Building a Better Nation: Assessing the Influence of Infrastructure on Economic Growth of Nigeria

⑤SAGE

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Abstract

The Nigerian economy has suffered huge infrastructure deficits since her independence in 1960, thereby limiting economic growth potential of the country considerably. Infrastructure is indispensable to achieve the main development targets in developing countries, such as urbanisation, industrialisation, export promotion, equitable income distribution and sustainable economic development. Late developing countries can benefit from previous development experience provided they choose the right model. However, the relationship between infrastructure and economic growth is still frequently debated. This article provides empirical evidence on the extent to which infrastructure investment impact economic growth in Nigeria. In this study, two models are specified and the substitution technique was adopted; the two models were collapsed to one; with this, it was possible to use OLS (Ordinary Least Square) to run the regression. The article also delves into the true nature of China's infrastructure financing in Nigeria. The findings show that infrastructure is an intermediate goods and service for the real sector, a finished goods and service for consumers and an integral part of Nigeria economic growth.

Keywords: China, economic growth, infrastructure, investment, Nigeria, poverty reduction

1. Introduction

The beginning of infrastructure is the beginning of development; this is because infrastructure makes policy intervention meaningful (Ehizuelen et al., 2013). Infrastructure is frequently mentioned as a key to fostering development and growth of a country. A binding constraint on Nigeria development is the country's crippling infrastructure deficit. In a nutshell, surveys have revealed that increasing the stock of infrastructure investments in core sectors by 1 per cent can upsurge GDP growth by up to 1 percentage point (African Development Bank (AfDB) 2010). In recognition of these facts, the development of Nigeria's infrastructure should be a key component of the strategic direction being pursued by Nigerian regime. Nigeria's infrastructure challenges, though substantial, are not daunting given the strength of the national economy. Due to the arrival of private sector investment and its abundant petroleum revenues, Nigeria is better placed than many of its African neighbours to upsurge the share of fiscal resources going to infrastructure. Compared to many of its African peers, Nigeria has relatively advanced

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infrastructure networks that cover extensive areas of the nation's territory. Transport infrastructure is inadequate though and has been described as one of the leading impediments to the country's growth. Roads are lagging far behind in investment and rail infrastructure is falling behind, too. On the other hand, airports and ports have seen considerable investment over the past few years, resulting in good international portals. It is estimated that raising the country's infrastructure level to that of the region's middle-income countries could boost annual real GDP growth by around 4 percentage points (Katz).

The government has also been advocating the increasing use of public–private partnerships for several transport projects. But infrastructure investments have to be managed from the start to project completion, because historically many of Nigeria's projects have been left unfinished and the country is littered with examples of well-founded, but unfinished projects, including roads, factories and oil and gas plants. Nigeria's infrastructure networks mirror the spatial concentration of economic activity in the south. The south is characterised by relatively high population density, and this is where many of the country's cities and larger towns are clustered. Meanwhile, there is also an important concentration of both population and agricultural activity in the north of the country. Fortunately, unlike some of its neighbours Nigeria has developed infrastructure backbones that are national in reach.

Nigeria has developed an extensive national network of roads and bridges. Nigeria's roads carry more than 90 per cent of domestic passengers and freight. Road network density is more than double that of other resource-rich African countries, although still only half of the levels found in Africa's middle-income countries. Road network conditions are generally quite patchy, alternating between good, fair and poor across the country. National connectivity and road quality will see an improvement once numerous projects are completed in the near future. Few areas remain unconnected to national back-bones, and those are generally concentrated in the central, western and eastern parts of the country. Nigeria's regional connections are fair, with a number of transnational corridors (Figure 1). These include connections to neighbouring countries like Niger, Chad, Cameroon and Benin, as well as coastal roads joining routes to Dakar in Senegal or Abidjan in Côte d'Ivoire. The Trans-Sahara Highway connects Nigeria with Algeria via Niger. A cross-African route, the Lagos Mombasa Highway, links Nigeria, Cameroon, the Central African Republic, the DRC (Democratic Republic of Congo), Uganda and Kenya.

Infrastructure development, both economic and social, is one of the major determinants of economic growth, particularly in developing countries. Direct investment in infrastructure creates (i) production facilities and stimulates economic activities, (ii) reduces transaction costs and trade costs improving competitiveness and (iii) provides employment opportunities to the poor. Development economists have considered physical infrastructure to be a precondition for industrialisation and economic development, where physical infrastructure, in general, consists of two parts: economic infrastructure, such as telecommunications, roads, irrigation and electricity, and social infrastructure, such as water supply, sewage systems, hospitals and school facilities (Murphy et al. 1989). It has been demonstrated that physical infrastructure development improves the long-term production and income levels of an economy in both the macroeconomic endogenous growth literature (Barro 1990; Futagami et al. 1993) and empirical studies (Calderón et al. 2015; Canning and Bennathan 2000; Canning and Pedroni 2008; Easterly and Rebelo 1993; Esfahani and Ramirez 2003; Jimenez 1995; Lipton and Ravallion 1995). Moreover, a number of micro studies have shown that development of infrastructure is one of the indispensable components of poverty reduction (Gibson and Rozelle 2003; Jacoby 2000; Jalan and Ravallion 2003; Lokshin and Yemtsov 2005; Van de Walle 1996).

In recognition of the role transport plays in the overall development of any society and the desire to promote rapid socio-economic development, particularly in the rural areas, the federal, state and local governments in Nigeria have been working towards the improvement and development of road transport infrastructure in the country. This is because the road accounts for more than 90 per cent of the
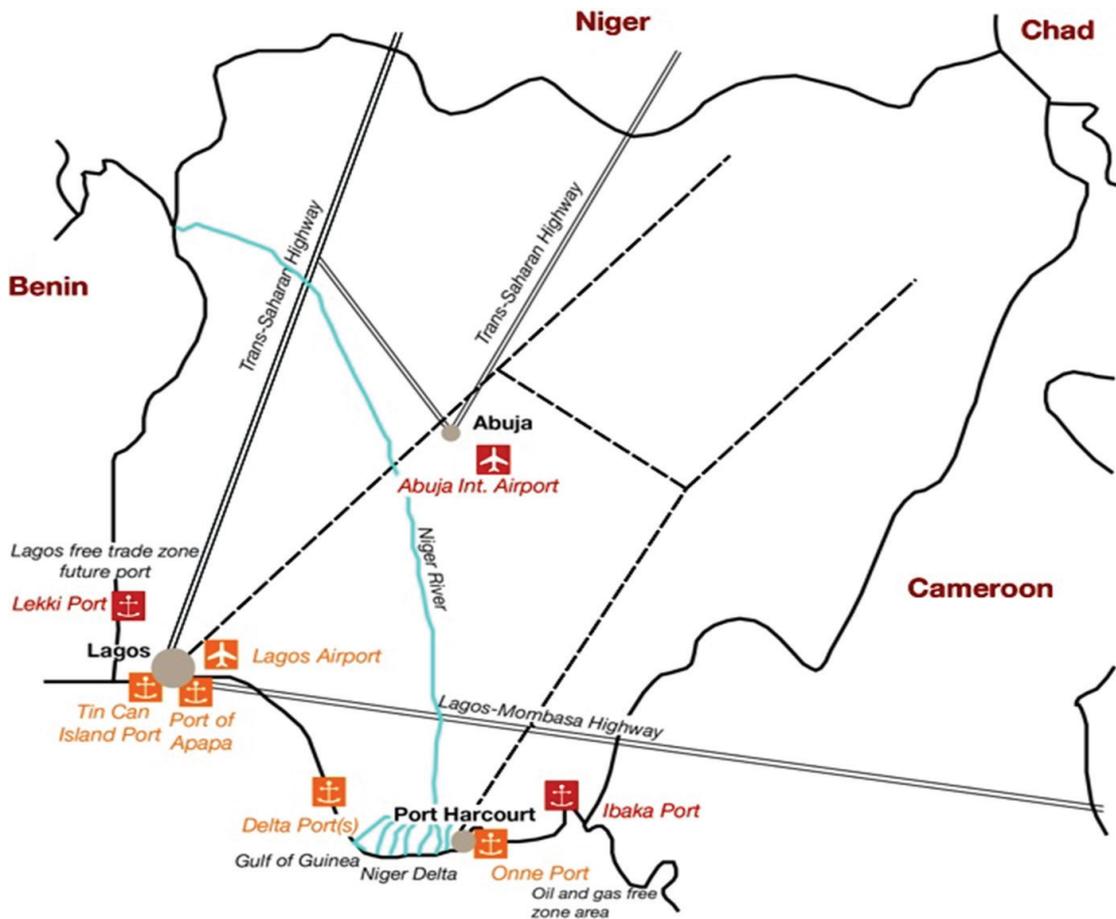
Figure 1. Nigeria Infrastructure Investment

