DOKUZ EYLUL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
FACULTY OF BUSINESS
DOCTORAL THESIS
DOCTOR OF PHILOSOPHY (PHD)

THE EFFECT OF ROAD TRANSPORTATION ON THE ECONOMIC GROWTH OF NIGERIA

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İZMİR - 2018

APPROVAL PAGE

DECLARATION

I hereby declare that this doctoral thesis titled as “The Effect of Road Transportation on the Economic Growth of Nigeria” has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honor.

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Kelechi C. AMAKU

ABSTRACT

Doctoral Thesis

Doctor of Philosophy (PhD)

The Effect of Road Transportation on the Economic Growth of Nigeria

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This research evaluates the impact of short-run and long-run impact of road transport infrastructure on GDP growth. It also examines the effect of road transportation infrastructure on poverty, the non-linearity relationship between road transportation systems and economic growth in Nigeria. Using an Autoregressive Distribution Lag, Ordinary Least Square Vector Autoregressive Model, it was found that the effect of road transport on GDP is positive and statistically significant in the long-run and short-run. It was also found that road transport has a significant positive effect on poverty reduction in Nigeria. The relationship between road transport and economic growth was found to be U shaped meaning that road transport is a drag on growth when the level of road construction is low. The positive growth effect of road network begins at road length of about 190 million kilometers for Nigeria. The Cause-Effect relationship between economic growth and road transportation is inconclusive. The thesis recommends an increased budget allocation to the road network and the need to ensure proper connectivity and linkages among federal, state and local roads. This will accelerate accessibility, the mobility of material and non-material resources which further improve economic growth and reduce poverty.

Keywords: Road Transportation, Economic growth, Poverty, Nigeria.

ÖZET

Doktora Tezi

Karayolu Taşımacılığının Nijerya'nın Ekonomik Büyümesine Etkisi

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Bu araştırma, karayolu taşımacılığı altyapısının kısa vadede ve uzun vadede etkilerinin GSYİH büyümesi üzerindeki etkisini değerlendirmektedir. Ayrıca, karayolu ulaşım altyapısı ve yoksulluk arasındaki bağlantıyı, karayolu taşımacılığı sistemleri arasındaki doğrusal olmayan ilişki ile Nijerya'daki ekonomik büyümeyi inceliyor. Bir Otoregresif Dağıtım Gecikmesi, Vektör Otoregresif Model ve Sıradan En Küçük Kareler kullanılarak, karayolu taşımacılığının GSYİH üzerindeki etkisinin uzun dönemli ve kısa dönemli pozitif, fakat çok küçük olduğu bulunmuştur. Ayrıca, kara taşımacılığının Nijerya'da yoksulluğun azaltılması üzerinde önemli bir olumlu etkisi olduğu bulunmuştur. Karayolu taşımacılığı ile ekonomik büyüme arasındaki ilişki U şeklindedir, bu da karayolu taşımacılığının seviyesi düşük olduğu zaman karayolu taşımacılığının büyümeye sürüklenmesi anlamına gelmektedir. Yol ağının olumlu büyüme etkisi, yaklaşık 190 milyon kilometre yol uzunluğunda başlar. Ekonomik büyüme ve karayolu taşımacılığı arasındaki Neden Etkisi ilişkisi yetersizdir. Bu tez yol ağına daha fazla bütçe tahsisi yapılmasını ve federal, eyalet ve yerel yollar arasında uygun bağlantı ve bağlantıların sağlanmasının gerekliliğini önermektedir. Bu, erişilebilirliği, ekonomik büyümeyi daha da artıran ve yoksulluğu azaltan maddi ve maddi olmayan kaynakların hareketliliğini hızlandıracaktır.

Anahtar Kelimeler: Karayolu Taşımacılığı, Ekonomik Büyüme, Yoksulluk, Nijerya.

THE EFFECT OF ROAD TRANSPORTATION ON THE ECONOMIC GROWTH OF NIGERIA

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ABBREVIATIONS

ADF	Augmented Dickey-Fuller test
AIC	Akaike information criteria
ARDL	Auto Regression Distribution Lag
BVAR	Bayesian Vector Autoregressive model
CONTRAN	Contribution of Road Transport to GDP
FDI	Foreign Direct Investment
FPE	Final Prediction Error
GDP	Gross Domestic Product
GCF	Gross Domestic Capital Formation
HQ	Hannan-Quinn Information Criterion
HDI	Human Development Index
K	Capital
L	Labour
LR	Sequential Modified LR criterion
OECD	Organization for Economic Co-operation and Development
OLS	Ordianry Least Square
POV	Poverty
PP	Phillips Perron
RGDP	Real GDP
SADC	Southern Africa Development Community
SIC	Schwartz information criteria
VAR	Vector Auto Regression Model
VECM	Vector Error Correction Model
X	Road Transport Nework

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Transport infrastructure is one of the bedrock of socio-economic development in any nation. It is a major indicator of economic development and has been linked to every stage of development beginning from a primitive economy, an industrial revolution, and mass production to globalization (Nistor and Popa, 2014). The relationship between transport infrastructure and economic growth has attracted a lot of interest from scholars, policymakers, and politicians since the seventeenth century. Adam Smith posited that transport is a productive branch that creates value, but not the use-value and facilitates the division of labor. Transportation is the movement of goods and people for certain purposes. Transport infrastructure, on the other hand, represents the major structure put in place to facilitate the provision of transport services and operations e.g. rail tracks, roads, air, and seaports. Transport is a derived demand rather it is linked to the survival of other sectors namely social, political and economic sector.

Road transport is a branch of transportation which involves the movement of goods and people on land. The adequacy of road transport infrastructure determines a country's rate of development, the rate of diversifying production, coping with population growth reducing poverty, expanding trade, or improving environmental conditions (Canning and Pedroni, 2008). A good road transport infrastructure raises national and sectoral productivity and lowers production costs. Good road infrastructure services help the poor contribute to environments sustainability. Clean water and sanitation, non-polluting sources of power, safe disposal of solid waste, and better management of traffic in urban areas provide environmental benefits for all income groups. The urban poor often benefit most directly from good road infrastructure

Good road network also facilitates agricultural production and tourism. Road links the rural remote areas to the urban areas, thereby promoting products movement and marketing. Ogunsanya (1995) found that an improvement in transportation facilitates

effective and efficient cattle delivery in Costa Rica and improved agricultural productivity in Thailand leading to multiple increases in rice, sugar cane, vegetables and bananas production. Inusa (2002) attributed the growth in the cities such as Lagos, Portharcout, Kano and Jos etc to the completion of the railway line. According to Inusa (2012), transportation contributed to improved profitability level of agricultural production in the Northern part of Nigeria when a railway line, completed in 1914, linked Lagos to Kano. According to Mabogunje (1971), some of the variables that determine the level of development in a given environment are easy accessibility and mobility. Transport affects agricultural marketing because it is the only means by which farmers can transport their produce to the market. Poor transportation in the rural areas has resulted in low productivity, low income and a fall in the standard of living of rural residents and high rate of poverty (Aloba, 1986).

The link between transport and economic growth has also been explored in many studies with particular focus on developed economies. According to Stephen (1998), transportation can form the focus of growth activity and it is an integral part of developmental behavior. For a nation to strive and contribute significantly to the domestic economy, there must be adequate transport system that is safe, convenient, fast and relatively cheap. Khadaroo and Seetanah (2007) found that tourism development is sensitive to Malaysia's transport infrastructure. Musa and Ndawayo (2015) revealed that transport facilities are the major determinant of economic development in Nigeria, where other factors are the availability of recreational and social facilities and security.

Nigeria like any other developing country recognizes the importance of and need to develop an efficient transport system evidently stated in the third National Development Plan of 1975 to 1980. The transportation system has to support the growth and development of agriculture, commerce and industry with efficient movement or people and goods throughout the country. As a matter of public policy, the government supports the continued development of efficient dynamic and flexible transport service as being vital to economic growth, expanding productivity and the general process of the nation. The efficient and effectiveness of transportation system influence the cost of every commodity consumed or exported, thereby affecting business economic and industrial

opportunities of every citizen the basic objective of the government in this field is to develop and assure the continued expansion availability if fast, safe and economical transport service needed in a growing and changing economy in order to move people and goods in response to public and private demand the lowest consistent with health safely, convenience, and their broad public objectives (Ahmans, 1990).

The development of the modern transport system in Nigeria can be categorized into two phases. These are colonial period and the post-colonial period. The network of rail, waterways, and road under the colonial period was geared basically to meet the exportation of cash crops (National Transport Policy, 2010). The main ideology of transport system in the post-colonial era is the unification of regions in Nigeria through network road and rail transport. The total length of national road network in the year 1960 was 6500Km. This grew up to 10,000Km in 1970 and 29,000Km in 1980 (Canning and Pedroni, 2008). As of 2011, the national road network has grown to 198,000Km (FRSC, 2011).

1.2. PROBLEM STATEMENT

Road transportation is the most commonly used mode of transportation in Nigeria. Nigeria's road network is less developed and has been described as one of the poorest among Sub-Saharan Africa countries. An index normally used to compare road transport internationally and regionally is road density. This measures the kilometers of road per 100 square km of Land area available per person (World Bank). The average road density in Nigeria is 21.0 km. This is relatively lower that of Ghana, Mauritius, Seychelles and South Africa whose road density is 24.0 km, 99 km, 110 km and 30 km respectively (World Bank, 2015). The Global Competitive Index (GCI) ranked the quality of roads in Nigeria as 127th out of 144 countries and 27th out of 34 in Sub-Saharan Africa. Apart from overall poor road network, another major concern is that rural road network is grossly inadequate to serve the rural economy. Many rural areas with abundant natural and agricultural products could not be linked with the markets for these products.

