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Long-run effect of Road Transport Infrastructure Development on Economic Growth and Poverty Level in Nigeria (1980-2012)

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Abstract

This study examined the long-run effect of road transport infrastructure development on economic growth and poverty level in Nigeria. This was with the view to providing empirical evidence on the long run effect of road transport infrastructure on economic growth and poverty level. The study used secondary data. Annual time series data from 1980 to 2012 on road network, Real Gross Domestic Product (RGDP) and Real Consumption Expenditure per Capita were collected from Central Bank of Nigeria (CBN) Statistical Bulletin (2012), National Bureau of Statistics (NBS) various publications and World Development Indicators (2012) published by the World Bank. Cointegration econometric technique was applied in the analysis of Solow model of long run growth that postulates a continuous production function linking output to the inputs of capital and labour which are substitutable.

The results showed that the cointegration test confirmed the existence of long run relationship among road transport infrastructure development, economic growth and poverty reduction, (trace statistics = 32.03, $p < 0.05$); Moreover, the result shows that 1 per cent increase in road transport infrastructure development significantly reduces economic growth by 2.5 per cent, ($t = 1.83$, $p > 0.05$), it also indicated that one per cent increase in road transport infrastructure development insignificantly reduced poverty level by about one per cent ($t = 1.64$, $p > 0.05$).

Introduction

Transport infrastructure is an important determining factor in the development process of a nation. Coupled with better human development, the development of transport infrastructure could generate a spillover effect on country's economic growth and poverty reduction efforts (Wei et al., 2008). This is because it helps in diversifying an economy production base, expanding trade and building resources and markets into an integrated economy, which could increase directly or indirectly the welfare of the people.

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The relationship between transport infrastructure development and economic development has always been contentious. The colonial authorities in Africa believed that investments in transport infrastructure positively influenced economic development through job creation, poverty reduction and increase in economic growth. This explains why these authorities were preoccupied with putting in place road and railway projects throughout the continent. Their actions were informed by regional and industrial development theories which assign a critical role to transportation. At the time, transport costs were viewed as a leading factor explaining the location of economic activities (Pedersen, 2001).

The replacement value of road network at 2001 prices is estimated between N3,500 billion and N4,300 billion (FGNDNTP, 2010). In 2004, Nigeria's Federal Road Maintenance Agency (FERMA) began to patch 32,000Km federal roads and in 2005, it initiated a more substantial rehabilitation. In 2009 the ministry has consciously embraced the Public Private Partnership Scheme to complement the developmental efforts of the Government. The pioneering project in this regard is the Lagos-Ibadan Expressway (105km). The ministry, on behalf of the Federal Government of Nigeria (FGN), entered into a 25-year concession with Bi-Courtney Consortium at the cost of N89.53 billion (approximately USD 604.95 million). The scope of work covers the reconstruction, expansion and modernization of the expressway. The expectation was that the road would be expanded from the existing four lanes to eight lanes under a Design Build Operate and Transfer (DBOT) agreement. In July 2013, the contract was taken away from the Bi-Courtney Consortium to Julius Berger and Reynords Construction Company (RCC) due to inability to execute the project with a new agreement that, the construction companies would provide 70% of the project fund. This becomes necessary considering the economic effect of Lagos-Ibadan expressway both to the country and the continent in large.

The importance of transport infrastructure development in promoting economic growth and reducing poverty level has not received adequate attention in the literature. Although, there are studies that concentrated on developed countries while few studies are found in developing countries. In the available studies, there exist contradicting views as to whether or not transport infrastructure development could affect economic growth and poverty level. The outcome of these studies has served as a guide for policy makers on policy formulation and implementation in the transport

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sector which has contributed tremendously to growth and development of many of the countries where the studies are carried out.

For instance, evidence have shown that, the expansion of road network, in addition to policy reforms and improvements in human capital, has been identified as one of the major engines of China's economic growth over the past decade (Fan, & Zhang, 2002). Therefore, a good knowledge of how policy initiative like road transport infrastructure development could impact on economic growth and poverty level is very important for policy formulation.

The macroeconomic situations in Nigeria require a thorough understanding of how road transport infrastructure development affects economic growth and poverty level in the Nigerian economy. There is therefore the need to carry out similar studies in developing country like Nigeria to establish the existence of these channels. The knowledge of this is important in guiding policy makers in understanding fully on how transport policy could bring about economic growth and pace of reducing poverty level of the country.

This is not to conclude that, there are no studies that have examined the effects of infrastructure on economic growth or poverty in Nigeria (see Ogun 2010; Akinlabi and Jegede, 2011; Onakoya et al., 2012 and Akanbi et al., 2013. However, these studies employed investment in transport and communication services rather than physical stock as a proxy for infrastructure development. Moreover, Calderon and Serven (2008a) and Sahoo et al., (2009) have argued that stock of physical infrastructure is more reliable than investment in infrastructure when considering empirical implications of infrastructure development on economic development. This is because in time-series context the issue of simultaneity is arguably more problematic for those studies using investment flows (or their cumulated value) to measure infrastructure than for those using physical asset stocks.

Therefore, the results of the above mentioned studies in Nigeria may not show a true picture of the transport infrastructure – economic development nexus of the country, since the data employed in their studies is recurrent expenditure on transport – communication services rather than capital expenditure on infrastructural sector. Moreover, most of these studies did not justified or lack fundamental grounds in recommending policies to transport sector using government recurrent expenditure on transport-communication service, which may not really affect economic positively

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given the Nigeria government attitude. In spite of this, it is difficult to formulate policies towards transport sector based on these findings.

On the basis of the issues above, the following research questions are raised:

(a) What has been the long run effect of road transport infrastructure development on economic growth in Nigeria on one hand? and

(b) What is the long run effect of road transport infrastructure development on poverty level in Nigeria on the other hand?

Therefore, the broad objective of this research work is to examine the long-run effect of road transport infrastructure development on economic growth and poverty alleviation in Nigeria between 1980 and 2012.