Source: PriceWaterhouseCoopers (PwC).

movement of people, goods and services and also essential for national socio-economic activities. The federal government is responsible for about 17 per cent, state governments 16 per cent and local governments 67 per cent of road maintenance in Nigeria, Central Bank of Nigeria (CBN) (Oladipo & Olomola, 2012). According to Buhari (2000), only 50 per cent of federal roads and 20 per cent of state roads in the country were in reasonably good condition, and only an estimated 5 per cent of total rural roads were freely motor able. According to Uche (2011), the author emphasises that, out of Nigeria's 198,000 kilometres of roads, less than 20 per cent are paved and over 65 per cent are in bad condition.

The federal government of Nigeria recognised that the development of transport infrastructure is essential to the growth of the economy, and for this purpose, substantial allocation has been made, following different developmental policies. This is because the mobility of people and goods provides for a more enhanced division of labour, increased productivity, structural change, greater competitiveness, growth in incomes and higher employment. Economic activity, reflecting higher productivity and consequent economic growth, is made possible by transport. In this chain of cause and effect, polices on

transport efficiency would be necessary for further progress in economic growth and poverty alleviation programme through an empirical investigation in Nigeria.

The remainder of this article is organised as follows: The second section looks at the link between infrastructure and economic development, the third section deals with road infrastructure and economic growth by looking at some empirical evidences followed by an explanation of the analytical methods. A description of the data and empirical analysis are then presented in fourth section. Fifth section concludes the paper with possible policy recommendations.

2. Infrastructure and Economic Development

Numerous theoretical works have been done on the contribution of infrastructure to output, productivity and welfare. Much of it is closely linked to a literature concerned with the macroeconomic role of productive public expenditure. Kurz and Arrow (1970) were the first to offer a formal analysis of the effects of public capital on output and welfare under alternative financing schemes. In their framework, public capital enters as an input in the economy's aggregate production function, in the context of a Ramsey model with long-run growth exogenously determined. The endogenous growth version of this basic set-up was developed first by Barro (1990), who assumed that the government's contribution to current production is driven by its flow of productive expenditure, and later extended by Futagami et al. (1993) to include both public and private capital stock accumulation.

This investigative literature has grown vastly for more than a decade, exploring a multitude of variants of the basic model, like alternative tax structures, considering simultaneously public capital and productive current spending flows, adding public capital services in the utility function, or allowing for public infrastructure congestion (see, for example, Baier and Glomm 2001; Ghosh and Roy 2004; Glomm and Ravikumar 1997; Turnovsky 1997). In turn, empirical survey on the influence of infrastructure took off relatively recently, following the seminal work of Aschauer (1989), but it has boomed over the last two decades—literally hundreds of papers have been devoted to assess the effects of infrastructure on growth, productivity, poverty and other development outcomes, employing a variety of data and empirical methodologies. Calderón and Servén (2008) provide a partial account of the literature on the growth and inequality effects of infrastructure; more comprehensive surveys include Estache (2006), Romp and de Haan (2007) and Straub (2008).

The greater part of the empirical literature on the effects of infrastructure has centred on its long-run contribution to the level or growth rate of aggregate income or productivity. The enormous ensuing literature on the output influence of infrastructure has used a variety of data, empirical techniques and infrastructure measures. The most popular methods include the estimation of an aggregate production function (or its dual, the cost function) and empirical growth regressions. Infrastructure is variously measured in terms of physical stocks, spending flows or capital stocks constructed accumulating the latter.

A majority of this literature discovers a positive long-run effect of infrastructure on output, productivity or their growth rate. More specifically, this is the case with nearly every survey employing physical indicators of infrastructure stocks, but results are more mixed among the growth surveys employing measures of public capital stocks or infrastructure spending flows (Straub 2008). According to Ali and Pernia (2003), the benefits of infrastructure development for poverty reduction are manifested via two key channels: via the effect on income distribution (the direct channel) and via the effect on economic growth (the indirect channel). The 'income distribution effect of infrastructure' brings about improved employment and earnings prospects for the poor as a result of growth in the non-agricultural sectors of
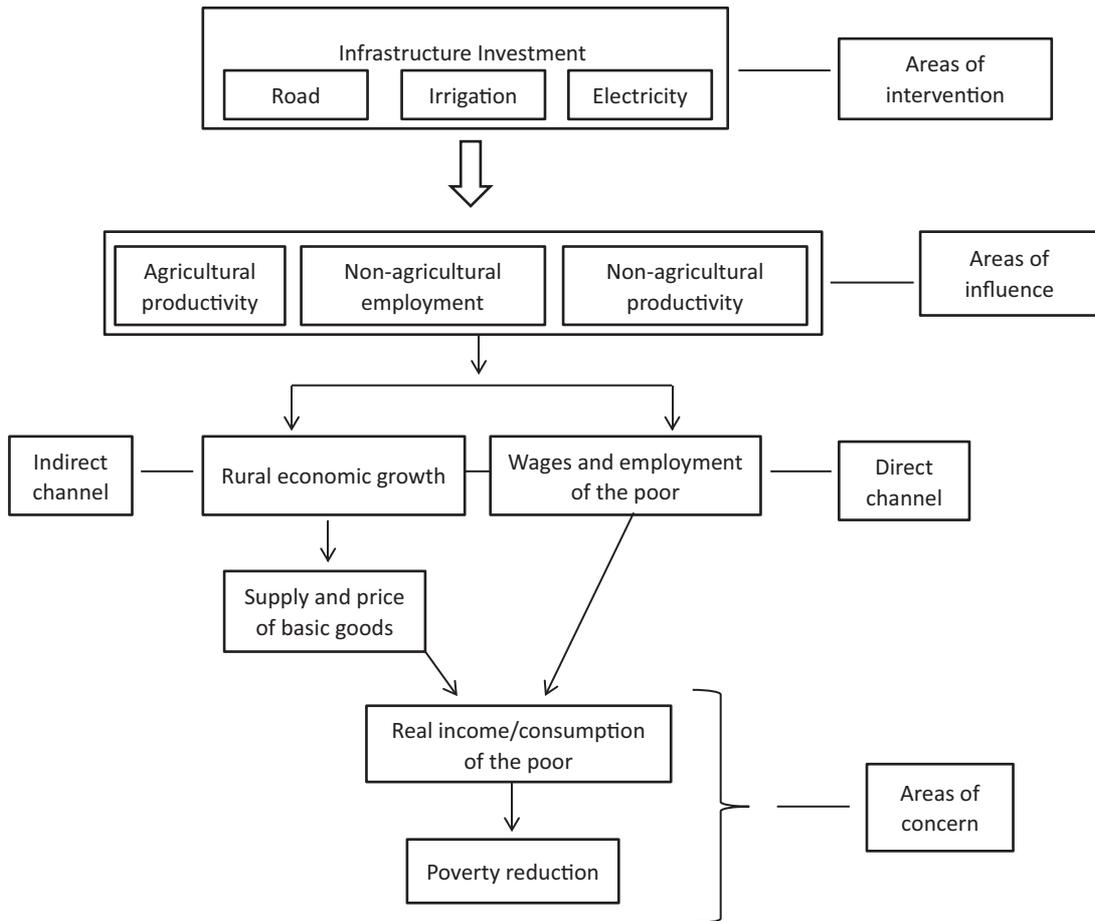
Figure 2. Showing the Connecting Role of Infrastructure in Alleviating Poverty