Although there are substantial works of literature on transport and economic growth in developed countries, studies in this field are limited in developing countries, particularly in Nigeria. Empirical studies on road transport in Nigeria are limited due to the scarcity of data on physical measurement of road transport. Most studies on road transport in Nigeria are descriptive in Nature (e.g Adesanya 1995; Eboh, 2005; Anyanwu, Adebusuyi, and Kukah; 2003 etc). Only a handful of studies relied on sound inferential statistics and econometric foundation to push forward their arguments. Some related studies in Nigeria include Aigbokhan (1999) who observed that transport infrastructure variables has a significant positive relationship with private investment and economic growth. The study found that expenditure on roads enhances distribution of goods and services and promotes industrial development. Anyanwu, Adebusuyi, and Kukah (2003) observed that economic activities and growth in Nigeria depended on the level of road transport development. Nwakeze and Yusuff (2010) examined the impact of road transport investment, accidents linked to traffics, and congestion on economic growth in Nigeria. With the use of error correction/cointegration, they observed that investments in road transport has a significant positive impact on economic growth, while, congestion and traffic accidents contribute negatively to economic growth. Also, Using the Ordinary Least Square Regression (OLS) technique, Bosede Abalaba and Afolabi (2012) found that that transport output and investment made on transport infrastructure in Nigeria have significant positive contribution to growth in Nigeria between 1981 and 2011, and Nworji and Oluwalaiye (2012) using government expenditure as proxy for transport infrastructure found that transport and communication exerted significant impact on the growth of the economy. Gramlich (1994) admitted that the direction of causality (cause-effect relationship) from road transport to economic growth or from economic growth to road transport is unclear. Also, the relationship between road transport and economic growth is not a direct one. The result depends on the measurement of road adopted, functional specification, and method of estimation and level of development of an economy.

More so, while several studies focus on the nexus between road transport and economic growth, only a handful studies focus on the impact of road transport infrastructure on poverty. An exception to this is Oladipo and Olomola (2015), who use

Vector Error Correction Model to examine the relationship among road transport, economic growth and poverty reduction in Nigeria. However, the study focuses only on the simple and naïve measure of poverty; consumption expenditure and ignore the fact that poverty is multidimensional in nature and requires multiple composite indexes for its salient features to be adequately captured. Thus, this thesis intends to examine the relationship between poverty level and road transport by using a composite index of poverty.

From the foregoing, the major problem in the literature regarding growth-transport nexus are;

i- There seems to be the difficulty of accurately pinning down the contribution of transport infrastructure to economic growth;

ii- The road transport infrastructure is remarkably weak making the contributions of transport to the Nigerian economy debatable. The current state of transport infrastructure in Nigeria is a major developmental challenge towards achieving the national vision of becoming one of the largest economies by 2020

iii- Previous studies in Nigeria consider road infrastructure data from investment perspectives which have a demerit of leading to systematic errors in stock estimates. Hence, there is still need for more research in the field in order to contribute to the existing literature.

In addition, available materials on this area in Nigeria do not explore the possibility of non-linear function for growth-transport function and seem not to cover sufficient period to warrant meaningful conclusion and generalization. Using large sample and enough periods give enough autonomy for the eradication of sampling error and thus, enhance the inferences that may be derived from this study. Also, while several studies have focused on the relationship between road transport and economic growth, however, to the best of my knowledge, no study has empirically examined the existence of threshold stock of road transport after which income will not be significantly impacted. As is noted from the literature that growth effect of infrastructure will be significant at a low level of income and its effect on growth deteriorates or even becomes insignificant as countries reach the middle/ higher bracket of development (in terms of output growth). Computing

this infrastructure threshold can serve as a yardstick to policymakers in charge of infrastructure in the country. Thus, this study intends to fill these gaps by examining the road transport threshold for the Nigerian economy.

1.3. OBJECTIVES OF THE STUDY

The overall objective of this study is to examine the effect of road transport infrastructure on economic growth in Nigeria between 1980 and 2015.

The specific objective includes;

i- investigate the short-run and long-run effect of road transport on GDP growth

ii- examine the effect of road transport on poverty level

iii- Examine the threshold stock of road transport for which income is not significantly affected, and

iv- Inspect the direction of causality between investments in road transport and GDP growth,

1.4. THEORETICAL FRAMEWORK AND STATEMENT OF HYPOTHESES

Road transportation is as old as mankind. It is one of the modes of transportation, rail, sea, and air are the other means of transportation. Road transport has become the most ubiquitous mode of transport and available to and made use of by the greatest proportion of the populace and covers the largest part of world land area. "Roads are strips of land that provide a route for movement from one place to another" (Filani 1978). The importance of road transport is glaring since other means of transportation would have been incapacitated for the complementary role played by road transport. Road transportation is a social infrastructure which creates new areas of economic activities, improves agricultural production, and improves trading activities and engenders urbanization process. Road transportation is indeed the lifeline of the economy in the local regions and the socio-economic development of any society depends to a large extent on

the nature and structure of the road transportation network of the society (Filani, 1978; Olubomehin, 2012).

All modes of transportation are important in one way or the other in facilitating development in a region. The choice of any specific mode of transportation for any particular purpose depends on a range of modes available, safety, relative costs, culture and convenience (Mbaye and Moustier, 2000). However, unlike other means of transport such as rail, the flexible nature of road transportation facilities makes it more preferable and reliable to people and the fact that it opens up remote and rural areas, making it more and easily accessible, thereby stimulating economic growth. Advantages of road transport over other modes of transport include; less capital outlay; door to door services which reduces cartage, loading and unloading expenses; accessible to rural areas; flexible services in terms of timing and routing; suitability for short distance; feeders to other modes of transport; savings in parking cost; and less cost. Roads transport enhances mobility, taking people out of isolation and therefore poverty. Trucks, buses, coaches, and taxis are safer, more efficient, cleaner and quieter today than ever before.

The roles of road transport in facilitating trade and commerce, productivity, growth and poverty reduction have long been recognized. "Not only does road transport infrastructure facilitate the direct provision of services to consumers, it also provides intermediate inputs that enter into the production of other sectors and raise factor productivity" (Anyanwu, *et al*., 1997). The potential significance of road transport toward promoting specialization, diversification and economic growth cannot be underestimated. Many countries (developed and developing) has been motivated to invest hugely in road transport infrastructure Thus, the stimulating role played by roads in economic development has motivated the government to spend a huge amount of money on transport development. This is especially noted in Nigeria during the National Development Plan, 1975-1980.

In Africa, roads are the primary mode of transport for both freight and passengers. For example, in the Southern Africa Development Community (SADC) region, road transport carries over 80% of the region's goods and services (Pinard and Greening, 2004). However, the road network in Africa is characterized by several constraints that limit

economic growth and development within the countries. The work of Food and Agriculture Organization (2002) indicates that apart from North Africa, Africa's rural infrastructure is generally inadequate and underdeveloped, with the lowest density of paved roads of any of the regions in the rest of the world.

A World Bank research (World Bank, 2001) indicated that a significant improvement in socioeconomic living conditions was estimated with rural roads investment. The estimated benefits include improved access to social infrastructure (schools and health centers), increased opportunities to access education and health facilities and improved social interaction and mobility, which are important for social and economic development.

Additionally, there is improved access to markets by reducing transport costs; improvement of the marketability of perishable goods through timely and cheaper transport that will provide a direct incentive for more market-oriented agriculture; and with more profitable cash crops, an increase in rural income and also additional employment opportunities.

Usually, benefits of road investments are direct, indirect or induced. The direct benefits include travel time savings, savings in vehicle operating costs and reduced accidents costs among others while indirect benefits are in form of employment opportunities that are related to the road investment. The induced benefits come from the local economic development – towards poverty alleviation – resulting from the road investment. This includes enhanced self-sufficiency, increased production, and efficiency, improved access to the market, social services (such as healthcare and educational facilities) and increase in household income and a more equal distribution of income (Lombard and Coetzer, 2007). But, just like Litman, Wallis (2009), also said that there is nothing 'special' about investment in transport infrastructure from a regional perspective. While there is some evidence regarding the responsiveness of growth to investment in transport infrastructure, this is no less true than other forms of public spending. It is unlikely that investment in transport infrastructure will have dramatic effects on regional economies.

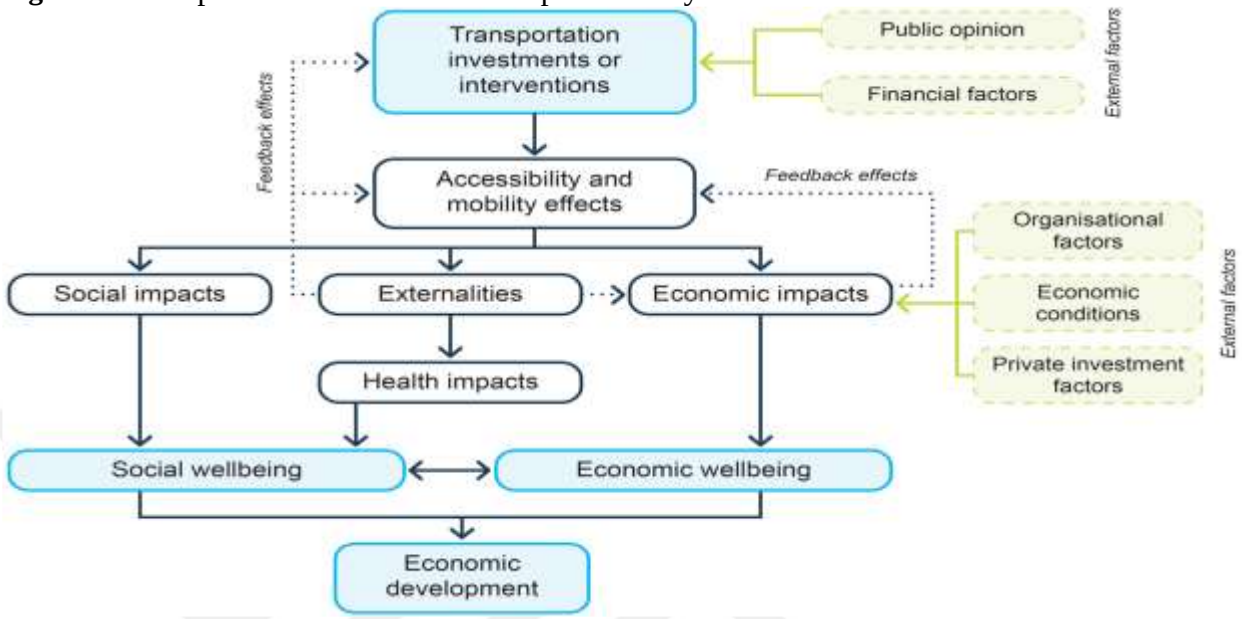
In general, development of transport infrastructure is a necessary but not sufficient condition for national and regional economic development and growth. The incremental economic gains of further investment in transport infrastructure especially in developed economies are likely to be small. Arguably, there is a spectrum within which some developed economies may experience greater gains than others, but solid evidence to this effect is lacking. In conclusion, as earlier implied, the link between road transport improvement and economic development depends on complementary regional infrastructure and specific contextual considerations.