This study is also necessary in providing empirical evidence and hence some implications for transport infrastructure policy towards promoting economic growth and poverty reduction. While there is a large body of empirical research addressing this, the study differs significantly from previous studies in terms of the measurement of road transport infrastructure development, poverty level and analytical frameworks. Therefore, this study is timely and important since substantial economic expansion is expected in Nigeria, and more also considering the transformation agenda of the government, there will be the need for empirical findings in assisting the government towards achieving their primary objective.

Review of Empirical Literature

In the literature on public infrastructure and economic development, the majority of empirical studies have been concerned with the question of whether or not infrastructure contributes towards output and productivity growth. The basic premise is that public investments in infrastructure can raise private output and productivity in both direct and indirect ways. Directly, public infrastructure services are thought of as intermediate inputs that enter into a firm's production process in the same way as private inputs (e.g. labour and private capital), while the indirect effect arises from the role of public infrastructure in augmenting the productivity of other private inputs. The selection of an appropriate paradigm provides us with some clue as to the likely effects of transport infrastructural investment; the issue is ultimately an empirical one. Today, there is a vast body of researches that examines the relationship between transport infrastructure development and economic growth with very few of them being on the

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impact of transport infrastructure improvement on poverty level. These studies have been carried out mostly in developed countries while little seems to have been done in developing countries. In some of these studies, cross-sectional and time series data were utilised.

For instance, Nadiri and Mamuneas (1994) analyse the effect of public infrastructure investment on the cost structure and performance of manufacture, and provide evidence of significant positive productivity effect. Bougheas, Demetriades and Mamuneas (2000), based on the endogenous growth model (Romer, 1987), introduce infrastructure as a technology which can reduce the costs of intermediate products, and conclude that infrastructure investment is positively related with cost-reducing specialization with manufacture data, that and there is robust "inverted-U shape" non-monotonic relation between infrastructure investment and economic growth with cross-section data. Fernald (1999) examines the relation between construction of inter-state highways in the USA in 1950s and 1960s and the growth in 1970s and then proves that transport investment is productive. For the same period of time, he points out that the productivity effect of transport to growth is once-and- for-all, instead of a permanent one.

Easterly and Rebelo (1993) use cross- section data of more than 100 countries between 1970 and 1988 and find out strong correlation between investment in transport and telecommunications and growth; the contribution of transport to growth is between 0.59 and 0.66. Demetriades and Mamuneas (2000) use panel data of 12 OECD countries to find out positive long-run effect of transport investment on production and demand. However, many others find out that the relation between transport investment and growth is either insignificant or even negative. Holtz-Eakin (1994) classifies public investment into four sub-groups: education, road and highway system, drainage system and public utilities. Although road and highway investment take a share of 34.5% in total public spending, there is no significant evidence of its positive effect on growth. This notwithstanding, studies have shown that the positive effect of transport investment on growth is tiny or even neglectable (Hulten & Schwab, 1991; Garcia-Mila, McGuire & Porter, 1996). Tatom (1991 and 1993) shows that there are no significant productivity effects of transport investment. Evans and Karras (1994) establish their empirics with panel data of public spending of the USA between 1970 and 1986, and concludes that productivity effect of transport is insignificant, a fact

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which offsets the positive effect of education and results in a gross negative effect of public spending on growth.

Taking these econometric problems into account, subsequent studies find weak evidence on the link between public capital and private sector production. At the national level, Tatom (1991) and Sturm and Hann (1995) find no significant evidence that public infrastructure is productive when including energy prices and time trends in regressions or using first-difference specifications. Based on usual specifications of error components for panel data analysis, state production function estimates indicate that the productivity effect of public infrastructure is much smaller than those obtained by previous studies (Andrews and Swanson, 1995) or even statistically insignificant (Evans & Karras, 1994; Holtz-Eakin, 1994; Baltagi & Pinnoi, 1995; Garcia-Mila et al., 1996).

In another stream of research, many studies have employed the duality between production and cost functions to investigate the productivity effect of public infrastructure. This is in contrast to studies based on an estimation of a production function in estimating a cost function in various forms revealing consistent evidence of production cost savings and productivity growth associated with public capital provision in manufacturing industries using data from the United States of America (Nadiri & Manuneas, 1994; Morrison & Schwartz, 1996; Cohen & Paul, 2004), the United Kingdom (Lynde & Richmond, 1993a), and West Germany (Seitz, 1993; Seitz & Licht, 1995). Broadening the cost function analysis to explore the cost saving and productivity effects in other industrial sectors, some studies have confirmed the link between infrastructure and reduced production costs for 35 two-digit industries of the USA economy (Nadiri & Mamuneas, 1998), and for three sectors of the West German economy: manufacturing, construction, trade and transport (Conrad & Seitz, 1994).

Fernald (1999) similarly estimates huge rates of return on investment in roads for US industries that use roads more intensively: in terms of a Cobb-Douglas specification like the ones used in state-level studies. He finds an output elasticity of road investment around 0.35. After noting that this is consistent with the initial results from Aschauer, he argues that the massive interstate highway network built in the 50s and 60s generated a one-time boost in productivity (of approximately 1%) rather than a permanent one, also explaining the post-1973 slowdown in productivity. In short, initial large investments in infrastructure may produce very high rate of returns, but

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this is no guarantee that additional investments would also be characterized by the same returns. In this view, Aschauer's results adequately captured the pre-1973 period. Additionally, this line of argument coincides well with the idea that once basic infrastructure is in place, adequate investment in maintenance might actually have a higher rate of return than new investment, as argued in Hulten (1996), who uses a cross-country sample similar to that of Easterly and Rebelo (1993) and finds that the impact of an effectiveness index of infrastructure is more than seven time larger than that of public capital itself (Rioja, 2003).

However, we should also note that other studies at international level have proved to be insignificant with mixed results of public investment on productivity and output growth. Ford and Poret (1991), using data on non-military public capital stock, and privately provided infrastructure services for 11 OECD countries over the period 1960-1988, found that his broad definition of infrastructure (including structures in electricity, gas and water and structures in transport and communication) had significant effect on productivity and output for 5 of the 12 countries, namely, US, Germany, Canada, Belgium and Sweden. He uses a total factor productivity growth and Autoregressive of order 1 and 2 models for his estimations. Other researchers report that the importance of infrastructure on economic development has been overemphasised. For instance, Taylor-Lewis (1993), using public capital data from Ford and Poret (1991) for the G7 countries over the period of 1970-87, but regressing a Cobb-Douglas function, contends that the contribution of public physical infrastructure to output was insignificant.