Source: Ali and Pernia (2003).

the economy and by increasing productivity in both the agricultural and non-agricultural sectors. By encouraging further economic activity, these productivity and employment gains drive the economic growth process leading to the so-called 'infrastructure growth effect'. Ali and Pernia (2003) offer a good diagrammatical summary of the links running from infrastructure investments to real income and consumption of the poor, and consequently to alleviating poverty (Figure 2).

Bagchi and Pradhan (2013) provide a neat diagrammatical summary of the links running from infrastructure investment on economic growth in India employing the vector error correction model (VECM), as displayed in Figure 3.

Bagchi and Pradhan discover that road transportation infrastructure investment had a bidirectional causality between gross domestic capital formation and economic growth and road transportation and capital formation. These authors also discover that rail infrastructure had a unidirectional causality between growth and rail transportation and gross capital formation and rail transportation. They proposed that for the Indian economy to experience substantial growth, gross capital formation and the
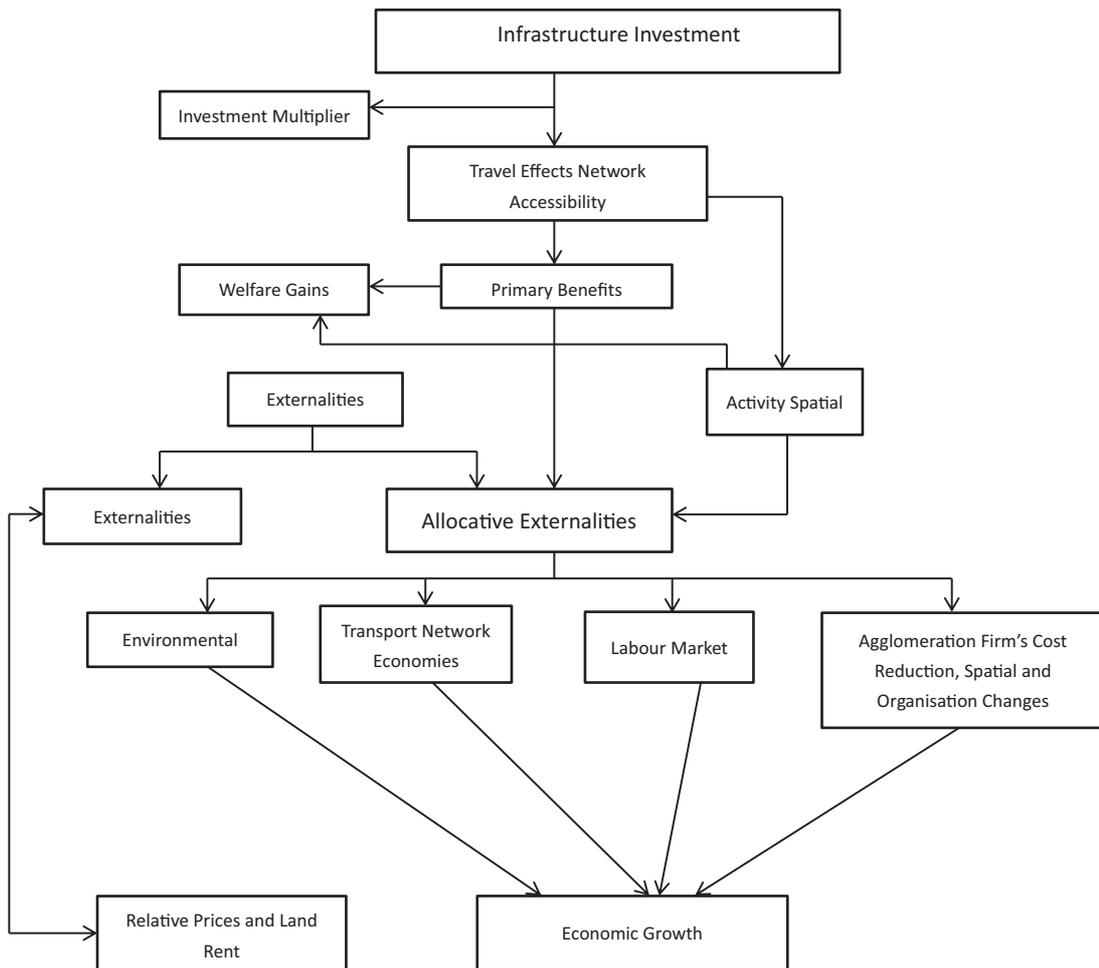
Figure 3. Displaying the Evaluation from Infrastructure Investment on Economic Growth Benefits
Source: Bagchi and Pradhan (2013).

expansion of transportation infrastructure (road and rail) must go hand in hand. Furthermore, in order for Bagchi and Pradhan to assess the economic development profits from transportation infrastructure, they applied Banister and Berechman's conceptual framework, presented in Figure 3, as a framework mitigating what they described as 'self-evident' causality. This conceptual framework is complex and addresses the multidimensional aspect of the connections between transport, development, location and other factors that play key roles in understanding the economic growth that may be fuelled by transportation investment.

Olorunfemi (2008) examines the direction and the strength of the relationship between infrastructure services and manufacturing output in Nigeria using time series data from 1981 to 2005 and Vector Autoregressive (VAR) model. Also, Granger causality test was carried out. Results show that transport and electricity services in Nigeria did not cause growth to occur in the manufacturing sector during the period. It is also revealed in the study that telecommunication and education contributed to the growth in the manufacturing sector.