Road transportation has contributed in many ways to the development of Nigeria. According to Babatunde (1998), road transport is important to the realizations of the overall development objectives of the average citizen's and nations' social and economic desires. Road transport opens up economic and settlement frontiers of a country. For instance, in Nigeria, the introduction of feeder roads services linked up to the major railway stations along the Lagos-Kano with products such as cocoa, groundnut, beans, palm produce, cow etc. Road transport facilitates movement of men and material, encourages trade and commerce, links industry and agriculture to markets and opens up backward regions (Babatunde, 1998).

Road construction engenders employment generating industries and services that help to sustain a transport allied industries. These include vehicle repairs, petroleum depot, and filling stations, etc. Furthermore, Road construction has also been playing an increasing role in the development of tourism. For example, in Nigeria, in some states, new roads have been constructed to provide access to places of tourism. Road transport also eliminates rural isolation, transformed urban development patterns, opened up new forms of recreation and changed human behavior and lifestyle (Onyeacha et al., (2015).

Figure 1 indicates the broad relationships between transport investment and economic development. From the figure, investment in transport was depicted to have multiple effects on economic growth. Some of the effects include accessibility and mobility effects which lead to social-economic well-being and create positive externalities. The externalities facilitate healthy being and improve life expectancy, all of which transform into economic development.

Figure 1: Transport and Economic Development – key Connections



Source: adapted from Leung (2006)

The theoretical basis for this thesis can be found in the neoclassical model of Solow (1956) and the economic theory of infrastructure and commons management popularized by Frischmann (2005). The former theory is relied on for factors affecting economic growth, while in the latter theory the role of road transport in economic growth is derived. The Solow neoclassical growth model has been the backbone of economic growth theories for the several since it was published. The major premise of the theory is that it seeks to explain the growth rate of aggregate output from various factors, such as labor, capital, and technological progress also known as the Solow residual.

The growth model. The standard neoclassical growth model relating these factors to output is given as follows:

$$Y(t) = A(t)\, f\,[\, K(t), L(t)\,]$$

Where $Y(t)$ represents output in time (t), $K(t)$ capital input in time (t) and $L(t)$ labor input in time (t). $A(t)$ denotes the technological progress or productivity in the economy.

The Solow growth model predicts that in a steady-state equilibrium the level of per capita income will be determined by the prevailing technology, as embodied in the

production function, and by the rates of saving, population growth, and technical progress, all three of which are assumed exogenous. Since these saving and population growth rates differ across countries, the Solow model yields testable predictions about how differing saving rates and population growth rates, affect different countries' steady-state levels of per capita income: other things being equal, countries that have higher saving rates tend to have higher levels of per capita income, and countries with higher population growth rates tend to have lower levels of per capita income.

However, given that population growth is constant in the long run, saving rate and productivity are the drivers of economic growth in the long run. Given that saving rate facilitates economic growth through capital accumulation or investment, Solow's theory gives credence to the notion of investment in road transportation infrastructure. Thus, in applying Solow's neoclassical theory to this study, it is expected to find that investment in road transportation infrastructure (road networks) would have a significant effect on economic growth in Nigeria. Hence, hypothesis one is stated as follows;

H1: There is a significant relationship (short run and long run) between road transport and economic growth in Nigeria.

The economic theory of infrastructure and commons management expounded by Frischmann (2005) also gives a theoretical basis for the importance of road transport in the socio-economic transformation of an economy. Frischmann contented that investment in infrastructure, such as a network of roads, would generate economic value and facilitate social change. These created economic values could lead to poverty reduction and improved standard of living through cost reduction, mobility, and rural-urban linkage. Analysts have also emphasized on how lower transportation costs transform a society by facilitating greater access to markets, decrease trade costs and close interregional price gaps, reduce input and output prices of crops and in turn affect agricultural returns (Casaburi et al 2013; Donaldson 2013). Thus, hypothesis two is stated as;

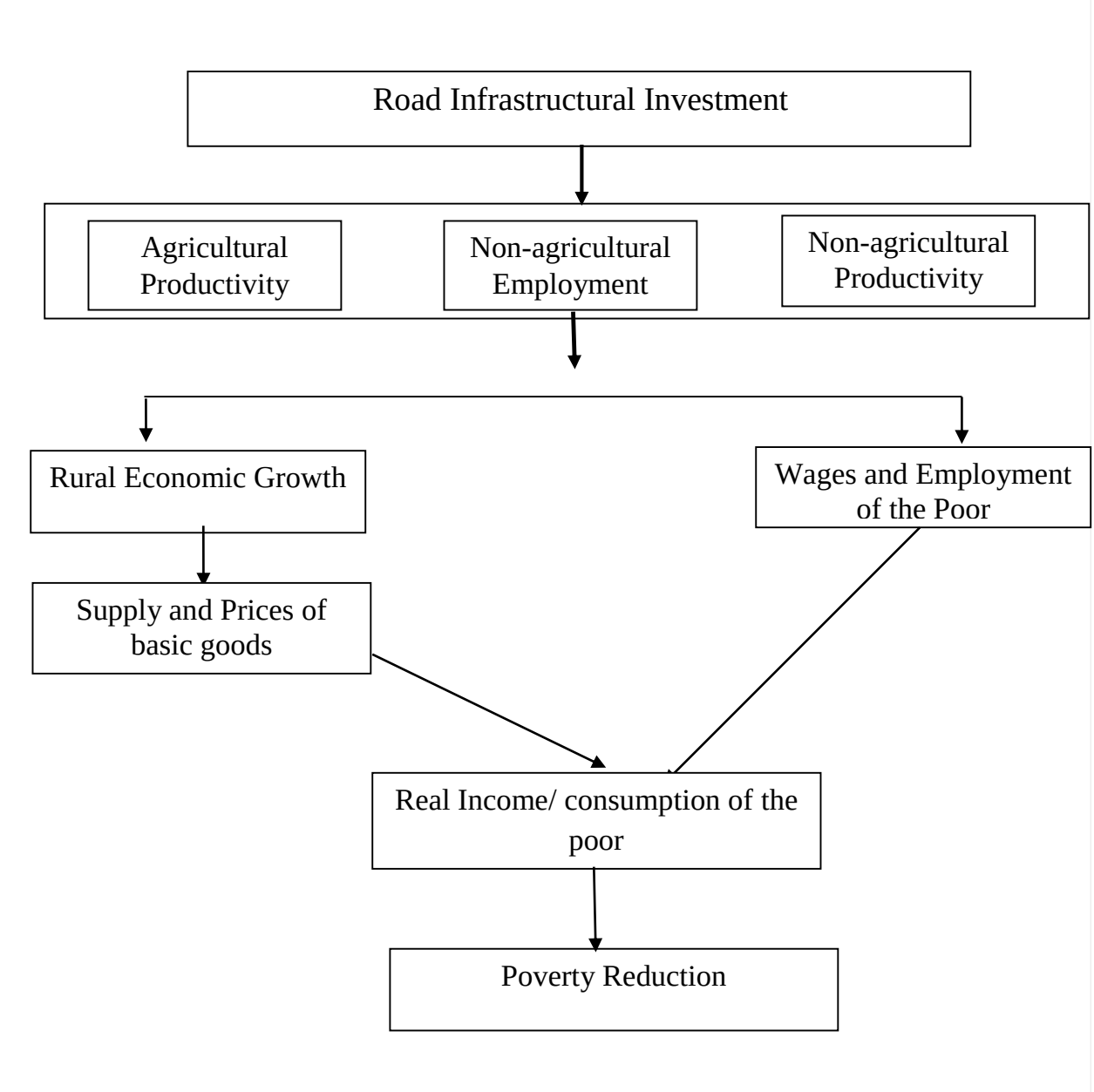
H2: Road Transport has a significant impact on poverty level in Nigeria.

The link between road transport infrastructure and poverty reduction has been studied over the last decades. Although there seems to be general agreement regarding the negative effect of road transport on poverty, the channels of influence of the former on latter vary. According to Jahan and McCleary (2005), the effect of road transport infrastructure on poverty comes informs of supply side and demand side impacts. Road transport infrastructure improves the production side of the economy by reducing the cost of production, creating access to markets, and enhancing business climates and opportunities. It also attracts domestic and foreign investment, thereby creating employment and ultimately reducing poverty. The demand side, on the other hand, leads to high demand for inputs for road construction, thereby creating new jobs and employment.

Road transport also increases access to basic infrastructures such as education and health facilities. Access to roads encourages mobility of high manpower and facilitates rural-urban linkage, thus promoting agricultural transformation and industrial development. All these directly or indirectly improve rural households' standard of living and reduce poverty (World Bank, 2004).

Figure 2 below is adapted from Ali and Pernia (2003). The figure emphasizes the linkage between road transport infrastructure and poverty and explains the channels through which the former affect latter. According to the figure, provision of road transport infrastructure by the government directly affects agricultural and productivity, employment and industrial productivity which in turn directly increase wages and employment of the poor and indirectly enhance rural economic growth. These further improve supply and reduce prices of basic goods, which then ultimately affect real consumption and poverty level.

Figure 2: linkage Between Road Transport Infrastructure and Poverty



Source: from Ali and Pernia (2003)

A number of empirical studies have found a negative relationship between road infrastructure and poverty level. For instance, Kwon (2000) found that poverty level in Indonesia falls by 0.3% for every 1% increase in road investment. Oladepo and Olomola (2015) established a positive relationship poverty reduction and road transport investment

in Nigeria. For China, Fan et al., (2002) reveal that road transport significantly reduces rural poverty through agricultural development. Other empirical studies such as Jacob, 1998, Seetanah, Ramessur and Rajid, 2000, Jahan and Ravallian 2002 etc. also establish a positive relationship between poverty reduction and road transport investment.

Although the potentials of road transport in poverty reduction is tremendous as noted above, poverty still persists in developing countries even with their yearly huge financial investment on road network. According to ADB (2002), the poor in these countries could not benefit from road transport investment due transport sector regulation which tends to fix fare. Most roads in these countries were not constructed with the primary aim of alleviating poverty but to satisfy the exploitation interest of the colonial master. The benefits of road investment is not also felt by the poor due to the corruption of those in leadership positions in these countries.

Hence, given the paucity of empirical studies on the nexus between poverty and road transport infrastructure in Nigeria, this thesis will be contributing to the literature as well as unraveling the nature of the effect of road infrastructure on poverty.

This thesis also relies on the theoretical literature on inverse U shaped growth impact of infrastructure. It is argued that certain threshold of infrastructure exists for sustainable economic growth. Any investment in infrastructure capital beyond this threshold will become unproductive and hence lead to "crowding out" of private capital and reduced economic growth. Many studies including Barro, 1990; Shi, Guo and Sun, 2015; Ding, 2013; Simon and Natarajan, 2017 have confirmed this scenario. However, it still remains to be confirmed in Nigeria. Thus, this will be tested in our thesis.