Romp and de Haan (2005), while reviewing the literature, note that 32 of 39 studies of OECD countries found a positive effect of infrastructure on some combination of output, efficiency, productivity, private investment and employment. (Of the rest, three had inconclusive results and four found a negligible or negative impact of infrastructure). They also review 12 studies that include developing countries. Of these, nine find a significant positive impact. The three that find no impact rely on public spending data which is a notoriously imprecise measure, especially for cross-country analysis. One other meta-analysis also shows a dominance of studies that point to a generally significant impact of infrastructure particularly in developing countries. However, Lahiri and Yao (2006) question the composition of transport infrastructure data used in previous studies and develop a leading economic indicator

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for the US economy based on transportation sector data. As the US economy has shifted from manufactured goods to service goods, the Bureau of Economic Analysis has had a general problem with counting service sector output as opposed to physical goods. Lahiri and Yao (2006) develop the Transportation Services Index to provide the BEA and the National Bureau of Economic Research with better measures of service sector performance. The Transportation Sector Index is being maintained by the Bureau of Transportation Statistics of the US Department of Transportation. The data series is currently considered preliminary in nature.

Kim (2006) in his dissertation on the effects of infrastructure on economic growth explores the impact of highway infrastructure on regional labour markets. Kim tests models both on a state (51 states) as well as for 81 Metropolitan Statistical Area (MSA). By studying the impact of changes in highway demand as well as highway supply, the author is able to estimate over a period of 19 years (1982-2000) the elasticity of net immigration of labour to a given region with respect to highway supply or demand. He gets an elasticity ranging between +0.129 and +0.454 for highway supply (as measured by per capital lane miles) and an elasticity of -1.511 to -0.015 for the demand for highways (as measured by vehicle miles travelled per lane mile) as compared to state economic performance. Both exhibit the expected sign for the elasticity. Additions to the supply of highways cause a positive impact on state economic performance and additional congestion causes a net reduction in the state economic performance. Kim also examines the location specific amenities including and excluding highway services. Interestingly, he defines New York State as an amenity poor state if we do not consider transportation resource but an amenity rich state if we include transportation services. Therefore, in Kim's ranking, transportation serves as a key differentiator in terms of social amenities.

Recently, Stephen.et. al., (2012) argued that, empirical evidence of the effects of transport and infrastructure investment on economic outcomes has been provided at the macro-level (Straub, 2011). This literature has focused the impacts of investment in roads and public infrastructure on several economic outcomes, such as aggregate productivity, growth or employment, finding mixed results (Gramlich, 1994; Martin & Rogers, 1995; Boarnet, 1998; Chandra & Thompson, 2000); Jiwattanakulpaisarn et al, 2010). Some recent papers have estimated, using careful identification strategies, the effect of roads on other outcomes in the US: urban growth (Duranton & Turner, 2011), road traffic (Duranton & Turner, 2011), suburbanisation (Baum-Snow, 2007), commuting patterns (Baum-Snow, 2010) or demand for skills (Michaels, 2008). In these works, the effect of transport was usually capture by connectivity to the network (either connected or not) or by some measure of the density of the network within some geographic boundaries and the focus is on correct identification of (long-run) effects. Other studies (Faber, 2012; Donaldson, 2010) have focused on developing countries (highways in China and railroad in colonial India) to study the effect of the reduction of transport costs due to transport networks development on trade integration and the consequent economic development. Only a handful of studies have looked at the effect of increased accessibility on firms' outcomes, and they have mostly focused on the analysis of firm relocation (Coughlin & Segev, 2000; Holl, 2004a, 2004c) or firm birth (Holl, 2004b, Melo et al, 2010), all finding positive relationships between the presence of roads and firms' relocation and creation. Holl (2011) studied the relationship between market access and firm productivity when market access changes due to road investments and changes in population. She exploits data for a panel of firms during a period of intense road construction in Spain. When using plant fixed-effects the estimates were imprecise, so she relied on GMM techniques in order to overcome endogeneity problems, with which she found positive significant effects of markets access on productivity. Li and Li (2010) used the construction of the Chinese highways system to evaluate the impact of improved transport infrastructure on the amount of inventories held by firms, arguing that the reduced inventories due to road construction improved efficiency and aggregate productivity.

Based on the above, Stephen.et. al., (2012), examined the impact of road transport infrastructure improvements on firms by using Firms' exposure to transport improvements as a measured of changes in employment accessibility (or effective density) along the road network in Britain, linked by detailed geographical location (10,500 wards) to the British road network and major improvements in it between 1998 and 2008. Estimates are based on an instrumental variables strategy using two-stage least squares. They found that, road improvements encourage firm entry or discourage exit but do not affect existing firms. This was in contrast to, Tatom (1991 and 1993), Holtz-Eakin (1994), Holtz-Eakin and Schwartz (1995) and Garcia-Mila et al. (1996) suggesting little evidence of an effect from infrastructure to income growth in a panel of U.S. state level data, particularly when fixed effects are included.

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Methodology

Theoretical Framework

Following Lakshmanan (2007), and based on extensive review of theoretical literatures, a simple diagram to illustrate how provision of transport infrastructure could potentially affect long-term growth within the framework of standard neoclassical macroeconomics framework, considering transport infrastructure as an augment in a production function, as that of Cobb-Douglas. Figure 1 shows the mechanisms and processes underlying the wider economic benefits of transport infrastructure development. It is a contemporary version of what Williamson (1974) and O'Brien (1983) call "forward linkages" of transport infrastructure. The lower cost and increased accessibility due to transport improvements modify the marginal costs of transport producers, the households' mobility and demand for goods and services. Such changes ripple through the market mechanisms, endogenizing employment, output, and income in the short run.