In a more empirical study by Ogun (2010), the impact of infrastructural development on poverty reduction in Nigeria is addressed. Specifically, the relative effects of physical and social infrastructure on living standards or poverty indicators are examined, with a view to providing empirical evidence for the implications of increased urban infrastructure for the urban poor. The article employs secondary data for the period of 1970:1 to 2005:4 while the Structural Vector Autoregressive (SVAR) technique is adopted for its analysis. The study unequivocally finds that infrastructural development leads to poverty reduction.

Usually, firms (local, national and international) established their presence and facilities around transportation sources to profit from access to raw materials, distribution channels and customer based (Njoh 2012). According to Porter (2000), such situation can generate investment in transportation infrastructure like railroads, airports and seaports connecting to economic clusters and enhancing economic development. Economic development policies of several developing nations, in which Nigeria is not exempted, display gaps in the understanding of the relationship between transportation infrastructure investment and economic development, and how economic development will happen at various stages of development paradigms (Hossein-Rashidi and Samini 2012; Usman 2014).

For several developing nations, transportation infrastructure planning, investment and execution are seen as dissimilar from economic development planning (AfDB 2015). This is to some extent due to the existing colonial period road infrastructure framework that was planned without the long view of sustainable economic development (Njoh 2012).

There is an extensive empirical literature on the effect of infrastructure on economic growth, but results are not conclusive. There are several issues, including data availability on infrastructure, measurement of infrastructure spending and its efficiency and potential reverse causation in which higher economic growth generates an increase in public capital spending; Pereira and Andraz (2013) provide comprehensive reviews. IMF (2014) and IMF (2015) are among the attempts to control for public investment efficiency. They estimate stronger growth effects of public investment for the high public investment efficiency regime.

In the case of Asia, Pradhan et al. (2016) assess the causal relationship among telecommunications infrastructure, financial development and economic growth in 21 Asian countries between 1991 and 2012. Their results reveal that there is causality, in a Granger sense, among the variables, both in the short and long run. For the region of Africa, Donou-Adonsou and Mathey (2016) investigate the impact of telecommunications infrastructure in Sub-Saharan Africa, in a panel of 47 countries over the period 1993–2012. Their results show that the Internet and mobile phones have contributed to economic growth. Also, their results suggest that the development of telecommunications infrastructure fosters economic growth in Sub-Saharan Africa.

3. A Perspective on the Broader Impacts of Infrastructure

Many development impacts of an infrastructure investment are in fact capitalised direct impacts. The role of infrastructure in the economy is multifaceted and plays out over a long period of time. Despite the fact that these surveys offer high-quality influence estimation for each infrastructure type in each region or country, we should be aware that infrastructure cannot exist in isolation. These estimates based on lessen-form models, or a 'black box' technique, may mask the significant causal mechanisms and spillover effects behind observed influences of infrastructure. To better interpret a wide variety of infrastructure assessment outcomes employing either experimental or non-experimental techniques, we can ask a fundamental question: what role does infrastructure play in an economy generally? According to Sawada (2015), the author puts the answer this way: the market is the mechanism that employs price signals to coordinate

profit-seeking individuals and companies. But market mechanisms often fail to efficiently earmark resources because of externalities, the existence of public goods, information problems and the lack of effective property rights. To correct such market failures, the state provides other mechanisms to force people to adjust their resource allocations. Especially, the state plays an important role in supplying global or pure public goods including infrastructure. In other words, a lack of infrastructure implies the presence of uncorrected market failures in an economy. According to this logic, existing evaluation studies presume that government or donor intervention is indispensable for providing infrastructure in order to mitigate market failures and improve resource allocation. However, the state can also fail because politicians, bureaucrats and donor agencies often pursue their own objectives.[1] Local participation is seen as the most effective and sustainable way of redressing local government failure—dealing with corruption, giving the poor a greater say in policy decisions, and holding local governments more accountable (Mansuri and Rao 2013).

Sawada's (2015) figure based on Hayami's (2009) framework links the role of community to the market and state mechanisms (Figure 4). The author argues that the community is the mechanism that employs social capital to foster voluntary partnership, facilitating the supply of local public goods like construction and maintenance of physical infrastructure, conservation of the commons and enforcement of informal transactions. By employing social capital, the community therefore plays a critical complementary role in correcting regime as well as market failures.

The complementarity of market, state and community can be understood via the use of the prisoner's dilemma game, in which the profit-seeking behaviour of self-interested group members leads to a sub-optimal result or non-Pareto efficient 'Nash equilibrium'. This is a canonical example of market failure where a laissez-faire system does not result in a socially optimal 'Pareto efficient' result. This kind of market failure can be corrected theoretically by the state's legal enforcement framework. If we follow the logic of Hayami (2009), social capital should also play a significant role in circumventing the prisoner's dilemma scenario by complementing the dearth of effective market and state mechanisms. In this review, the role of physical infrastructure is taken as an instrument of facilitating mutual complementarities in connecting the market, state and community mechanisms (Figure 4).
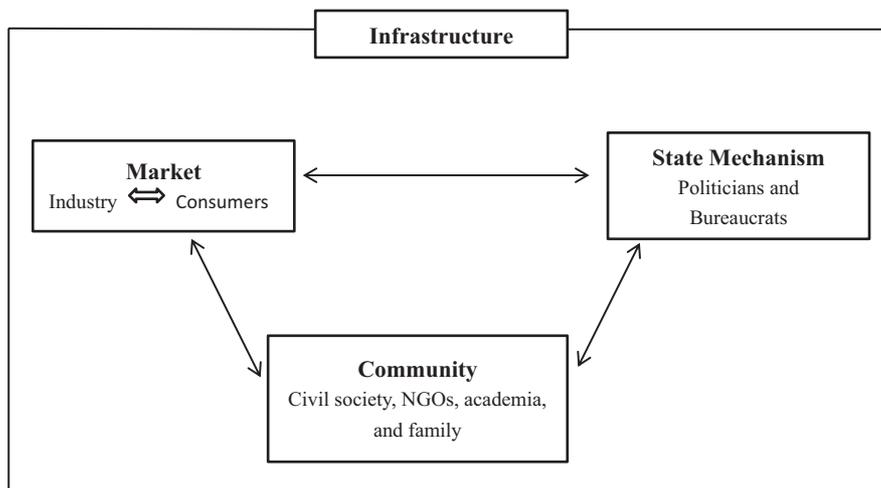
Figure 4. Connecting the Role of Infrastructure to the Market, Community and State Mechanism
Source: Sawada (2015).
Note: NGO—non-governmental organisations.

To exemplify this debate in a concrete manner, let us employ irrigation infrastructure for instance. Irrigation involves substantial cooperative work and collective action problems among community members, as the maintenance and productive use of the irrigation system require regular cleaning of the canals, necessitating coordination and cooperation among community members (Aoki 2001; Hayami and Godo 2005; Ostrom 2011). This feature of irrigation infrastructure helps us to clearly identify the determinants of the community mechanism. There have been several studies hypothesising about the role of irrigation and other communal physical infrastructure in facilitating social capital accumulation (Aoki 2001; Hayami 2009; Hayami and Godo 2005).