H3: There exists a threshold level of transport infrastructure after which the impact on income is not significant.

Lastly, the direction of causality between road transport infrastructure and economic growth is still debatable. The reason for this lack of consensus is the dual natures of road transport in economic development. While Badalyan, Herzfeld, and Rajcaniova (2014) established a bidirectional relationship, Fernald (1999) De la Fuente (2000) Mittnik and Neumann (2001) found a unidirectional causality running from road transport to

economic growth. To Gramlich (1994) the direction of causation from transport infrastructure to economic growth or vice-versa is unclear. The result depends on the measurement of road adopted, functional specification, and method of estimation and level of development of an economy. The OECD (2003)'s study also claims that, despite the obvious benefits of transport infrastructure to economic growth and development, it is difficult to establish a direct causal link between the two. Thus, this thesis will also test the direction of causality between road transport and economic growth. Hence, hypothesis four is;

H4: Causality exists between road transport and economic growth in Nigeria.

1.5 SIGNIFICANCE OF THE STUDY

This thesis attempts to examine one of the elements of economic transformation, which is the ability of African Nations including Nigeria to attract tourist and develop her agricultural sector through transport development, although the research will be paying attention exclusively to road transport infrastructure. To ascertain the potential roles of road transport in poverty reduction and economic growth are some of the reasons for conducting this research work. The transport sector used to be one of the sectors that suffered a major setback in the country, due to neglect from several governments. Although the problem was a result of the fact that the Federal Government single-handedly controlled the sector, private participation in transport and tourism can also be attracted.

The thesis provides insight on the roles of road transport infrastructure in social change and development by focusing on multidimensionality of poverty as a complement to existing studies which focused only one monetary measure of poverty in Nigeria. In this way, this thesis added to the existing literature an understanding of the impact of road transport infrastructure on poverty reduction. It is argued that good roads networks may reduce transportation cost and driving time, encourages access to market and rural-urban linkage and hence, contributes to rural empowerment and nation's economic development.

A study of the nexus between poverty and road transport infrastructure will be helpful to the government and policymakers who aim at reducing poverty level in the country.

More so, the available studies in this area in Nigeria do not explore the possibility of non-linear function for growth-transport function and seem not to cover sufficient period to warrant meaningful conclusion and generalization. Using large sample and enough periods give enough autonomy for the eradication of sampling error and thus, enhance the inferences that may be derived from this study. In the developing countries where there is the paucity of financial capital for capital investment, knowledge about the threshold of road transport investment that would ensure sustainable growth and development is highly desirable. Research into the desirable road infrastructure threshold would not only benefit the country, it would assist in avoiding the investment in road transport infrastructure that is unproductive and would crowd out private investment

In essence, this research work helps in stimulating further research and that could significantly contribute to future research work with regards to transport, tourism, and agriculture in Nigeria and as well as providing a reference to the researcher who will also research on this topic. The recommendations made by the researcher can assist in formulating new strategies with the view of attracting more investment in transport into Nigeria.

1.6 ORGANISATION OF THE STUDY

This thesis is divided into five chapters. Following this chapter, chapter two reviews the previous literature on road transport infrastructure and economic development. In chapter three research methodology is presented. The chapter describes the model and methodologies to be used in order to get robust estimations of the relationship between road transport infrastructure, poverty, and economic growth. Chapter four presents and discusses the results and the last chapter summarizes, concludes and proffers recommendations.

CHAPTER TWO
LITERATURE REVIEW

This chapter focuses on the roles and effects of road transportation on tourism and economic growth. The chapter begins by examining the definition of transportation and its links with national development. It concludes by reviewing empirical works of literatures on the impact of road transport on economic growth.

2.1 CONCEPT OF TRANSPORTATION

Transportation can be defined as the movement of people, animals, and goods from one location to another. It is the conveyance of human and non-human materials from one place to another. Generally, it is the actual physical movement of people and goods from one place to another (Ahukannah*et al.*, 2003). This definition, although correct, fails to consider the movement of non-physical materials such as electronic data. Thus, transportation encompasses physical and non-physical movement of people and goods from one place to another.

Means or modes of transportation are the mediums through which movement of people and goods are possible. These include road, air, rail, water, cable, pipeline and space (Beaver, 2002). Transport infrastructure, on the other hand, consists of the physical installations that made transport possible and may be roads, airways, railways, waterways, canals and pipelines, and terminals such as airports, railway stations, bus stations, warehouses, trucking terminals, refueling depots and seaports (Onyeocha et al., 2015).

All modes of transport are all important individually and are complementary to one another. For instance, Air and rail transport are more efficient in the conveyance of people and high valued goods over a long distance but these modes of transport (air and rail) can only be reached by road. Water transport is also important in its ability to carry bulk cargo over long distances at cheaper rates than other forms of transport modes, but like air and rail transports, it relies on roads transport for door-to-door services.

The above-mentioned arguments signify the importance of road transport to the economy and how its complement other modes of transport. A road has been described as an integrated system that is made up of nodes and routes (Schneider, 1994). The nodes are towns which are connected to the roads, the route, on the other hand, is the different types of roads. According to Howe (1984), roads are routes which are required to facilitate investment in new economic activities such as agriculture, manufacturing and trade. Corroborating the view of Howe (1984), Musa (2003) sees roads as those socio-economic infrastructures which are essential factors of all aspect of economic and social development in any society. According to him (2003), roads connects the most remote areas and has been found to be necessary for the movement of goods for distribution and marketing in both rural and urban areas.

Road transport is the most widespread and complex network. "It covers a wide range, physically convenient, highly flexible and usually the most operationally suitable and readily available means of movement of goods and passenger traffic over short, medium and long distances" (Ajiboye and Afolayan, 2009). Road networks are observed in terms of its components of connectivity, accessibility, traffic density, and density of particular roads, level of service and compactness of the road. According to Onakomaiya (2012), road accessibility facilitates commerce and trade that engenders and stimulate growth in other sectors. Good road network contributes to poverty alleviation by raising the standard of living and opening the avenues for further trade and employment. This implies that road projects are social projects that comes with various externalities- positive and negative. One of the positive externalities of the road network is the attraction of cluster of projects around itself. Since commerce and trade cannot thrive without transport, every production activity that relies on commerce and trade also have their success intricately linked to transport.

2.2 TRANSPORTATION IN NIGERIA

Total road network	Federal Road	State Road	Paved roads
195, 000km	32,000km	31,000km	60,000km

Source: World Bank 2015

An efficient and effective road transport is essential for Nigeria's economic growth. This is the bedrock of a good economic and social wellbeing. Nigeria with a population of about 200 million people has 195,000km road network of which 135,000km are untarred and 60,000km are tarred. The proportion of the untarred roads is large and accounts for 69% of the total road Network. Only 31% of Nigerian road is in good condition.

32,000km of the total road network in Nigeria are Federal roads while 31,000km are state roads. Nigeria has a road density of 0.21km per square km.

The Federal roads cuts across regional boundaries and extend to international borders, are divided into Federal trunk A and Federal truck F. Federal trunk A are owned, maintained and developed by the federal government from inception till date. The federal trunk F were roads previously owned by the state government but have now been taken over by the state government with the aim of developing them to federal roads standard (Nnanna et al 2003). 95% of the movement of goods and is by road. 80% of all the vehicles and freights traffics are conveyed via Federal roads. The state roads called Trunk B roads are roads that are owned and maintained by the various state governments and aimed to develop socio-economic development of the state. The local government roads are classified into truck C. these roads are owned and maintained by the local governments in Nigeria. The local roads are divided into Urban, Rural and Village roads. Urban roads are roads in urban areas. Rural roads are roads in the rural area and there are over 72,000km. Village roads are roads in the villages. Maintained by the local government Village roads are mainly earth roads

2.2. TRANSPORTATION AND NATIONAL DEVELOPMENT

The value of transportation to a nation in her development process cannot be overemphasized. It is a catalyst for growth and development. It forms the bedrock on which the efficient planning and managing of agriculture, industry, commerce, education, health, and tourism among others are built. Transport has been described as the engine of growth of a nation's social, economic and political life. It represents a major social infrastructure that creates positive externalities and attracts series of other investments. According to Olubomehin (2012), transportation is a wealth creating industry and the life-line of an economy. Transportation and development are closely related because each of them influences the fortune and the relative growth of the other in any nation. The successful and continued existence of a society is crucially depended upon the availability of adequate transport facilities (Adekanye, 1971). Also, Wane (2001) asserted that ''transportation is a crucial vector for urban insertion since it gives access to economic activity; facilitate family life, and helps in spinning social networks''.

Sieber (1997) noted that the study of transport network has attracted several attentions from different scholars with diverse expertise with each relating transport to focus of his/her specialization. For instance, the economists and geographers relate transport development with urban growth and commercial and economic activities of any given region. The Historians are interested in how transportation contributed to the civilization of any particular society. Others such as geologists and anthropologist focus on how transport facilities relate with relics and mineral resources. Howel (1984) supported this by stating that transportation is clearly a necessary ingredient of every aspect of economic and social development. It plays a role in getting land into production and in making other services accessible.

The presence of an adequate, reliable and efficient transport system is critical to economic development. In fact, the provision of a high-quality transport system has been acknowledged as a prerequisite for national development (Camemark, 1979). The impact of transport infrastructure on socio-economic growth and development has been prominence in many countries. For instance, Ogunsanya (1995) showed that improvement

in transportation facilitates effective and efficient cattle delivery in Costa Rica. The author also found that in Thailand, the Friendship Highway opened up the jungles and improved agricultural productivity leading to multiple increases in rice, sugar cane, vegetables and bananas production. The provided highways with its consequential cost reduction also improved the level of interaction and interdependence between Saraburi and Korat. Inusa (2002) attributed the growth in the cities such as Lagos, Portharcout, Kano and Jos etc to the completion of the railway line. According to Inusa (2010), transportation contributed to improved profitability level of agricultural production in the Northern part of Nigeria when a railway line, completed in 1914, linked Lagos to Kano. Taaffee, Morril and Gould (1995) showed that the construction of railways and development of feeder roads assisted in opening up the hinterland and boosting internal and external trade in Nigeria. In Bolivia, the highway from Cochabamba to Santa Cruz reduced travel time from many weeks to a matter of hours (Ogunsanya, 1995).