Over time, dynamic development effects derived from the mechanisms set in motion when transport service improvements activate a variety of interconnected economy-wide processes and yield a range of sectoral, spatial, and regional effects that augment overall productivity. The lower costs and enhanced accessibility due to transport infrastructure and service improvement expand markets for individual transport using firms. As such market expansion links the economies of different localities and regions, there is a major consequence in terms of shifting from local and regional autarky to increasing specialisation and trade and the resultant upsurge in productivity. Opportunities for exporting and importing goods are enhanced, in turn opening up several channels of economic effects, both in product market and in factor markets in a manner analogous to the results from tariff reduction and trade area expansion.

First, export expansion will lead to higher levels of output, which allow higher sales to cover fixed cost of operation, yielding efficiencies; second, increasing imports put competitive pressure on local prices. Such pressures lead not only to the removal of monopoly rents but also to improved efficiency. Schumpeterian dynamics come into play, firm entry, exit, expansion and contraction. As firms promote linear production processes which lower cost of production and raise productivity, further restructuring

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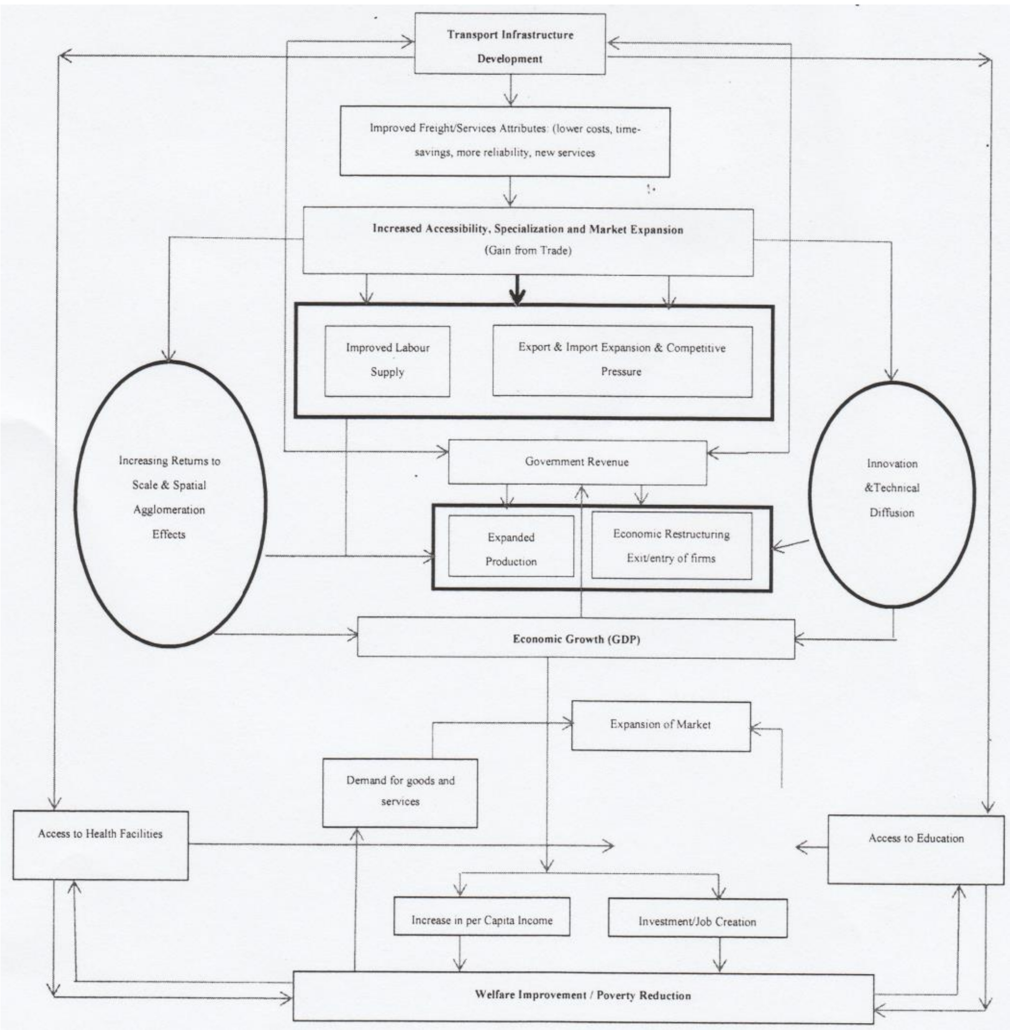
Figure 1

Linkage between Transport Infrastructure Development and Economic Development



(Source: Adapted from Lakshmanan (2007)

of the economy occurs. Third, lower transport cost and increased accessibility enlarge the market for labour and other factor inputs. A firm will likely draw labor from a broader area and, with a greater range of attributes, improve labour supply and with lower costs. Similarly, effects in land and other factors markets are possible as transport improvement open up new land for economic activities. Finally, there is the suggestion that the two mechanisms in the oval boxes, one dealing with innovation and the other with spatial arrangement in the economy would create, in the context of transport

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infrastructure improvements, conditions (in activity clusters) which would enhance economic performance, and promote total factor productivity and endogenous growth.

Transport improvements can have an endogenous growth effect to the degree they impact the rate of growth of the economy through the creation and commercialization of new knowledge, thereby promoting Productivity leading to economic growth measured by increases in GDP. In the contemporary knowledge economy, firms are concerned with the reduction of new class costs or adaptive costs incurred by the firm, it monitors the environment for changes in technology and products, identifies competitive strategies, and implements such strategies quickly enough to retain or improve market share (Hage and Alter, 1997; Lakeshmanan and Button, 2008). Firms minimises their adaptive cost by participating in economic network in the activity cluster or agglomeration made possible by transport infrastructure improvements.

Increase in the density of transport connections and accessibility can reduce transport input per unit of production, improve reliability of good deliveries and diminish inventories and storage cost, leading to firm productivity gains, particularly in urban areas. Such improvements can also induce a clustering of facilities in a certain place, thus yielding further productivity gains (agglomeration economies). Nonetheless, enhanced accessibility may cause centrifugal forces by allowing some firms to reduce their land costs by choosing low rent locations away from dense activity centers. These relocation decisions can possibly be fostered by establishment of intermodal freight transport facilities in the urban peripheries, which help reduce transshipment, cargo handling and storage costs.