In this context, Aoyagi et al. (2014) examined the influence of physical infrastructure on social capital accumulation by comparing two hypotheses: the habit formation hypothesis and the repeated interaction hypothesis of social capital. They used a unique dataset from an irrigation project in Sri Lanka under a natural experimental situation in which a significant portion of irrigated land was allocated through a lottery mechanism. Also, they elicited the level of social capital employing an artefactual field experiment, such as trust games by a strategy method based on a within-subject design. By means of a hybrid experiment of the natural experiment and the artefactual field experiment, they found that physical distance embedded in irrigation systems explain variations in trust across irrigation communities, suggesting that the level of particularised trust is significantly higher than that of generalised trust. Also, within-community variation in particularised trust is driven largely by each individual's years of access to irrigation and is not necessarily affected by social distance or repeated interaction among farmers. Their outcomes indicate that social preference emerges from a technological environment determined by physical access to irrigation, supporting the habit formation of the pro-social behaviour hypothesis.

From the results of Aoyagi et al. (2014), the study can derive broader implications regarding the role of infrastructure construction in developing nations, where market mechanisms for resource allocation are generally underdeveloped. To correct such market failures, the state has other mechanisms to force people to adjust their resource allocations. But the state can also fail, especially in developing countries where governance is generally weak. In contrast, the community is the mechanism that uses social capital to promote voluntary cooperation, facilitating the supply of local public goods. Social capital thus plays a critical complementary role in correcting both market and government failures (Hayami 2009). In fact, the complementarity between the market and social capital can be better understood by the trust game adopted in their study (Sawada 2014). The trust game is a version of the prisoner's dilemma game, representing market failure, in which laissez-faire cannot achieve an efficient outcome and thus the 'Nash equilibrium' is socially sub-optimal. In the trust game, levels of trust are defined as the extent to which the observed outcome deviates away from the socially inefficient Nash equilibrium and towards the social optimal level. In other words, the trust level elicited by the trust game captures complementarity between market mechanisms and social capital.[2] Their empirical results indicate that such a complementarity can be strengthened by investments in irrigation infrastructure and resulting habit formation of pro-social behaviour. In sum, infrastructure can play an important role in amending market and government failures by solving the prisoner's dilemma problem.

3.1 Examining the True Nature of China's Infrastructure Financing in Nigeria

Nigeria has a huge infrastructure deficit, requiring capital investment of about US$25 billion annually (Financial Nigeria Development and Finance 2016). For the next half a decade, Nigeria is reported to require US$166 billion (Douglas and Stonefield 2016) to provide energy and infrastructure for its

growing population. Demand for energy and infrastructure in Nigeria, Africa's largest economy, is ever increasing as its population grows. Consequently, so has the demand for viable financing solutions to support investment in such infrastructure projects, which according to the AfDB has an infrastructure deficit of US$300 billion (ibid.). In fact, overall infrastructure spending (and in turn demand for financing) in Nigeria is growing. Where will this financing come from? Nigeria has recently attracted Chinese financial and technical support for its ambitious infrastructure plans. This part of the article examines the true nature of China's infrastructure financing in Nigeria.

Nigeria's infrastructure challenges have become protracted due to a number of reasons which include: (i) dwindling oil revenues, which makes up around two-thirds of the country's revenue due to the fall in global prices; (ii) instability in Nigeria's oil producing Delta region, due to a series of attacks on oil pipelines in southern Nigeria by militants causing crude output to hit the lowest levels in decades; (iii) United States dollar scarcity; and (iv) currency exchange risk volatility. According to Nigerian Bureau of Statistics, these macroeconomic challenges have obstructed infrastructure investment in Nigeria and contributed to Nigeria's GDP growth rate contracting 13.7 per cent in the first quarter of 2015 to a 25 year low. Nigeria GDP growth is forecasted to be 3.8 per cent in 2016 (ibid.); however, the International Monetary Fund (IMF) has cut the growth drastically to −1.8 per cent, lowest in 29 years.

This puts Nigeria GDP growth at 2.3 per cent because export dropped about 40 per cent in 2016 (The Cable 2016), as investments will seek to somewhat rebound an economy, which has grown around 7 per cent per annum for the past decade. In light of the challenges, Nigeria regime intends to address the infrastructure funding gap and support business which now need competitive, cheaper and longer term financing to fund infrastructure and other related projects in Nigeria. One of the mechanisms to address the infrastructure funding gap has been a US$6 billion loan commitment from China to fund infrastructure project in Nigeria. It is understood that Nigeria government can access this credit facility by identifying and putting forward the relevant projects to the Chinese presumably through a series of tranches in respect of each identified project.

The loan commitment coincided with a currency swap deal agreement between the Industrial and Commercial Bank of China Limited (ICBC), which is China and the world's largest bank, and the Central Bank of Nigeria (CBN). The entry into these two agreements also coincided with the signing of several memoranda of understanding (MoU) and definitive agreements for several infrastructure development projects, which reportedly include: (i) North South Power Company Limited and Sinohydro Corporation Limited (SCL) signing an agreement valued at US$478 million dollars for the construction of a 300 MW solar power in Niger State; (ii) Granite and Marble Nigeria Limited and Shanghai Shibang signing an agreement valued at US$55 million for the construction and equipping of a granite mining plant; (iii) Infrastructure Bank of Nigeria and SCL signing an agreement for the construction of a greenfield expressway for Abuja-Ibadan-Lagos valued at US$1 billion; speaking of Abuja, in the past China has undertaken a major project in Abuja. This was the Abuja All-Africa Games village that was contracted to the China Civil Engineering Construction Corporation (CCECC) in 2000 to build some 5,000 housing units for international athletes participating in the 8th annual All-Africa Games (Utomi 2008); (iv) the signing of a US$2.5 billion agreement for the development of the Lagos Metro Rail Transit Red Line project in Lagos State; and (v) the signing of a US$1 billion facility for the establishment of a hi-tech industrial park in Ogun-Guangdong free Trade Zone in Ogun State.

More recently, the Nigerian National Petroleum Corporation (NNPC) arranged an investor roadshow in China with the objective to bridge the funding gap in the country's oil and gas infrastructure sector, including pipelines, refineries, power facilities and upstream projects. MoUs between NNPC

and several Chinese counterparties were signed worth approximately US$80 billion. It goes without saying that collaboration between the two countries in relation to infrastructure projects can work (for Nigeria, it needs to work) and over the coming (in the near future) months both countries hope to play a significant role in facilitating to financial close projects between China and Nigeria that can bridge the infrastructure gap. Major infrastructure projects built by Chinese firms that have dramatically enhanced Nigeria's overall infrastructure include the Abuja Light Rail, Abuja-Kaduna railway and Lagos Rail Mass Transit System. In 2014, China Railway Construction Corporation Limited (CRCC) was awarded a US$11.97 billion contract with the Nigerian government, Beijing's single largest overseas contract. The train system would run 1,402 kilometres connecting Nigeria's economic capital Lagos in the west with Calabar in the east (China Daily, 2014).