Inadequate transportation network limits a country's ability to fully utilize its natural resources, distribute agricultural products and other finished goods, link the manufacturing and agricultural sectors; provides medical, education and other infrastructural amenities (Brown, 1999). Transport plays a very important role in the socio-economic development of the country but meanwhile, this expansion also poses great challenges to the safety and security of the traveling public. Transport investments within cities and across cities are essential for economic growth, job creation, and poverty reduction. Apart from facilitating cheaper and more efficient movements of people, goods, and ideas within and outside the country, transport also enhances the distribution of economic activities across the country.

2.3. TRANSPORT AND ECONOMIC GROWTH: AN EMPIRICAL REVIEW

Empirical studies on the relationship between transport and economic growth and development are mixed across countries and regions. These inconclusive results might be due to different data and methodologies. Some studies found a positive impact of transport on growth, while others reported little or no significant relationship between the two

variables. According to Gramlich, (1994), despite that the relationship between transport infrastructure and economic growth has attracted a lot of attention and research effort from various scholars; the effect of transport infrastructure on growth and the direction of causation between these macroeconomic two variables remains essentially unclear.

The empirical study of the impact of transport on economic growth by in the US for the period 1949-1985by Aschauer (1989) shows an evidence of a strong and positive relationship between public investment in transport and growth. He attributed the US economy's relatively poor economic performance between the 1970s and 1990s to decrease in public investment. In another study, Aschauer (2000) finds that the public infrastructure capital has a significant effect on the total factor of productivity and that investments in public sector capital not only improve quality of life but also increase economic growth and make returns on private investments attractive. In contrast, Tatom (1993), Holtz-Eakin and Schwartz (1995) and Garcia-Mila (1996), in their independent panel studies of U.S. state-level data, revealed that there is little evidence of an effect of transport infrastructure on growth. Also, Fernald (1999), using a panel of US industries, found a positive impact on the highways stock on Total Factor Productivity growth. In another study of the nexus between road transport and economic growth in the US, Cohen and Morrison (2004) found that an increase of the highways capital stock of 10% correlated with a reduction of variable costs of about 1.5% in the US manufacturing industries.

In Europe, the results obtained by Montolio and Solé-Ollé (2009) also support the idea that productive public investment in road infrastructure has positively affected relative provincial productivity performance in Spain. Mamatzakis (2002) finds a positive effect of public infrastructure (ports, railways, roads, electricity, and communications) on output and private capital productivity of the Greek industrial sector. He also finds that the causal relationship is from public infrastructure to productivity, Ivanova and Masarova (2013) analyze the importance of road infrastructure in economic development and competitiveness and inflows of foreign direct investment in the Slovakian economy between 2000 and 2011. With the aid of correlation analysis, they found that a strong positive relationship exists between expenditure on road infrastructure and GDP and a

negative relationship with FDI influx. The authors argued that the negative association between expenditure on road infrastructure and FDI could imply that foreign investors are motivated by other factors, other than road infrastructure.

For Indian economy, Tripathi and Gautam (2010) use cointegration approach to examine the long-run relationship between road network and macroeconomic variables such as output, employment and gross private capital formation. They also analyze the impact of road transport infrastructure on the macroeconomic variables. Their results show that a long-term relationship exists between road network and GDP, and also with the gross private capital formation. However, the long-term relationship does not exist between road network and gross private capital formation. Through the VAR approach estimates, it was established that road infrastructure has a positive effect on output. Also, they found that increase in road network has a negative effect on private investment and employment indicating that investment in road network crowds out private investment and employment. Looney (1997) analyses the effects of several types of public infrastructure in Pakistan and finds that public infrastructures have not been instigating private sector expansion but have been rather a response to the needs of the sector. Pradhan (2010) investigates the relationship between transport infrastructure and economic growth in India between 1970 and 2007. He finds evidence of unidirectional causality running from transport infrastructure to economic growth.

Also, Banerjee, Duflo, and Qian (2009) estimated the impact of access to road networks on economic growth in China over the period of 1986-2003. Results from the study show that proximity to transportation networks has a large positive effect on GDP growth across sectors. Cheteni (2013) examines the effect of transport sector productivity and transport infrastructure investment on South African economic growth for the period 1975-2011. A Vector Error Correction Model (VECM) and a Bayesian Vector Autoregressive model were used. The result from the VECM reveals that economic growth is influenced by domestic fixed transport investments, inflation, and real exchange rate, while the BVAR model shows that fixed transport investments, inflation, domestic multifactor productivity, and real exchange rate have a significant effect on economic growth in South Africa.

Results from other cross-country studies on the relationship between transport and growth are also inconclusive. While studies of Easterly and Rebelo (1993), Sanchez-Robles (1998) and Demetriades and Mamuneas (2000) demonstrate a positive effect of investment in transport on economic growth, studies such as Ashipala and Haimbodi (2003), Canning and Pedroni (2008) and Egart et al. (2009) could not find a significant effect of transport on economic growth. Boopen (2006) analyzed the contribution of transport capital to growth for a sample of 38 Sub- Saharan African countries using both cross-sectional and panel data analysis. In both sample cases, the analysis concludes that transport capital has been a contributor to the economic progress of these countries. In a related panel study, Canning and Pedroni (2008) examined the influence of various types of public infrastructure provision (road, rail, electricity etc) on economic growth. They found that while public infrastructure tends to induce long-run economic growth, there is substantial variation across countries. In another cross-country study, Ashipala and Haimbodi (2003) examine the relationship between public investment and economic growth in South Africa, Botswana and Namibia using the Vector Error Correction Model. They find an insignificant effect of public investment on growth. However, they find evidence of a reverse causality from GDP growth to public investment.

In some causality studies, the direction of causation between transport and growth could not be definitely established. An empirical study by Fernald (1999) revealed that construction of more roads stimulates productivity and growth in the industries that use the road more intensively. This study implies that the causality between road and productivity is more likely to be former to the latter, rather than the other way around. De la Fuente (2000)'s cross-regional study of the effect of public investment in infrastructure on economic growth in Spain and the US concluded that causality flows from public infrastructure investment to economic growth. Although Mittnik and Neumann (2001) established a positive influence of public investment on GDP, the study did not find a significant causal link flowing from GDP growth to public investment. Using panel cointegration analysis and panel causality analysis Badalyan, Herzfeld and Rajcaniova (2014) investigate the association and the direction of causality between transport infrastructure, investment in infrastructure and economic growth in three countries

Armenia, Georgia and Turkey for the period 1982-2010. They found that gross capital formation and road/rail goods transported have a strong positive impact on economic growth in the short-run, and a bidirectional causality exists between economic growth and infrastructure investment, and between infrastructure investment and road and rail passengers carried in both the short and long-run.

In recognition of the disparate findings, Kessides (1996) noted that major reason for lack of consensus on the impact of transportation infrastructure on growth is that "it has so far not adequately accounted for simultaneity of effects-economic growth can lead to the development of the transport system as well as result from it". In line with this, Dodgson (1997) claimed that for the fact that GDP is influenced by so many other variables, it becomes extremely difficult to obtain empirical evidence that backs up theoretical links. The OECD (2003)'s study also claims that, despite the obvious benefits of transport infrastructure to economic growth and development, it is difficult to establish a direct causal link between the two. Eberts (1999), on the other hand, concluded that there is no definitive estimate of the effect of public transport infrastructure on GDP.

The study of the effect of road transport on economic growth in Nigeria also abounds but without definite results. Ajiboye and Afolayan (2009) examined the impact of transport development on agricultural production in a developing country which focuses on kola nut production in Nigeria. The study revealed that improved transportation would have a positive impact on farmers" productivity, income, employment and reduce poverty. Using error correction method, Nurudeen and Usman (2010) found that rising government expenditure on transport leads to an increase in economic growth. Nwakeze and Yusuff (2010) using the extended Cobb Douglas production function examine the effect of road transport infrastructure on economic growth in Nigeria. In their study, the road network was proxied by physical stock of road infrastructure. error correction/cointegration technique was used to derived the estimates from the Cobb Douglas production function. Their result shows that road transport investments positively contribute to economic growth in Nigeria. However, traffic accidents were found contribute negatively to growth. The authors recommend the need for improvement in the quantity and quality of road network.

Precious (2011) investigated the effects of road transport development on spatial integration in Kaduna State. The author employs different policy regimes between 1960 and 2009 to show how road transport has developed over four time periods in the state and how it impacts on the movement of the people in the state. It was revealed that the huge investment on road development in the state has facilitated and improved accessibility and connectivity of remote areas decreased travel cost and time and reduced poverty level in the rural areas. Tunde and Adeniyi (2012) examine the impact of road transport on agricultural development in Ilorin East, Kwara State, Nigeria. The study combines the use of primary and secondary data. Their findings show that road transport effect on agricultural development is not definite. While the stock of road transport has a beneficial effect on agricultural production, the bad conditions of the road increase cost of transporting agricultural produce which in turn affect the rural farmers' income and standard of living. In a study in Gwagwalada Area Council, Abuja, Nigeria, Dakyes, and Ogbuli (2012) in their empirical study of transport and growth, concluded that road transport development enhances the well-being of the people as well as the socio-economic development of the rural area. Olamigoke and Emmanuel (2013) investigate the relationship between transport system and local economic growth in Nigeria. The study establishes a robust link between transport and growth. Kayode et al. (2013) through OLS investigate the impact of public road transport infrastructure on economic growth in Nigeria from 1977 to 2009. The author built an empirical model from the endogenous growth framework in which road transport infrastructure entered into the production function as input. The results reveal that road transportation has an insignificant impact on economic growth in Nigeria. The author, thus recommends an increase in capital expenditure and overhauling of the road transportation system in Nigeria. Chukwuemeka, Nyewe, and Ugondah (2013) employ the OLS technique to examine public spending on transport infrastructure and economic growth in Nigeria between 1981 and 2010. They found that public spending on transport infrastructure has an insignificant negative effect on economic growth. The authors recommend increased government funding of transport sector.

In a recent study, Nedozi, Obasanmi, and Ighata (2014) employ a simultaneous method to investigate the impact of infrastructural development and economic growth of Nigeria. The regression results show that infrastructure contributes positively Nigeria's economic growth. Uma, Ogbonna, and Hyacinth (2014) examine the effect of transportation network on economic growth in Nigeria over the years 1981-2009. The Ordinary least square approach was employed to estimate the desired parameters after confirming the level of stationarity and the long-run relationship among the time series data. The results reveal that road transport has a significantly positive impact on the real gross domestic product (RGDP).