In addition, the role of suitable privatization and deregulation policies, which are increasingly adopted nowadays, can be critical in the urban and regional development process, since they can increase (privately-provided) transport infrastructure and levels of mobility and service at affordable prices, managerial efficiency and financial viability of transport facilities. The economics literature recognizes the enormous importance of public capital typically associated with infrastructure as an additional factor in the production process, along with labor and private capital, since it increases its productive capacity. The role of transport infrastructure (mostly roads) and equipment is central in core infrastructure provision, together with the stock of communication and energy facilities, water system and sewers. By and large, transport infrastructure and services can be seriously regarded as partially or purely public goods,

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and can result in economies of agglomeration and economies of scale in production. Since the late 1980s and throughout the early 1990s, the first studies using formal analysis to measure the effect of public capital on economic activity started to be systematically conducted. Specifically, Aschauer (1989) and Munnell (1992) initiated a new exciting stream of research in the macroeconomic effect of public capital provision.

There are two possible ways in which transport infrastructure could affect firm production (Meade, 1952). The basic premise in the theoretical literature is that the stock of transport infrastructure available enters the production process as an unpaid input, directly contributing to firm production. Obvious examples are public roads that are available free of charge to industrial and commercial activities. On the other hand, transport infrastructure is considered to enter the production process as a factor that augments the productivity of other inputs employed by firms. Therefore, improvements in transport infrastructure can generally be regarded as an increase in the technology of production that could enhance the overall productivity of affected businesses.

Better transportation systems, for instance, enable the movement of goods and workers to be more efficient. It can also increase firm productivity by lowering the transportation costs of inputs and outputs. Moreover, productivity gains may come from a reduction in other business costs. For example, good quality roads could lead to savings on vehicle maintenance costs. An increase in the reliability of transport allows firms to reduce stock inventory costs. In some circumstances, transport improvements may also help improve access to customers or remove trade barriers, encouraging firms to exploit economies of scale by serving larger markets. This will result in a reduction in long-run average costs of such firms that can be translated into an increase in productivity. Therefore, one way in which transport infrastructure development influences firm productivity is by its effect on production costs.

Furthermore, overall productivity growth may also arise because transport infrastructure development can be directly responsible for augmenting the productivity of labour. For example, exhausted workers may be less productive if they have to spend more time commuting. Thus, improvements in transportation services can have a direct impact on labour productivity by lowering commuting time which is spent getting to and from work (Prud'homme and Lee, 1999; SACTRA, 1999; OECD, 2002). In another particular case, an increase in labour productivity can result from a better match between the supply of jobs and skilled workers. The underlying reason for this is that transport investments can lead to an increase in labour supply by attracting in-migration of households and improve job accessibility. With more choices of prospective employees, firms will have more opportunities to recruit those who have working experience and appropriate skills they need, to the extent that investments in transport infrastructure enhance the overall productivity of firms. This could lead to changes in the quantities of inputs of production on the one hand and result in poverty reduction and economic growth on the other hand.

Transport infrastructure improvements may lead to a rise in consumption pattern of the people and labour demand by firms. This suggests that the net employment effect is ambiguous. The primary reason for this is twofold. First, the overall cost reduction associated with increased productivity enables firms to expand their markets. One specific example would be the case of competition in goods markets. That is, firms experiencing productivity gains could lower the prices of their products in order to increase market share. Falling relative prices would stimulate the demand for outputs produced by these firms, thus increasing the demand for workers and also increase the welfare of the people. This impact on the demand for labour depends on the price elasticity of product demanded (Button, 1998; Lakshmanan, et al., 2001). If it is high, then one may anticipate a large increase in output and potentially in employment. Second, a higher productivity environment could be attractive to investment.

Transport infrastructure development that enhances a region's productivity and competitive position may thus encourage expansion of existing businesses and attract private inward investment to enter the region. This could generate an increase in overall production and a higher demand for employment. Noting the fact that reduced transport costs associated with transport infrastructure development remove trade barriers and allow export of products to other regions, there could be the employment effects from this interregional trade competition (Button, 1998; Rietveld & Bruinsma, 1998; Rietveld & Nijkamp, 2000). As an increase in the demand for employment is anticipated from those expanding their markets geographically, poverty reduction in the region becomes realizable.

Following the link between transport infrastructure, economic growth and poverty reduction as informed by the theoretical framework, Solow's growth model

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will be employed in this study in line with the work of Frankel (1962), Griliches (1979), Romer (1986), and Lucas (1988).

Model Specification

Although the analysis of transport infrastructure development, economic growth and poverty reduction in Nigeria has not received full attention in the literatures, in the developed countries, studies have given more consideration to the development of transport infrastructure as a way of accelerating the pace of economic growth and reduction of the poverty level. Thus, following the work of Faridi et al. (2011), Qian and Noboru (2008) and Boopen (2006), this study employs Solow model of long run growth that postulates a continuous production function linking output to the inputs of capital and labour which are substitutable.

In a capital augmented Solow model of economic growth, assuming that the economy produces one good, output (Y) given as:

$$Y_t = K_t^{\alpha} Q_t^{\beta} [A_t L_t]^{1-\alpha-\beta} \qquad \text{.........} 1$$

Where $\alpha, \beta \in [0,1], \alpha + \beta \in [0,1]$, and t denotes time. This implies that the production function exhibits constant returns to scale in its three factors: physical capital (K), transport infrastructure capital (Q), and productivity-augmented labour (AL). Specifically, it is a Cobb-Douglas production function. All markets (both input and output markets) are assumed to be perfectly competitive. All firms are assumed to be identical. The economy can then be described by a representative agent.

Physical capital and transport infrastructure capital are assumed to be accumulating factors. That is, the representative agent saves output to have more capital (physical or transport infrastructure). Their equations of motions are:

$$\dot{K}_t = s_K Y_t - \delta K_t$$
$$\dot{Q}_t = s_Q Y - \delta Q_t$$

Where s_K and s_Q are the saving rates for physical capital and transport infrastructure capital respectively. They are exogenously given. Notice that both physical capital and human capital are assumed to depreciate at the δ.

