a weak positive correlation between rural productivity and road transport, suggesting a slight association between higher productivity and higher transport activity, other correlations such as between rural productivity and interest rate or inflation rate are weak or very weak, indicating minimal associations. These findings suggest that the influence of interest rates and inflation rates on rural productivity may be limited in the short term. The trends observed over the period from 1990 to 2023 reveal fluctuations in rural productivity, influenced by factors such as weather patterns, technological advancements, and government policies. In contrast, road transport

infrastructure shows a relatively stable pattern, highlighting the need for sustained investments to improve rural connectivity and facilitate economic activities.

The ARDL estimates show both the short-term and long-term relationships between the variables. In the short run, past changes in rural productivity positively influence current levels, while interest rates exhibit a positive relationship with rural productivity. However, road transport and inflation rates do not significantly impact short-term changes in rural productivity. In the long run, improvements in road transport infrastructure and higher interest rates contribute positively to rural productivity growth, while inflation rates show no significant influence.

Similarly, this study aligns with Obademi, Nwokobia, and Onuh (2023) which emphasizes the importance of rural road infrastructure for agricultural advancement, specifically in the Otukpo and Agatu LGAs in Benue State. Their findings reveal a deficiency in well-constructed road access, posing obstacles to agricultural development. This complements the current research findings, which highlight the positive long-term relationship between road transport infrastructure and rural productivity growth. Both studies advocate for collaborative efforts and governmental intervention to address infrastructure gaps, thereby promoting rural development and improving the livelihoods of rural residents.

Contrary to the current findings, Akinpelu's (2015) research suggests a correlation between the enhancement of road accessibility and socioeconomic activities in rural regions encompassed by the Ayedire Local Government, Osun State. While the current research emphasizes the positive long-term relationship between road transport infrastructure and rural productivity growth, Akinpelu's findings suggest that subpar road conditions may adversely impact socioeconomic activities and travel patterns. This highlights the importance of considering variations in regional contexts and the quality of road infrastructure when assessing its impact on rural development.

5. Conclusions

In conclusion, the findings suggest that while rural productivity in Nigeria demonstrates moderate levels with some variability, road transport infrastructure plays a crucial role in facilitating long-term rural productivity growth. Interest rates also influence rural productivity, highlighting the importance of favourable monetary policies for stimulating investments in rural sectors. However, inflation rates appear to have minimal effects on rural productivity. Building upon successful implementations in other regions or countries, policymakers in Nigeria can consider the following recommendations: Prioritize and execute extensive rural road construction and maintenance efforts to improve connectivity and facilitate economic activities in rural areas. Collaborate with private entities and leverage public-private partnerships to accelerate infrastructure development. Implement monetary policies that incentivize investment in rural sectors by providing access to affordable credit and fostering an enabling environment for business growth. This can stimulate productivity gains and contribute to long-term economic development. Invest in robust data collection mechanisms and analytical tools to continuously monitor rural productivity trends, road transport activity, interest rates, and inflation rates. This will enable policymakers to make informed decisions and adapt strategies to evolving economic conditions.

The limitation of the study is inherent in the use of aggregate data that may obscure region-specific variations in rural productivity and road infrastructure quality, which could provide more detailed insights. Additionally, the focus on road transport infrastructure excludes other critical factors, such as electricity and irrigation, which also contribute to rural productivity. Future research should explore the role of other infrastructure elements, such as energy and irrigation, in rural productivity, offering a more comprehensive view of rural development. Extending the study to a broader time frame and incorporating region-specific data would allow for a more robust understanding of the relationship between road transport, financial variables, and rural productivity. Future studies could also explore how digital technologies and innovations affect rural connectivity and productivity.

Authors' contribution: *Introduction, L.A.; Literature review, L.A.; Methodology and data, L.A.; Research results and comments, A.K.; Conclusion, A.K.*

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