Building is what China has been doing on a massive scale, with projects of all kinds sited in African cities and spread across this vast continent. China recently signed a contract worth 12 billion to build the Coastal Railway in Nigeria stretching 650 kilometres across the country from Calabar in the east to Aba, Port Harcourt, Warri, Benin City and Lagos in the West. Never before in human history have we seen the spectacle of a continental-sized China, which was as poor as most African countries only 30 years ago, building up Africa's infrastructure on such a scale that could help the world's poorest continent catch up in development.

4. Empirical Evidence on Highway Infrastructure and Economic Growth

To access the contribution of road infrastructure on economic growth, a number of studies specified an aggregate production function that included transportation infrastructures among the explanatory variables. According to Uwagboe (2011), the author estimated a Cobb-Douglas production function for 47 developing countries and 19 developed countries. Infrastructure was specified as gross national output from transportation and communication industries per square kilometre of land area. Uwagboe found that transportation infrastructure was an effective factor of production. Canning and Bennathan (2000), using cointegration methods, estimated the rate of returns to paved roads of 41 countries for a period of over the past four decades. Canning observed that the highest rate of return to roads infrastructure occurs in countries with infrastructure shortages. Canning and Bennathan (2000) also analysed whether physical capital, labour and other infrastructure variables are complement or substitute to road or highly correlated with physical and human capital. He however found that the margined return to roads decline rapidly if the length of paved roads increased in Isolation from other inputs. Fan et al. (2005) study on the impact of road investment in promoting production growth in China, consistently displayed the importance of road investments in fostering production growth in China.

From Table 1, it is clear that the contribution of road transport to GDP has not been encouraging in spite of government effort at revamping road development. The table shows that as at 1981, the total contribution of road transportations to GDP was 2,328.7 representing 4.89 per cent of the total GDP. This fell to 1,860.9 in 1983 representing 3.50 per cent of the total GDP leading to −2.3 growth rate of road transportation. This, however, increased to 46687.5 in 1995 representing 2.42 per cent of the total GDP leading to 156.5 growth rate of road transportation. In the year 2000, the growth rate of the sector was 19.5 per cent, this rate was not sustained, the rate fell to 5.1 per cent in 2005, rose a little to 6.9 per cent in 2010 and rose again in 2013 to 7.85 per cent; this indicates an improvement in the sector.

Table 2 reveals that out of the total GDP of 47,619.7 in 1981, rail transport and pipeline transportation contributed 110.6 representing 0.23 per cent of the total GDP. In 1994 and 1995, rail transport

Table 1. The Contribution of Highway Transportation to Gross Domestic Product 1981–2013

Year	Total GDP (NM)	Contribution of Road Transport	Growth Rate of Road Transport
1981	47,619.7	2,328.7	–
1982	49,089.3	1,905.1	18.2
1983	53,107.4	1,860.9	2.3
1984	59,622.5	2,089.8	12.3
1985	67,908.6	3,030.5	45.0
1986	69,147.0	3,171.1	4.6
1987	105,222.8	3,430.0	8.2
1988	139,035.3	3,710.0	8.2
1989	216,797.5	4,019.6	8.3
1990	267,550.0	4,886.6	21.6
1991	312,139.7	5,293.8	8.3
1992	532,613.8	8,050.8	52.1
1993	683,869.8	13,548.2	68.3
1994	899,863.2	29,826.6	120.2
1995	1,933,211.6	46,687.5	156.5
1996	2,702,719.1	66,621.7	29.8
1997	2,801,972.6	69,876.1	15.3
1998	2,708,430.9	90,067.6	28.9
1999	3,194,015.0	106,212.1	17.9
2000	4,582,127.3	116,336.7	19.5
2001	4,725,086.0	129,967.8	11.7
2002	6,912,381.3	160,679.9	23.6
2003	8,487,031.6	205,936.7	28.2
2004	11,411,066.9	344,913.0	67.5
2005	14,572,239.1	362,605.3	5.1
2006	18,564,594.7	416,240.3	14.8
2007	20,657,317.7	444,990.0	6.9
2008	23,842,170.7	472,495.3	6.1
2009	718,977.33	17534.51	6.8
2010	776,332.21	18727.95	6.9
2011	834,000.83	20017.89	6.9
2012	888,893.00	21394.38	5.85
2013	9,29,1515.40	23073.84	7.85

Source: Various issues of CBN Statistical bulletin and other periodicals.

contributed 2.9 and 2.4 respectively leading to a negative growth rate of 95.1 and 17.2. However in 2008, rail and pipeline transportation contributed 11.8 to GDP leading to a growth rate of 22.9 per cent. The year 2008 witnessed the highest growth in the sector. Since then, the sector witnessed a sharp fall to 5.7 per cent in 2009. The sector maintained stead rates in 2011 and 2012 which are 5.9 per cent respectively. In 2013, the sector managed a marginal growth rate to 6.47 per cent.

Table 2. Contribution of Rail Transport and Pipeline to Real Gross Domestic Product in Nigeria 1981–2013

Year	Total GDP (₦M)	Contribution of Road Transport	Growth Rate of Road Transport
1981	47,619.7	110.6	–
1982	49,089.3	128.3	16.0
1983	53,107.4	110.5	−13.9
1984	59,622.5	109.3	−1.1
1985	67,908.6	131.5	20.3
1986	69,147.0	138.3	5.2
1987	105,222.8	93.7	−32.3
1988	139,035.3	79.8	−14.8
1989	216,797.5	58.7	−26.4
1990	267,550.0	50.9	−13.3
1991	312,139.7	59.3	16.5
1992	532,613.8	42.7	−28.0
1993	683,869.8	58.7	37.5
1994	899,863.2	2.9	-95.1
1995	1,933,211.6	2.4	−17.2
1996	2,702,719.1	2.9	20.8
1997	2,801,972.6	3.7	27.5
1998	2,708,430.9	3.9	5.4
1999	3,194,015.0	4.2	7.7
2000	4,725,086.0	4.5	7.1
2001	4,725,086.0	4.9	8.9
2002	6,912,381.3	5.4	10.2
2003	8,487,031.6	5.9	9.3
2004	11,411,066.9	6.4	8.5
2005	14,572,239.1	6.9	7.8
2006	18,564,594.7	7.5	8.7
2007	20,657,317.7	9.6	2.8
2008	23,842,170.7	11.8	22.9
2009	718,977.33	2.12	5.7
2010	776,332.21	2.24	5.8
2011	834,000.83	2.37	5.9
2012	888,893.00	2.51	5.9
2013	9,29,1515.40	2.67	6.47

Source: Various issues of CBN Statistical bulletin and other periodicals.

4.1 Some Empirical Evidence on Telecommunications Infrastructure and Economic Growth

In spite of the clear policy relevance of telecommunication infrastructure, there are far few surveys that accentuated on the specific impact of telecommunications on economic growth. Employing data for over 15 developed and 45 developing nations from 1960 to 1973, Hardy (2014) regressed GDP per capital on

lagged telephone per capita and the number of lagged radios. He concluded that telephone per capita do have a significant impact on GDP, whereas the spread of radio does not. However, when the regression was attempted for developed and developing economies separately, no significant effects occurred. Calderon and Serven (2008) employed the causality and reverse causality analysis to confirm the existence of feedback process in which economic activities and growth stimulates demand for telecommunication services. As the economy grows, more telecommunication facilities are needed to conduct the increased business transactions. This study confirms at both the state and country's level using data from the state of Pennsylvania, USA, that telecommunication investment affects economic activities and that economic activities can also affect telecommunication investment. Roller and Waverman (2009) on their part estimated the impact of telecommunication infrastructures on economic growth from 21 Organisation for Economic Co-operation and Development (OECD) countries over the past 20 years using simultaneous approach. After accounting for simultaneity and country specific fixed effect, Roller and Waverman (2009) found that the impact between telecommunication infrastructure and aggregated output was much reduced and statistically insignificant.