Peter, Rita, and Edith (2015) examined the impact of road transportation on economic growth in Nigeria using both primary and secondary data. A Probit model was used to analyze the primary data while the multivariate model was used for analyzing the secondary data to determine the long run relationship between growth and road transportation in Nigeria. The study adapted Bloch and Tang (2003)'s model by adding capacity utilization, government expenditure on transport and exchange rate. Their result shows that the road transport sector has a positive impact on the economic growth in Nigeria. The authors suggested that the policy makers should come up with sustainable policies on road development and maintenance that will further enhance good road network in Nigeria. Oladipo and Olomola (2016) apply cointegrating equation technique on Solow growth model to analyze the long-run impact of the road network on economic growth and poverty level in Nigeria between 1980 and 2012. It was found that long-run relationship exists among road transport network, economic growth and poverty level. Estimates from the results indicate a significant negative effect of the road network on economic growth, and an insignificant negative impact of road transport infrastructure on poverty level.

From the foregoing empirical review, it seems the empirical relationship between transport and economic growth depends on the nature of existing stock of transport infrastructure of a country. The relationship between transport and economic growth seems to be positive and robust for most developing countries that are yet to have an effective road network. However, empirical results on the nexus between transport and

economic growth in developed nations remain inconclusive or insignificant. This finding implies that the relationship between transport and growth is linear and as such any linear representation between the two variables.

2.4. CONTRIBUTION OF THE RESEARCH TO EXISTING RESEARCH

The current Ph.D. thesis aims at researching the implications of road transport infrastructure on economic growth and poverty reduction in Nigeria. Nigeria like any other developing country recognizes the importance of and need to develop an efficient transport system to facilitate growth and development. This is evident as the country disposed huge financial and material resources towards road network in her third National Development Plan of 1975 to 1980. However, the state road network is yet to be developed due to corruption, lack of political will, lack of continuity among government etc. The average road density in Nigeria is 21.0km^2 which relatively lower than that of Ghana, Mauritius, Seychelles and South Africa whose road density are 24.0 km^2, 99 km^2, 110 km^2 and 30 km^2 respectively (World Bank, 2015). The country road network was ranked 127th out of 144 countries by The Global Competitive index (GCI). With this situation, it was quite surprising when most empirical studies of road network and economic growth reported a positive effect of former on latter. This quite surprising given the level of poverty in the country.

In the following section, we will provide a series of arguments on how Ph.D. thesis contributes to a significantly less explored aspect of this topic in Nigeria, namely to: inclusion of poverty and transport threshold analysis in the study. This thesis introduced two aspects that have not been **explored by the existing literature on road transport network and growth in Nigeria- threshold analysis and poverty. This makes this thesis original and to some extent informative**. The estimation of the threshold of stock of road for which income is not significant in Nigeria will help policymakers not to know when to redirect income away from road construction to other economic needs and make profound fiscal policy decisions.

As noted in the literature, the empirical relationship between transport and economic growth depends on the nature of existing stock of road transport infrastructure of a country. For developing, road network was found to have a significant positive effect on economic growth. The empirical results on the nexus between transport and economic growth in developed nations remain inconclusive or insignificant. This finding implies that the relationship between road network and economic growth may not be linear. The existence of non-linearity has been confirmed by authors including Barro, 1990; Shi, Guo and Sun, 2015; Ding, 2013; Simon and Natarajan, 2017. It was claimed that the relationship between road network and economic growth is inverse U shaped. This implies that road transport has limited growth effect to certain stock level of road. By this, a certain threshold of road infrastructure exists for sustainable economic growth. Any investment on infrastructure capital beyond this threshold will become unproductive and hence lead to "crowding out" of private capital and reduced economic growth. No study in Nigeria has estimated the threshold road infrastructure for the country. The importance of conducting threshold analysis lies in it fact that, it would preempt waste of resources and potential crowding out of private investment. It would also show the deficit level of road network required and act as a guide for policymakers. By estimating road thresholds, this thesis contributes significantly to existing state knowledge.

Furthermore, the thesis's contribution to knowledge is also notable stem from its examination of linkage between road network and poverty reduction in Nigeria. The convention among authors in Nigeria is to link road transport and economic growth. This set of studies are abundant with most reporting a positive correlation between road and economic growth. However, road impact on economic growth is not direct. Road network affects variables that are closely related to poverty than overall economic wellbeing. Thus, focusing on growth –road linkage will not reveal the clear picture at an individual or social level. This thesis will correct this view and carefully explore the relationship between poverty reduction and road transport infrastructure using a multidimensional measurement of poverty. This thesis, by this endeavor, will be helpful to the government and policymakers who aim at reducing poverty level in the country.

Literature review shows that there is no consensus as regards the effect of road transport on economic growth. While some authors found a positive effect of road transport on economic growth, some reported a negative effect and for some no relationship between the two variables. Even for Nigeria, a consensus result is yet to be seen. Also, as claims by Gramlich (1994), the direction of causation from transport infrastructure to economic growth or vice-versa is unclear, and the relationship between road transport and economic growth is not a direct one. The result depends on the measurement of road adopted, functional specification, and method of estimation and level of development of an economy. Lack of definite relationship between road transport and economic growth call for further research to assist policymakers with adequate and appropriate decision making.

Also, studies on road transport and economic growth in Nigeria are limited due to the scarcity of data on physical measurement of road transport. Most studies on road transport in Nigeria are descriptive in Nature (e.g Adesanya 1995; Eboh, 2005; Anyanwu, Adebusuyi, and Kukah; 2003; Dakyes and Ogbuli, 2012; Tunde and Adeniyi, 2012 etc). Only a handful of studies based their arguments on sound inferential and econometric foundation and as such remain unreliable. Even those that use econometric proxied road transport with expenditure on road without recourse to the stock of road network. This study also fills this gap.

Lastly, while several studies have focused on the relationship between road transport and economic growth, however, to the best of my knowledge, no study has empirically examined the existence of threshold stock of road transport after which income will not be significantly impacted. As is noted from the literature that growth effect of infrastructure will be significant at a low level of income and its effect on growth deteriorates or even becomes insignificant as countries reach the middle/ higher bracket of development (in terms of output growth). Computing this infrastructure threshold can serve as a yardstick to policymakers in charge of infrastructure in the country. Thus, this study intends to fill these gaps by examining the road transport threshold for the Nigerian economy.

Table 1: Summary of Empirical Review

Author	Country	Dependent Variable	Independent variables	Method of Analysis	Findings
Aschauer (1989)	USA	GDP growth	Stock of road network	Johannsen cointegrating equation	A positive relationship was established. Between economic growth and road transport. Also, there was a bi-causality relationship between road transport capital and Economic growth
Montolio and Solé-Ollé (2009)	Spain	GDP	Employment, capital stock, the stock of road transport infrastructure	VAR	public investment in road infrastructure has a positive impact on productivity v in Spain
Ivanova and Masarova (2013)	Slovakia	GDP and FDI	Expenditure on road infrastructure	Correlation analysis	A strong positive relationship existed between expenditure on road infrastructure and GDP and a negative relationship with FDI influx.

Badalyan, Herzfeld and Rajcaniova (2014)	Armenia, Georgia and Turkey	Gross domestic product,	Gross domestic capital formation, roads and rail goods transported, roads and rail passengers carried and roads and rail network length	panel cointegration analysis and panel causality analysis	gross capital formation and road/rail goods transported have a strong positive impact on economic growth in the short-run, and a bidirectional causality exists between economic growth and infrastructure investment, and between infrastructure investment and road and rail passengers carried in both the short and long-run.
Ashipala and Haimbodi (2003)	South Africa, Botswana and Namibia	GDP growth	public and private investment	VECM methodology	Public investment has an insignificant effect on growth, and there is a reverse causality from GDP growth to public investment. \
Cheteni (2013	South Africa	Gross Domestic	Gross Domestic Product, Multi-	Vector Error Correction Model	The VECM reveals that

		Product, Multi-Factor Productivity, Real Effective Exchange rate, Inflation, Real Domestic Transport fixed investments.	Factor Productivity, Real Effective Exchange rate, Inflation, Real Domestic Transport fixed investments.	and a Bayesian Vector Autoregressive model	economic growth is influenced by inflation, domestic fixed transport investments, and real exchange rate, yet on the BVAR model it was influenced by inflation, domestic fixed transport investments, multifactor productivity, real exchange rate and second period Gross Domestic Product
Tripathi and Gautam (2010)	India	Gross private capital formation, output, employment	Road network,	Cointegration and VAR	A long-term relationship exists between road network and GDP, and also with a gross private capital formation. Road infrastructure has a positive effect on output, And that increase in road

					network has a negative effect on private investment and employment.
Ajiboye and Afolayan (2009)	Nigeria	Agricultural Productivity	Road transport investment	Survey/ Descriptive Statistics	Improved transportation would have a positive impact on farmers‟ productivity, income, employment and reduce poverty
Nurudeen and Usman (2010)	Nigeria	GDP	Capital expenditure, total recurrent expenditures, and government expenditure on education, government expenditure on transport and communication	cointegration and error correction methods	Government expenditure on transport leads to an increase in economic growth
Nwakeze and Yusuff (2010)	Nigeria	Real GDP	Real Gross Capital Formation, labor force, total road network, automobile density, and traffic accidents	Error correction model	Road transport investments positively contribute to economic growth in Nigeria. While accidents caused by traffics were found contribute

					negatively to growth.
Precious (2011)	Nigeria	Accessibility, connectivity, cost and poverty	Road transport network	Survey/ Descriptive Statistics	Investment on road development has facilitated and improved accessibility and connectivity of remote areas, decreased travel cost and time and reduced poverty level in the rural areas.
Dakyes and Ogbuli (2012)	Nigeria	Employment and income	Road transport related questions	Descriptive statistics	Road transport development enhances the well-being of the people as well as the socio-economic development of the rural area.
Tunde and Adeniyi (2012)	Nigeria	Agricultural productivity	Road Transport network	Survey/ descriptive Statistics	Road transport effect on agricultural development is not definite. While the stock of road transport has a beneficial effect on agricultural

					production, the bad conditions of the road increase cost of transporting agricultural produce which in turn affect the rural farmers' income and standard of living.
Kayode et al., 2013	Nigeria	Real GDP	private physical capital, transport capital, public capital investment, and secondary school enrolment	OLS	Road transport investment has a negative effect on economic growth
Chukwuemeka, Nyewe and Ugondah (2013)	Nigeria	Real GDP	public spending on transport and communication, public spending on roads and construction, public spending on the other economic services (electricity and water supply) public spending on education, public spending on health	OLS	Public spending on transport infrastructure has an insignificant negative effect on economic growth.