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$\dot{L}_t = nL_t$ and $\dot{A} = gA_t$

Where *n* and *g* are exogenously given growth rates.

With these five equations, we can solve for the balanced growth paths of output, physical capital and transport infrastructure capital. The trick here is to find some transformation of these variables which converges to a steady-state. Solow model can be transform so that everything is expressed in per 'effective' worker terms. This means that we divide variable by $A_t L_t$, or the number of effective workers (Productivity-augmented worker) in the economy at time *t*. This is also called putting the system into intensive form. We will follow the same strategy here:

$$\tilde{y}_t = \frac{Y_t}{A_t L_t}, \tilde{k}_{t=} \frac{K_t}{A_t L_t}, and \tilde{q}_t = \frac{Q_t}{A_t L_t}.$$

In the intensive form, the production function and equations of motion for physical and transport infrastructure becomes:

$$\frac{Y_t}{A_t L_t} = \frac{K^{\alpha}{}_t Q^{\beta}{}_t [A_t L_t]^{1-\alpha-\beta}}{A_t L_t}$$

$$\tilde{y}_t = \tilde{k}_t^{\alpha} \tilde{q}_t^{\beta} \quad \text{..........} 2$$

Taking the rate of change of $\tilde{k}$ and that of $\tilde{q}$ we have:

$$\dot{\tilde{k}}_t = \frac{\dot{K}_t}{A_t L_t} - \frac{K_t}{[A_t L_t]^2}[\dot{A}_t L_t + A_t \dot{L}_t] \quad \text{..........} 3$$

$$\dot{\tilde{k}}_t = s_K \tilde{y}_t - [n + g + \delta]\tilde{k}_t \quad \text{..........} 4$$

$$\dot{\tilde{q}}_t = \frac{\dot{Q}_t}{A_t L_t} - \frac{Q_t}{[A_t L_t]^2}[\dot{A}_t L_t + A_t \dot{L}_t] \quad \text{..........} 5$$

$$\dot{\tilde{q}}_t = s_Q \tilde{y}_t - [n + g + \delta]\tilde{q}_t \quad \text{..........} 6$$

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$$s_K \tilde{y}_t = [n+g+\delta]\tilde{k}_t$$
$$s_Q \tilde{y}_t = [n+g+\delta]\tilde{q}_t$$

In a steady-state, physical and transport infrastructure capital per effective worker must be constant. This implies that we can solve for the steady-state by finding the value for $\tilde{k}$ and $\tilde{q}$ which set the above equations of motion to zero (other than the trivial steady-state given by setting either $\tilde{k}$ or $\tilde{q}$ equal to zero). The steady-state conditions are then:

$$s_Q \tilde{k}_t^{\alpha} \tilde{q}_t^{\beta} = [n+g+\delta]\tilde{q}_t \quad\text{.........7}$$

$$\tilde{q}_t^{\beta-1} = [\frac{n+g+\delta}{sQ}]\tilde{k}_t^{-\alpha} \quad\text{.........8}$$

$$\tilde{q}_t = [\frac{sQ}{n+g+\delta}]^{\frac{1}{1-\beta}} \tilde{k}_t^{\frac{\alpha}{1-\beta}} \quad\text{.........9}$$

Then, we substitute this expression into the other steady-state condition, and solve for $\tilde{k}$.

$$s_K \tilde{k}_t^{\alpha} \left[[\frac{sQ}{n+g+\delta}]^{\frac{1}{1-\beta}} \tilde{k}_t^{\frac{\alpha}{1-\beta}} \right]^{\beta} = [n+g+\delta]\tilde{k}_t \quad\text{.........10}$$

$$\tilde{k}*_t = \left(\frac{s_K}{n+g+\delta} \right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{s_Q}{n+g+\delta} \right)^{\frac{\beta}{1-\alpha-\beta}} \quad\text{.........11}$$

The asterisk denotes the steady-state value of a variable. Now, we can substitute this back into our expression for $\tilde{q}$.

$$\tilde{q}*_t = \left(\frac{s_Q}{n+g+\delta} \right)^{\frac{1}{1-\beta}} \left[\left(\frac{s_K}{n+g+\delta} \right)^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{s_Q}{n+g+\delta} \right)^{\frac{\beta}{1-\alpha-\beta}} \right]^{\frac{\alpha}{1-\beta}} \quad\text{.........12}$$

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$$\tilde{q}*_t = \left(\frac{s_Q}{n+g+\delta}\right)^{\frac{1-\alpha}{1-\alpha-\beta}} \left(\frac{s_K}{n+g+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \text{...}13$$

With these expression for $\tilde{k}*$ $\tilde{q}*$

$$\tilde{y}_t * = \tilde{k}_t^{\alpha} * \tilde{q}_t^{\beta} * \text{..}14$$

$$\tilde{y}*_t = \left(\frac{s_K}{n+g+\delta}\right)^{\frac{\alpha}{1-\alpha-\beta}} \left(\frac{s_Q}{n+g+\delta}\right)^{\frac{\beta}{1-\alpha-\beta}} \text{...}15$$

Note that $y = A\tilde{y}_t *$ and taking the log of equation 15 as thus:

$$\ln \tilde{y}_t * = \ln A + \frac{\alpha}{1-\alpha-\beta}\ln[\frac{s_K}{n+g+\delta}] + \frac{\beta}{1-\alpha-\beta}\ln[\frac{s_Q}{n+g+\delta}] \text{.................................}16$$

For simplicity let $\ln A = \beta_0$, $\frac{\alpha}{1-\alpha-\beta} = \beta_1$, $\frac{\beta}{1-\alpha-\beta} = \beta_2$, $\frac{s_K}{n+g+\delta} = k$

and $\frac{s_Q}{n+g+\delta} = q$, equation 16 Becomes

$$\ln \tilde{y}_t * = \beta_0 + \beta_1 \ln k + \beta_2 \ln q \text{...}17$$

Globally, good transport network in an economy stimulates the level of productivity which positively affects the growth effect of such economy. Hence, the multiplier effect of this sector will enhance the growth of other sectors meaning that development in transport infrastructure in terms of good road network will systematically advance the growth of other sectors.