Table 3 reveals that the contribution of the communication industry to GDP has actually not been encouraging until times. For example in 1981, communication contributed 159.9 to total GDP of 47,619.7 representing 0.33 per cent of the total GDP. However in 2001, communication contributed 6,891.2 to total GDP of 4,725086.0 representing 0.12 per cent of the total GDP and growth rate of 583.0 per cent which indeed was amazing. This sector witnessed the highest growth rate in 2006 with increase to 318.9 per cent from 82.9 per cent in 2005. In 2008, the sector witnessed a sharp fall in growth rate, but this was reversed in 2011 from 7.5 per cent in 2008 to 31.8 per cent, and in 2013, it dropped marginally to 24.75 per cent.

Table 3. The Contribution of the Communication Industry to Real GDP in Nigeria 1981–2013

Year	Total GDP (₦M)	Contribution of Road Transport	Growth Rate of Road Transport
1981	47,619.7	157.9	–
1982	49,089.3	179.7	11.9
1983	53,107.4	145.5	−19.0
1984	59,622.5	151.1	−3.8
1985	67,908.6	186.0	23.1
1986	69,147.0	191.8	3.1
1987	105,222.8	201.7	5.2
1988	139,035.3	215.7	6.9
1989	216,797.5	219.5	1.8
1990	267,550.0	247.9	12.9
1991	312,139.7	252.3	1.8
1992	532,613.8	323.3	28.1
1993	683,869.8	446.2	38.0
1994	899,863.2	452.2	1.3
1995	1,933,211.6	525.7	16.3

(Table 3 Continued)

(Table 3 Continued)

Year	Total GDP (₦M)	Contribution of Road Transport	Growth Rate of Road Transport
1996	2,702,719.1	605.7	15.2
1997	2,801,972.6	684.5	13.0
1998	2,708,430.9	743.3	8.6
1999	3,194,015.0	814.0	9.5
2000	4,725,086.0	1,009.1	24.0
2001	4,725,086.0	6,891.2	583.0
2002	6,912,381.3	9,891.2	42.5
2003	8,487,031.6	13,206.7	34.5
2004	11,411,066.9	21,609.5	63.6
2005	14,572,239.1	39,513.2	82.9
2006	18,564,594.7	65,524.1	318.9
2007	20,657,317.7	234,551.0	47.1
2008	23,842,170.7	261,868.8	7.5
2009	718,977.33	26,298.88	34.4
2010	776,332.21	35,339.34	34.6
2011	834,000.83	47,561.70	31.8
2012	888,893.00	62,697.40	31.8
2013	9,29,1515.40	78,215.01	24.75

Source: Various issues of CBN Statistical bulletin and other periodicals.

5. Methodology and Data

5.1 Model Specification

The study empirical analysis used a simultaneous analysis. The study specifies two models, one which is the Cobb-Douglas production function, $Q = f(K^\alpha, L^{1-\alpha})$ and the other which is on infrastructure. After applying the simultaneous equation, the two models composed to one (below for details):

From the original Cobb-Douglas production function

$$Q = f(K^\alpha, L^{1-\alpha}) \tag{1}$$

$$K^\alpha = g(\text{infra, infl, exr, } Q) \tag{2}$$

From Equation (1)

$$Q = \beta_o + \beta_1 K^\alpha + \beta_2 L^{1-\alpha} + u_t \tag{3}$$

From Equation (2)

$$K^\alpha = \delta_0 + \delta_1 \text{infl} + \delta_2 \text{exr} + \delta_3 Q + \delta_4 \text{infra} + e_t \tag{4}$$

Using the reduced form equation under the simultaneous equation method, the researcher substitute Equation (4) into Equation (3), the researcher has

$$Q = \beta_0 + \beta_1 (\delta_0 + \delta_1 infl + \delta_2 exr + \delta_3 Q + \delta_4 infra + e_t) + \beta_2 L^{1-\alpha} + u_t \tag{5}$$

$$Q = \beta_0 + \beta_1\delta_0 + \beta_1\phi_1 exr + \beta_1\phi_2 infl + \beta_1\delta_3 Q + \beta_1\ \delta_4 infra + \beta_1 e_t + \beta_2 L^{1-\alpha} + u_t \tag{6}$$

Collection of like terms

$$Q - \beta_1\delta_3 Q = \beta_0 + \beta_1\delta_0 + \beta_1\delta_1 exr + \beta_1\delta_2 infl + \beta_1\delta_4 infra + \beta_1 e_t + \beta_2 L^{1-\alpha} + u_t \tag{7}$$

$$Q(1 - \beta_1\delta_3) = \beta_0 + \beta_1\delta_0 + \beta_1\delta_1 exr + \beta_1\delta_2 infl + \beta_1\delta_4 infra + \beta_2 L^{1-\alpha} + \beta_1 e_t + u_t \tag{8}$$

Dividing by $(1 - \beta_1\delta_3)$ the researcher has

$$Q = \Omega_0 + \Omega_1 exr + \Omega_2 infl + \Omega_3 infra + \Omega_4 L^{1-\alpha} + v_t \tag{9}$$

Where,

$$(\beta_0 + \beta_1\delta_0)/(1 - \beta_1\delta_3) = \Omega_0$$

$$\beta_1/(1 - \beta_1\delta_3) = \&'_1$$

$$\beta_2/(1 - \beta_1\delta_3) = \&'_2$$

$$\beta_3\delta_1/(1 - \beta_1\delta_3) = \&'_3$$

$$\beta_3\delta_2/(1 - \beta_1\delta_3) = \&'_4$$

$$(\beta_3 e_t + u_t)/(1 - \beta_3\delta_3) = v_t$$

In order to remove the exponential in Equation (9), the researcher log the equation,

$$LogQ = \Omega_0 + \Omega_1 \log exr + \Omega_2 \log infl + \Omega_3 \log infra + \Omega_4 (1-\acute{a}) \log L + v_t \tag{10}$$

Therefore the model of infrastructure and growth is

$$LogQ = \varphi_0 + \varphi_1 \log exr + \varphi_1 \log infl + \varphi_1 \log infra + \varphi_4 \log L + v_t \tag{11}$$

Where, Q = GDP (gross domestic product), exr = exchange rate, L = labour force, Infla = inflation rate, infra = contribution of infrastructure, v_t = error term, $\varphi_i > 0$, where i = 3 and 4, $\varphi_j < 0$ where j = 1 and 2.

5.2 Empirical Results

The study used time series data obtained from various sources, such as CBN statistical bulletin, journals and Internet. Due to the spurious nature of data series, unit root test was used to check for the stationarity of each variable under consideration.