Uma, Ogbonna, and Hyacinth (2014)	Nigeria	Real GDP	road transport output, railway output, airway output and waterway output	OLS	Only road transport has a significant impact on real GDP
Nedozi, Obasanmi and Ighata (2014)	Nigeria	GDP	exchange rate, labor force, inflation rate, the contribution of infrastructure to GDP	Simultaneous equation method	Infrastructure the contributes positively to Nigeria's economic growth.
Peter, Rita and Edith (2015)	Nigeria	Real GDP	Road network, government expenditure on road, capacity utilization, exchange rate	OLS	Road transport has a significant positive impact on GDP
Oladipo and Olomola (2016)	Nigeria	RGDP and Poverty level	Stock of Road network	Cointegrating equation technique	Road network has a significant negative effect on economic growth, and an insignificant negative impact on poverty level.

CHAPTER THREE
RESEARCH METHODOLOGY

This chapter details the methodology used in this thesis. It explains the model specification for each objective, followed by the method of analysis and sources and nature of data used. It also elaborates on different diagnostic and reliability tests used in the thesis.

3.1 SOURCES AND MEASUREMENT OF DATA

The data of interest are Gross Domestic Product, gross capital formation, the contribution of road transport to GDP, road network and HDI. All data, apart from data on human capital, HDI, and road transport network, were sourced from the Central Bank of Nigeria (CBN)'s statistical Bulletin (2016). Human capital and road density were obtained from World Bank development indicator (2016). HDI was sourced from UNDP report.

Road transport was resented by physical stock of road infrastructure. Government on road was proxied by real public expenditure on transportation. Human capital was captured with data on secondary school enrolment. Economic growth was represented by real gross domestic product, and capital was proxied by real gross domestic product.

Table 2: Measurement of Data

Time series	**Measurement**	**Source**
Economic Growth	Gross Domestic Product (million nairas)	Central Bank of Nigeria (CBN)'s statistical Bulletin (2016)
Capital	Gross capital formation (million nairas)	Central Bank of Nigeria (CBN)'s statistical Bulletin (2016)
Labor force	Secondary school gross enrolment	World Bank development indicator (2016).
Poverty	Human Development Index	UNDP report. 2016
Road Transport	Length of the road (in hundred /km) and Contribution of road transport to GDP (thousand nairas)	World Bank development indicator (2016).

3.2 METHODOLOGY FOR OBJECTIVE I: INVESTIGATE THE SHORT AND LONG RUN EFFECT OF ROAD TRANSPORT ON GDP GROWTH

Objective 1 is associated with hypothesis 1 where we test whether there is a significant relationship (short run and long run) between road transport and economic growth in Nigeria. In order to explore objective 1 and test hypothesis 1, a Solow growth model in which aggregate income is modeled to include capital, labor, and road transport infrastructure (a proxy for technical progress) is used to examine the long run and short-run effect of road transport on economic growth. There are two production functions used in modeling the impact of transport infrastructure (a form of public capital good) on macroeconomic variables. One is the model where road transport infrastructure enters as

a standard Solow growth model alongside labor and physical capital (Barro, 1990), and another in which road transport infrastructure is seen as a factor affecting the productivity of the standard Solow growth model (Shioji, 2001). This thesis follows the second approach to modelling the relation between road transport infrastructure and economic growth where the effect of road transport on growth will be captured by using the productivity transmission mechanism.

In this study, the neoclassical growth model was employed to build a model that gives transport infrastructure a role in economic growth. The standard neoclassical growth model for this exposition assumes that productivity (or technical progress) measured by Solow residual, is endogenous. In a Solow model, the growth rate of aggregate output is said to be determined by factors such as labor, capital and technological progress. The standard neoclassical model relating these factors to output is given as follows:

$Y_t = A_t f[K_t, L_t]$……. *(1)*

Where Y_t represents output in time (t), K_t represents capital input in time (t) and L_t represents labor input in time *(t).* A_t denotes the technology level or technical progress in an economy.

Technical progress is explained by various factors including infrastructure. Many growth models agree that infrastructures have a significant role in productivity. According to Rosenterm-Rodan (1940)'s treatise, provision of infrastructure has to be made simultaneously with the establishment of industries for the big push into economic maturity to be effective.

Thus, to determine the relationship between road transport infrastructure and economic growth in Nigeria, a Solow growth model is adapted.

$Y(t) = K(t)^{\alpha} H(t)^{\beta} X(t)^{\gamma} (A(t)L(t))^{1-\alpha-\beta-\gamma}$ 2

where;

Y= output

K=capital

L= labour

H=human capital

X= road infrastructure

Expressing equation 1 in per capita' it becomes

$Y_t = K_t^{\beta 1} H_t^{\beta 2} X_t^{\beta 3}$ 3

Linearizing equation 2, the model becomes;

$\ln Y_t = \beta_0 + \beta_1 K_t + \beta_2 H_t + \beta_3 X_t + \xi_t$.....4

Following Peter et al., (2015), government expenditure on road transport (GER) is added to equation 3 as a control variable. Thus, the model specification becomes;

$\ln Y_t = \beta_0 + \beta_1 \ln K_t + \beta_2 \ln H_t + \beta_3 \ln X_t + \beta_4 \ln GER_t + \xi$.....5

3.2.1. Estimation Method for Hypothesis 1

To empirically estimate the long-run and short-run impact of road transport on economic growth in Nigeria, we estimate equation (5) (Derived from equation 1, 2, 3and 4) using the bounds testing (or autoregressive distributed lag (ARDL) cointegration procedure, developed by Pesaran, et al., (2001). The ARDL procedure can be used when the regressors are integrated of order zero or one unlike the strict prerequisite of Johansen approach which required all variables to be only integrated of order 1 (Fosu and Magnus, 2006). The ARDL procedure is also relatively more efficient than Johansen approach in small or finite sample data size as is the case in this thesis. The ARDL, however, is not efficient and should not be used when variables are stationary at second difference.

The ARDL cointegration procedure involves several stages. In the first stage, the stationary properties of time series variables in equation (4) were examined by conducting unit root test. All variables were tested in level and in the first difference using the Augmented Dickey-Fuller (ADF) Test and Phillip Perron unit root test. The second stage involves testing for the existence of a long-run relationship between economic growth, road transport and all other regressors within a univariate framework. Following Pesaran

et al., (2001), the bounds test procedure was adopted by modeling the long-run of equation (5) as a general vector autoregressive (VAR) model of order p as follows:

$\Delta lny_t = C_0 + \beta_1 lny_{t-1} + \beta_2 lnk_{t-1} + \beta_3 lnh_{t-1} + \beta_4 lnx_{t-1} + \beta_5 lnGER_{t-1} + \sum_{i=1}^{p} \phi_1 \Delta lny_{t-1} + \sum_{i=1}^{p} \phi_2 \Delta lnk_{t-1} + \sum_{i=1}^{p} \phi_3 \Delta lnh_{t-1} + \sum_{i=1}^{p} \phi_4 \Delta lnx_{t-1} + \sum_{i=1}^{p} \phi_5 \Delta lnGER_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots 6$

where βi and ϕ are the long run and short-run multipliers respectively, C_0 is the drift and μ_t are white noise errors.

In ARDL procedure, equation (5) is estimated by ordinary least squares (OLS) in order to test for the existence of cointegration or long-run relation among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables, i.e

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (There exist no long-run relationship)

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$

We compare the estimate F-statistic from equation (6) with the critical value tabulated by Pesaran *et al.,* (2001). If the estimate of F-statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the underplaying order of integration of the variables is zero or one (Pesaran *et al,*. 2001).

Once cointegration is established the conditional ARDL (p_1, q_1, q_2, q_3, q_4, q_5) long-run model for equation (5) can be estimated as:

$lny_t = C_0 + \sum_{i=1}^{p} \beta_1 lny_{t-1} + \sum_{i=0}^{q1} \beta_2 lnk_{t-1} + \sum_{i=0}^{q2} \beta_3 lnh_{t-1} + \sum_{i=0}^{q3} \beta_4 lnx_{t-1} + \sum_{i=0}^{q4} \beta_5 lnGER_{t-1} + \mu_t$ 7

Where all variables are as previously defined. This involves selecting the orders of the ARDL (p_1, q_1, q_2, q_3, q_4, q_5) model in the six variables using Akaike information criteria (AIC).

The last and final step of an ARDL bound procedure is to obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates. This is specified as follows:

$\Delta lny_t = C_0 + \sum_{i=1}^{p} \phi_1 \Delta lny_{t-1} + \sum_{i=1}^{p} \phi_2 \Delta lnk_{t-1} + \sum_{i=1}^{p} \phi_3 \Delta lnh_{t-1} + \sum_{i=1}^{p} \phi_4 \Delta lnx_{t-1} + \sum_{i=1}^{p} \phi_5 \Delta lnGER_{t-1} + \phi_6 ECM_{t-1} + \mu_t \ldots\ldots\ldots\ldots 8$

Where ϕ is short-run dynamic coefficients of the model,

3.3 METHODOLOGY FOR OBJECTIVE II: EXAMINE THE EFFECT OF ROAD TRANSPORT ON POVERTY

Objective 2 is associated with hypothesis 2 where we test whether road transport has a significant impact on poverty level in Nigeria. To determine the impact of road transport on poverty reduction, this thesis adopted the model specified by Oladipo and Olomola (2015). The theoretical foundation of the model was based on the Solow neoclassical growth model. The model has also been formerly employed individually by Faridi et al. (2011), Qian and Noboru (2008) and Boopen (2006).

The model was derived through modification of variables and derivations of the long term steady state growth rate. The Solow model of long run growth postulates that output is related to inputs in which capital and labour are substitutable as:

$$Y = K^{\alpha} Q^{\beta} (AL)^{1-\alpha-\beta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

With the assumption of a constant return to scale in capital (K), transport infrastructure capital (Q), and productivity-augmented labour (AL), α and β are between 0 and 1. It is further assumed that inputs and output markets are perfectly competitive, all firms are identical and the economy produces single good. It is also assumed that net capital and transport infrastructure capital are dependent on savings minus depreciation is given by;

$$\acute{K} = s_k Y_t - \delta K_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

$$Q = s_q Y_t - \delta Q_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 11$$

Where s_k and s_Q are the exogenous saving rates for capital and transport infrastructure capital respectively. δ is the depreciation rate.

Labour and technology are assumed to grow at a constant rate of n and g respectively. With these equations and assumptions, the balanced growth paths of output can solve for physical capital and transport infrastructure capital. This involves finding "some transformation of these variables which converges to a steady-state' (Oladipo and Olomola, 2016).