The relationships between growth and the exogenous variables are equally established in respect of the relationships between poverty and the exogenous variables discussed above. It has been established in the literature that transport infrastructure development leads to economic growth which in turn reduces poverty (Wei et al., 2008). This assumption is relied on in formulating the poverty equation. Thus poverty (*pt)* could perfectly substitute for economic growth with the same apriori expectations

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since real consumption expenditure per capita is used in capturing poverty level in this study.

Then, equation 17 now divided into economic growth equation and poverty equation for easy identification

Economic Growth equation is specified as:

$$ly_t = \beta_o + \beta_1 lpt_t + \beta_2 q_t + e_t \quad \ldots\ldots 18$$

A-prior expectation; β_1>0, and β_2>0

Poverty equation is specified as thus:

$$lpt_t = \beta_o + \beta_3 ly_t + \beta_4 lq_t + e_t \quad \ldots\ldots 19$$

A-prior expectation; β_3>0, and β_4>0

Measurement and Definitions of Variables

The above equation in a Cob-Douglas function will be used in this study to show the relationship between output (economic growth) and input (transport infrastructure).

$\ln y_t$ is the log of Real Gross Domestic Product (RGDP) which is defined as the nominal GDP deflated by the composite consumer price index. This will be used as a proxy for economic growth.

$\ln q_t$ is the transport infrastructure development in Nigeria, proxy by the length of paved federal road in kilometers as data constraint restricts to segregate the transport capital figures from the country’s total investment (k). This has been used in many studies (see Canning, 1999, Canning and Bennethan, 2000, Faridi et al (2011), Qian and Noboru (2008) and Boopen (2006) among others).

pt represents poverty rate in Nigeria, however, real consumption expenditure per capital will be used in replacement of poverty only in the long run relationship analysis i.e. objective two. Though an alternative to this measure is per capita income, this study employed real consumption expenditure per capita on the basis of the consensus of opinion that an expenditure measure of poverty is superior to income measures (Okojie, 2002 and Ogun 2010).

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Sources of Data

This study uses essentially secondary data for analysis. The data on road transport network, net export, RGDP and poverty indicator from (1980-2012) were sourced from the following sources. (i)Central Bank of Nigeria (CBN) Statistical Bulletin (2012) (ii) National Bureau of Statistics (NBS) various publications (iii) World Development Indicator (2012)

Estimation Techniques

Given the objectives, the long run effect of transport infrastructure development on economic growth and poverty level was achieved following these steps: As the substantial data used in this study are macroeconomic data; there is the need to first and foremost examine the characteristics of the data to ensure their validity for further econometric application. The variables were initially tested for stationarity. This is essential given the fact that most recent developments in macro econometric modeling suggest that macroeconomic time series are not stationary in their levels and that many time series are most adequately represented by first differences (Dickey, Jensen and Thornton, 1991).

To examine the existence of unit root problem in the data series, two methods were used: Augmented dickey Fuller (ADF) and the Philips-Perron Tests. Both tests are superior estimation techniques over other methods because they both control for higher order autocorrelation. The unit root test was followed by the determination of the lag length by employing Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC), and Hannah-Quinn Criterion (HQ). The basis for selection of the appropriate lag length is identifying the criterion with the minimum lag length as the optimal lag length. This is followed by cointegration test using a multivariate approach proposed by Johansen (1988) and Johansen and Juselius (1990). This approach is based on two likelihood ratio test statistics (trace test and maximum eigenvalue test) used to test the null hypothesis of at most r cointegrating vectors among variables. The approach of the trace test presupposes that the null hypothesis is; the cointegrating vector is less than or equal to k, where k=0, 1, 2. In the case of maximum eigenvalue test, the null hypothesis states that k=0 against the alternative hypothesis that k=1. Since the study is interested in the long run effect, the co-integration equation will then be performed twice given equation 18 and 19 respectively. This is to normalized

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economic growth at first and then poverty level at the second time which gives the effect of our independent variables on the dependent variables after transposed.

Empirical Analysis and Result

Unit root Test for Annual Data Series

Table 1 presents the results of unit root tests using Augmented Dickey Fuller test and Philips and Perron test applied on annual data series.

Table 1
The Result of Unit Root Test Using Augmented Dickey Fuller Test

Series	Level	First Diff	Remark
Lpt	-0.09	-5.38	I(1)
Lq	-1.47	-5.76	I(1)
Ly	-0.02	-4.42	I(1)

Table 2
The Result of Unit Root Test Using Philips and Perron Test

Series	Level	First Diff	Remark
Lpt	-1.16	-10.14	I(1)
Lq	-1.58	-5.87	I(1)
Ly	-0.04	-4.42	I(1)

Source: Author's Computation
Note: at 5 per cent critical value = -2.96. *Lg, Lq and Lpt are log (of real gross domestic product, road transport infrastructure development, poverty level.).*

Evidence from the results shown in Table 2 confirms that all the variables (real gross domestic product (g), road transport infrastructure development (q) and poverty rate (pt), are not stationary at level. However, they became stationary after first difference under the augmented dickey fuller and Philips and Perron test. Since the series are integrated of order one i.e. I (1). Consequently, the presence of significant co-integration relationship among the variables could be determined.

Although, the results of the unit root test show that all the variables were random walk processes. It does not however imply that in the long-run, the variables could not express long-run convergence i.e. long run equilibrium. The stationarity of the residuals is a potent evidence that there is evidence of convergence to long-run equilibrium among the integrated variables. To be able to ascertain whether there is cointegration among these variables, it necessary to determine the optimal lag length

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of variables before proceeding. Therefore, the Akaike Criterion (AC), Schwarz Bayesian Criterion (SBC) and Hannan-Quinn criterion (HQC) are used to indicate the optimal lag structure for the VAR upon which the cointegration analysis is based on. The SVAR models are estimated, in order to obtain the lag length. The endogenous variable orderings enter the structural VAR models in line with equation 1.