5.3 Analysis for ADF Unit Root Test

Table 4 results on the ADF unit root tests indicate that the variables (both explained and explanatory) are not stationary at 1(0) levels but are stationary at 1(1) first difference except infra (infrastructure) which is stationary at 1(2), that is, second order difference. The stationarity of the variables are at 1 per cent,

Table 4. ADF Unit Root Test Result

Variable	Values	1 % Critical Value	5 % Critical Value	10 % Critical Value	Order of Integration
EXR	−1.671363	−3.7076	−2.9798	−2.6290	I(1)
GDP	−0.356657	−3.7076	−2.9798	−2.6290	I(1)
INFL	−2.499352	−3.7204	−2.9850	−2.6318	I(1)
INFRA	−0.261163	−3.7076	−2.9798	−2.6290	I(2)
L	−2.463575	−3.7076	−2.9798	−2.6290	I(1)

Source: Author's computation using E-views 3.1.

Table 5. Result of the Regression Analysis Showing Beta Co-efficient and *t*-statistic

Variable	Co-efficient	*t*-statistic
C	0.602152	0.238085
Log*L*	0.956655	0.494467
LogINFRA	0.787663	6.856789
LogINFL	0.111694	3.462135
LogEXR	0.165190	1.735265
AR (15)	0.492507	2.838969

Source: Author's computation using E-views 3.1.

5 per cent and 10 per cent levels. Summarily, the results of the ADF tests suggest that all the variables of interest have a unit root (that is, the null hypotheses of all the relevant variables having unit root could not be rejected). This means that in order to eliminate the possibility of spurious regression results and enormous inferences, the first differences of the relevant variables in the estimation process was used.

From the result on Table 5, the R^2 estimation shows that there is goodness of fits of the model. Also, the 99 per cent indicates that the explanatory variables (*L*, exr, infra and infl) explain the explained variable (GDP) very well. This is endorsed by the *R*-bar-square of 98 per cent. This means that the explanatory variables (*L*, exr, infra and infl) have good account of the dependent variable (GDP). The f-test statistic value of 86.23 indicates that at least one of the explanatory variables is statistically significant or that the explanatory variables are jointly statistically significant in the determination of the relationship between infrastructure development and economic growth of Nigeria.

$R^2 = 0.99$
$\bar{R}^2 = 98$
F-stat = 86.23
DW stat = 1.99

For the *t*-statistic which is used to measure the individual statistic of the independent and using the rule of thumb which specifies that any *t*-value which is not up to two (2) is considered not statistically significant. From the result above, it is clear that only infra and infl (infrastructure and inflation) are individually significant in this study while others (exr, and) are not individually significant. The result of the *t*-statistic is in line with the study of Udegbunam (2000), Fan and Cha-Kong (2005), Roller and Waverman (2009) and Fedderke and Luiz (2011). In the three estimations mentioned, infrastructure was divided in components; furthermore, all the coefficients have negative coefficients which are contrary to

economic theory. As for the coefficient of the explanatory variables (exr, L.infl and infra), it is observed that outside these variables, the economic growth (GDP) will operate at approximately 0.602 rate. This means that an increase of one unit in the autonomous will generate a positive increase in the GDP by 0.602 units.

All the explanatory variables conform to a priori expectation except inflation which is in line with economic theory. For labour force (L), holding other explanatory variables constant, a unit increase in labour force will decrease GDP by 0.96 units. Also, for exr, infl and infra, a unit increase in them will increase GDP by 0.79, 0.11 and 0.17 unit respectively. Finally, the result of the DW statistic of 1.99 shows the absence of serial autocorrelation in the estimation; this makes the model/estimation acceptable.

6. Conclusion

In this survey on the impact of infrastructure on the economic growth in Nigeria, the following issues were addressed: first, the proper identification of the causal effectiveness of infrastructure in reducing poverty and promoting economic growth; and, second, the broader complementarities in the trinity of the market, state and community mechanisms. As to the first issue, two models are specified, and after applying the substitution method (reduce form equation), the two models collapsed to one which enabled the researcher use OLS estimation approach to run the regression. From the findings, it is obvious that infrastructure is an intermediate goods and service for the real sector, a finished goods and service for consumers and an integral part of Nigeria's economic growth. It is suggested that the government should intensify their effort in mobilising more resources towards the provision and improvement of basic infrastructure. Furthermore, the results suggest that the development of infrastructure capital creates multiple-year positive impacts on private capital formation as well as job opportunities.

Infrastructure is as well significant to household and firms as the availability and quality of infrastructure result in different decisions to invest and may influence migration, business establishment location. Although, the result of the two estimations speak that infrastructural development has a positive linkage with economy growth but, the researcher believes this is in term of availability and quality of infrastructure in the economy. As to the second issue, evaluators of infrastructure projects need to place them in a broader community framework, correcting both market and government failures. As a methodological instrument, evaluators can adopt, for example, a hybrid method of natural and artefactual field experiments to elicit the role of infrastructure in facilitating the complementarity of the market, state and community mechanisms. Developing nations such as Nigeria need to recognise that when infrastructure investments are made, the derived profit from the investment usually extend beyond economic transformation and development to social transformation.

6.1. Policy Recommendations

Infrastructure is a key driver for progress across Nigeria and a critical enabler for productivity and sustainable economic growth. However, as can be inferred from the studies by other experts, infrastructure investments alone do not have a significant influence on economic growth. The institutional environment is a very important complement, allowing infrastructure investments to be translated into economic growth.

Based on this, the recommendations provided in this study offer effective guidelines for future action. Politicians, policymakers in Nigeria and other developing countries can use them as relevant policy guidelines when establishing new policies, the private sector can use them as a check list to determine

business potential in the developing world and donor countries and NGOs can use them as the basis for examining new directions for infrastructure assistance and cooperation.

1. Infrastructure demands strong planning and coordination functions: Coordination functions not only address economic factors—they include environmental and social considerations and require coordination among central government offices and local governments. Old models of top-down economic planning should give way to a model where the government coordinates, with other stakeholders, strategic plans that respect the modern ideals of democratisation and an active role for the private sector.
2. Fiscal space for infrastructure is critical: The long-term goal is to pay for infrastructure through user fees. But it may be necessary over the short term to cap those fees, and large investments generally require upfront financing. In those cases, short-term financing from public sector is necessary. And when private capital is invested, the public sector may have to share some of the risks. In Nigeria, infrastructure development should receive public sector financing, on condition that governments take the necessary steps to ensure macroeconomic stability, sound fiscal and debt management and private sector participation. Investments for worthwhile infrastructure can create a 'virtuous circle' of growth leading to more fiscal revenue. The challenge is to select the right projects and implement them with effective policies and regulations.
3. Nigeria needs reliable and responsive development partners: Infrastructure is a long-term asset, so Nigeria government needs reliable partners with the aim of promoting infrastructural development that makes use of both public sector financing from development partners and private sector investments. Public sector financing must be linked more closely to the development policies and poverty reduction strategies of Nigeria. The role of the development partner, not only in terms of financing but also in offering knowledge, is very important.
4. Nigeria can introduce regulated pricing systems to generate dedicated revenue streams that would provide a long-term solution to the problem of road investment, maintenance and finance.

Notes

1. For different motives of donors, see, for example, Alesina and Dollar (2000).
2. Karlan (2005) found this complementarity among microcredit clients in Peru.

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