Determination of Optimal Lag Length

For the purpose of testing for cointegration among variables, the determination of the appropriate and optimal lag length is important. Therefore, the test statistics adopted in testing for appropriate lag length are the Akaike Criterion, Schwarz Bayesian Criterion and Hannan-Quinn Criterion.

Table 3 depicts the various test statistics used to determine the optimal lag length for the variants of unrestricted VAR models. In panel 1, the Akaike information criteria (AIC) indicated an optimal lag length of 4. The Schwarz information criteria (SIC) showed a lag length of 1 while the Hannah-Quinn information (HQ) depicted an optimal lag length of 4. The last SVAR model (23) gave optimal lag length using SC as 1 while AIC and HQ as 4. It is so obvious that the results from this optimal lag length selection using these three methods are contradictory. A way to overcome this in the literature is to choose the Schwarz information criterion (SC) as it has a relatively better performance in lag choice accuracy than the other selection methods in majority of the

Table 3
Test Statistics and Choice Criteria for Selecting the Order of VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-62.042	NA	0.0299	5.00326	5.148421	5.04506
1	16.2675	132.524	0.00015	-0.32827	0.252393*	-0.16106
2	25.3256	13.2388	0.00015	-0.33274	0.683419	-0.04012
3	32.2657	8.5417	0.00019	-0.17428	1.277366	0.24374
4	55.72439	23.45870*	7.45e-05*	-1.286492	0.600653	-0.74306*
5	65.01981	7.15032	0.0001	- 1.3092*	1.013424	-0.64038

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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cases (Hacker & Hatemi-J, 2008). It is therefore selected as the most efficient and reliable criterion. Besides, the Schwarz information criterion (SC) is generally more conservative in terms of lag length than the Akaike Information Criteria (AIC).

The Relationship among Road Transport Infrastructure Development, Economic Growth and Poverty Reduction in Nigerian

In obtaining the long run relationship among road transport infrastructure development, economic growth and poverty reduction, the Trace Statistics, Max-Eigen Statistics and the Normalized Cointegrating Coefficient is obtained from the Johansen co-integration test. This is presented in Table 4 and Table 5.

Cointegration Test

Having determined the weakly exogenous variable, the cointegration test was conducted. In testing for cointegration, the maximum likelihood approach by Johansen and Julius (1990) was adopted. This is a superior test that lies on asymptotic property and therefore sensitive to error in small sample. Moreover, since most of the variables used in this study are highly trended, the Johansen test was performed under the

Table 4
Cointegration Test (Trace Value)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.540061	35.0272	29.79707	0.0114
At most 1	0.318846	12.504	15.49471	0.1343
At most 2	0.046109	1.368967	3.841466	0.242

Table 5 Cointegration Test (Max –Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.540061	22.5232	21.13162	0.0317
At most 1	0.318846	11.13503	14.2646	0.1476
At most 2	0.046109	1.368967	3.841466	0.242

Source: Author's Computation
Trace and Max –Eigenvalue indicates 1 contigrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

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assumption of linear deterministic trend in the data. Table 5.6a and 5.6b reports result obtained when the linear combination of variables as reflected in the VAR model was subjected to cointegration test.

The results of the co-integration in Table 4 and Table 5 confirm that there is at least one co-integration relationship among the macro-economic variables included in the model. Specifically, the result of the co-integration test suggests that transport infrastructural development has equilibrium condition with economic growth and poverty level at 5% level of significance, which keeps them in proportion to each other in the long run. This evidence of co-integration among the variables rules out spurious correlations and applies that one direction of influence can be established among the variables.

It is important to note that the existence of co-integration vectors among a group of variables did not tell us the nature of the long run relationship and also may not imply that there is causal influence between pairs of variables in the model of co-integration test. The Normalized Cointegrating Coefficient is obtained from the Johansen co-integration test in ascertaining the nature of the long run relationship as:

$$1y = \underset{\substack{(0.24)\\ [6.85]}}{1.62}lpt - \underset{\substack{(1.38)\\ [1.83]}}{2.53}lq + c \quad \text{.............} \quad 20$$

$$lpt = \underset{\substack{(0.96)\\ [1.64]}}{1.57}lq + \underset{\substack{(0.15)\\ [4.27]}}{0.62}ly + c \quad \text{.............} \quad 21$$

Standard error in ( ) *and t-statistics in* [ ]

From equation 20, with one lag period shows that 1 per cent increase in road transport infrastructure development significantly reduces economic growth by 2.5 per cent, while an increase in real consumption expenditure per capita as measure of poverty level increase economic growth by 1.6 per cent. Also, from equation 21, with one lag period shows that 1 per cent increase in road transport infrastructure development insignificantly reduces poverty level given an increase in real consumption expenditure per capita by 1.6 per cent. Also, 1 per cent increase in economic growth increases real consumption expenditure per capita by 0.62 per cent bringing about a reduction of 0.62 per cent in poverty level. Moreover, all the effects relation was significant at 5 per cent level of significance, except the effect of road transport infrastructure development on poverty reduction is insignificant at 5 per cent level of significance.

Conclusion/ Recommendation.

The general observation from these findings is that road transport infrastructure development could be seen as an important indicator of poverty reduction programme in Nigeria. However, the potential of road transport infrastructure development in contributing to the economic growth in the long seems to be unattainable. This could have been attributed to the way it is being handled through the various Federal Government agencies without proper monitor, and implementation needs to be critically examined and corrected. At present, road transport infrastructure has not been effectively utilised to generate maximum benefits in the Nigerian economy.

Moreover, the fact that the effect of road transport infrastructure development on economic growth and poverty reduction contradicts theory in Nigeria given the insignificant level of road transport infrastructure development on poverty reduction and its negative effect on economic growth in the long run suggests that, there is the need for the Nigerian government to re-assess its existing federal roads to know if many of them are motorable or truly in existence. This is because, most of the constructed roads could only be on paper while they are not in existence and where they truly exist, they could not stand the tension of plying them over time based on; demand exceeding supply, inferior materials use in constructing them and poor maintenance attitude among others. Based on this, many industries have close down while many others have relocated to other countries due to inability to break even given the decayed level in road transport infrastructure that increases cost of doing business in Nigeria.

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