After transforming the variables into per capita and obtaining the steady state growth (see Oladipo and Olomola (2016), the road transport and growth was derived as follows:

$$\ln Y_t = \beta + \beta \ln K_t + \beta \ln q_t + \mu \quad \text{.....12}$$

Where, yt, kt and qt are economic growth, physical capital, and road transport capital respectively.

According to Oladipo and Olomola (2016), based on the literature support for the effect of transport network on poverty via economic growth, poverty could perfectly substitute for economic growth in equation 12 with the replacement of capital with economic growth. The equation thus becomes:

$$\ln P_t = \beta + \beta \ln Y_t + \beta \ln Q_t + \mu \quad \text{.....13}$$

Where; P_t represents poverty, Y_t is economic growth and Q_t is road transport capital.

3.3.1. Measurement of poverty

This thesis, unlike in Oladipo and Olomola (2016) which is the only study (known to me) that focus on road transport and poverty in Nigeria, captured poverty level using the human development index (HDI) developed by the United Nation. Oladipo and Olomola (2016) measured poverty by employing consumption expenditure. This measure, although has been acclaimed to be better than the income-based measures, has some limitations. Firstly, consumption-based measures of poverty are susceptible to variation

in price and can be seriously affected when there is high inflation. Secondly, price and quality of good depending on location. So the fact that two different households have a similar amount of consumption does not imply that they are equally endowed. Also, consumption is measured at a household level, while poverty is defined at an individual level (Sarabia, 2016). Lastly, poverty goes beyond income and consumption. It is a multifaceted phenomenon that also includes social, cultural and psychological deprivations. Using income or consumption measurements do not suffice.

With regards to these limitations, the thesis chooses to use the HDI. HDI is a composite measure that measures deprivations in three basic need of man; health, education, and standard of living. Health is measured by longevity. Education is captured by adult literacy rate, while the standard of living is represented by the percentage of the population

With sustainable access to an improved water source and percentage of children underweight (UNDP, 2005).

Just as the first objective, ARDL approach was also employed in estimating the long-run and short-run impact of road transport on poverty in Nigeria, equation 13 will be estimated using the bounds testing (or autoregressive distributed lag (ARDL) co-integration procedure, developed by Pesaran, et al., (2001). The steps in the estimation of ARDL model as described above were also followed.

We began the estimation by examining the unit root properties of time series variables on poverty, road transport stock and economic growth through the Augmented Dickey-Fuller (ADF) Test and Phillip Perron unit root test. After this, the existence of a long-run relationship between poverty and road transport network was confirmed with bound co-integrating test. After which the long run and short run estimates of parameters in equation 13 were derived.[1]

[1] HDI= $[\frac{1}{3}(P_1{}^{\alpha} + P_2{}^{\alpha} + P_3{}^{\alpha})]^{1/\alpha}$

Where P_1= the probability at birth of no surviving to age 40 (times 100)

P_2= Adult literacy rate P_3 = unweighted average of population without subsistence

3.3.2. Method of Estimation II

Just as the first objective, ARDL approach was also employed in estimating the long-run and short-run impact of road transport on poverty in Nigeria, equation 13 will be estimated using the bounds testing (or autoregressive distributed lag (ARDL) cointegration procedure, developed by Pesaran, et al., (2001). The steps in the estimation of ARDL model as described above were also followed.

We began the estimation by examining the unit root properties of time series variables on poverty, road transport stock and economic growth through the Augmented Dickey-Fuller (ADF) Test and Phillip Perron unit root test. After this, the existence of a long-run relationship between poverty and road transport network was confirmed with the bound cointegrating test. After which the long run and short run estimates of parameters in equation 13 was derived

3.4. METHODOLOGY FOR OBJECTIVE III: ESTIMATE THE THRESHOLD STOCK OF ROAD TRANSPORT FOR WHICH THERE IS NO SIGNIFICANT EFFECT ON INCOME

Objective 3 is associated with hypothesis 3 where we aim to test whether there is a threshold level of transport infrastructure over which there is no significant impact on income. To determine the threshold stock of road transport at which income is not significantly affected for Nigeria's economy, equation 5 is re-specified with slight modification by adding the squared of log road transport in order to capture the non-linearity nature of the equation.

The modified equation is presented as follows;

$$\ln Y_t = \beta_0 + \beta_1 \ln K_t + \beta_2 \ln H_t + \beta_3 \ln X_t + \beta_4 \ln X_t^2 + \beta_5 \ln GER_t + \xi \quad \text{..... 14}$$

3.4.1 Method of Estimation III

Ordinary least square estimation technique was used to equation 8 in order to derive general stock threshold that associates with diminishing or increasing income. However, the non-linearity specification of income function (equation 14) would be tested by examining the significance of $\ln X_t^2$.

Equation (14) is a complex function and as road transport grows higher, equation 8 implies that transport has diminishing effects on income. That is, income will reach a point of saturation, and it will thereby reverse its trend

Equation 8 is non-monotonic income function that takes note of non-linearity property of the function. The sign and significance of the coefficient of $\ln X_t^2$ would indicate the shape of the function and from the road stock required for the function to reaches its maximum/minimum point can be calculated.

This is derived by finding the critical point of equation 14 as follows.

$\delta \ln Y_t / \delta \ln X_t = \beta_3 + 2\beta_4 \ln X_t = 0$ …….....15

From equation 15, $\ln X_t = -\beta_3 / 2\beta_4$

The trade-off point or the diminishing effects of road stock on income in the above dynamic function are simply the first derivatives with respect to road stock infrastructure. Thus exp $(-\beta_3/2\beta_4)$ is the turning point of road stock that corresponds to the maximum (minimum) point of an inverted U shaped income curve depending on the sign of the β_1 and β_2.

3.5 METHODOLOGY FOR OBJECTIVE IV: EXPLORES THE DIRECTION OF CAUSALITY BETWEEN INVESTMENTS ON ROAD TRANSPORT AND GDP GROWTH

Objective 4 is associated with the hypothesis 4 where we examine the causality between investment and GDP growth. In order to test the causal relationship between road

stock infrastructure and economic growth, a causality test is adopted. Granger causality examines to what extent the change in past value of one variable explains the variations in another variable.

3.5.1 Method of Estimation IV

The variance autoregressive model has often been used to confirm the causal relationship between two or more variables. The VAR is commonly used for forecasting systems of interrelated time series and for analyzing the impact of random disturbances on the system of variables. The VAR approach makes unnecessary the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous and exogenous variables in the system of equation thus forming a vector.

Granger causality test shows whether the equation below

$GDP = F(RD)$ ……16

Where;

GDP=gross domestic product and it is a proxy for economic growth

RD= road network

The VAR model for equation 16 is specified below;

$RGDP_t=\alpha_0 + \sum\alpha_i RGDP_{t-i}+ \sum\varphi_i RD_{t-i}+\mu_t$ ……17

$RD_t = \beta_0 + \sum\beta_i RD_{t-i}+\sum \delta_i RGDP_{t-i}+ \xi_t$ ……18

Where RGDP is the real gross domestic product (a proxy variable for economic growth), RD is road transport network, α_i and β_i are parameter estimates; μ_t and ξ_t are respective error terms with all standard assumption that they are both uncorrelated are white noise. In framework above, road transport network does not Granger cause economic growth if $\varphi_i = 0$, similarly, economic growth does not Granger causes road transport network if $\delta_i = 0$.

Since this model shows how changes in an endogenous variable are related to changes in its own lags, as well as to changes in other variables and their lags, a VAR, the optimal lag length needs to be determined. Some of the criteria used in determining the

optimum lag length of a VAR model are the Schwartz information criteria (SIC) and Akaike information criteria (AIC) (Verbeek, 2008). However, in addition to these criteria, Sequential Modified LR criterion (LR), the Final Prediction Error (FPE) and the Hannan-Quinn Information Criterion (HQ) were also used.

3.6. DIAGNOSTIC TESTS

Apart from confirming the unit root properties of the time series used in this study and the existence of long run relationship among these variables, various diagnostic test will be conducted. These include, serial correlation test, heteroscedasticity test and functional model test.

3.7. UNIT ROOT TEST

In any economic study of functional relationships between two or more variables that involve time series data, it is imperative to take into consideration the properties of time series data used in making any judgment or inferences. A time series is considered to be stationary if it's mean, variance and covariance are not changing with respect to time. Regression of a non-stationary time series on another non-stationary time series may produce unstable regression result. In other word, the model may yield misleading values of coefficient of determination R^2, Durbin Watson test of autocorrelation, t-statistic and F statistic. Thus the estimation technique used in this analysis will be based on test of stationarity using Augmented Dickey Fuller (ADF) and Phillip Perron tests of unit root before moving on to testing the existence of short run and long run relationship between the dependent and independent variables.

CHAPTER FOUR
PRESENTATION AND DISCUSSION OF RESULTS

This study examines the effects of road transport infrastructure on economic growth in Nigeria. This chapter has the estimation results of the specified equations. The four different models were estimated. The first model deals with the long run and short run impact of road transport on economic growth in Nigeria. The second model focuses on the effect of road infrastructure on poverty. In the third model, we examine the presence of linearity in economic growth-road transport relationship. It also calculated the maximum road investment which is consistent with high economic growth, and the last model focuses on the determination of direction of a causality between road infrastructure and economic growth. This chapter begins with the description of time series used in this study, followed by testing of unit root properties of these series. Estimations of models and discussion of findings for each model conclude the chapter.

4.1. DESCRIPTIVE STATISTICS

Table 3: Descriptive Analysis

	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera	Probability
Gross Domestic Product (logGDP) (million naira)	12.399	12.270	12.862	12.061	0.261	4.275	0.118
Gross capital formation (logK)	28.975	28.649	30.039	27.995	0.611	3.521	0.172
Contribution of road transport to	12.468	12.215	13.411	11.756	0.574	4.563	0.102

GDP (logTRACON) (thousand km)							
Secondary School Gross Enrolment (logL)	16.046	15.553	20.431	13.198	1.747	12.856	0.002
Length of road **(**logX) (hundred km)	8.949	8.717	10.105	7.063	0.682	0.004	0.998
Human Development Index (HDI)	0.411	0.390	0.567	0.316	0.088	3.594	0.166

This section presents and summarizes statistical properties of variables. In the descriptive statistics attention was on information such as mean, minimum value, maximum value, and the Jarque_Bera statistic. Time series used, beside HDI, were examined in their log form. The descriptive statistics of the variables from 1980- 2015 is provided in Table 3 above.

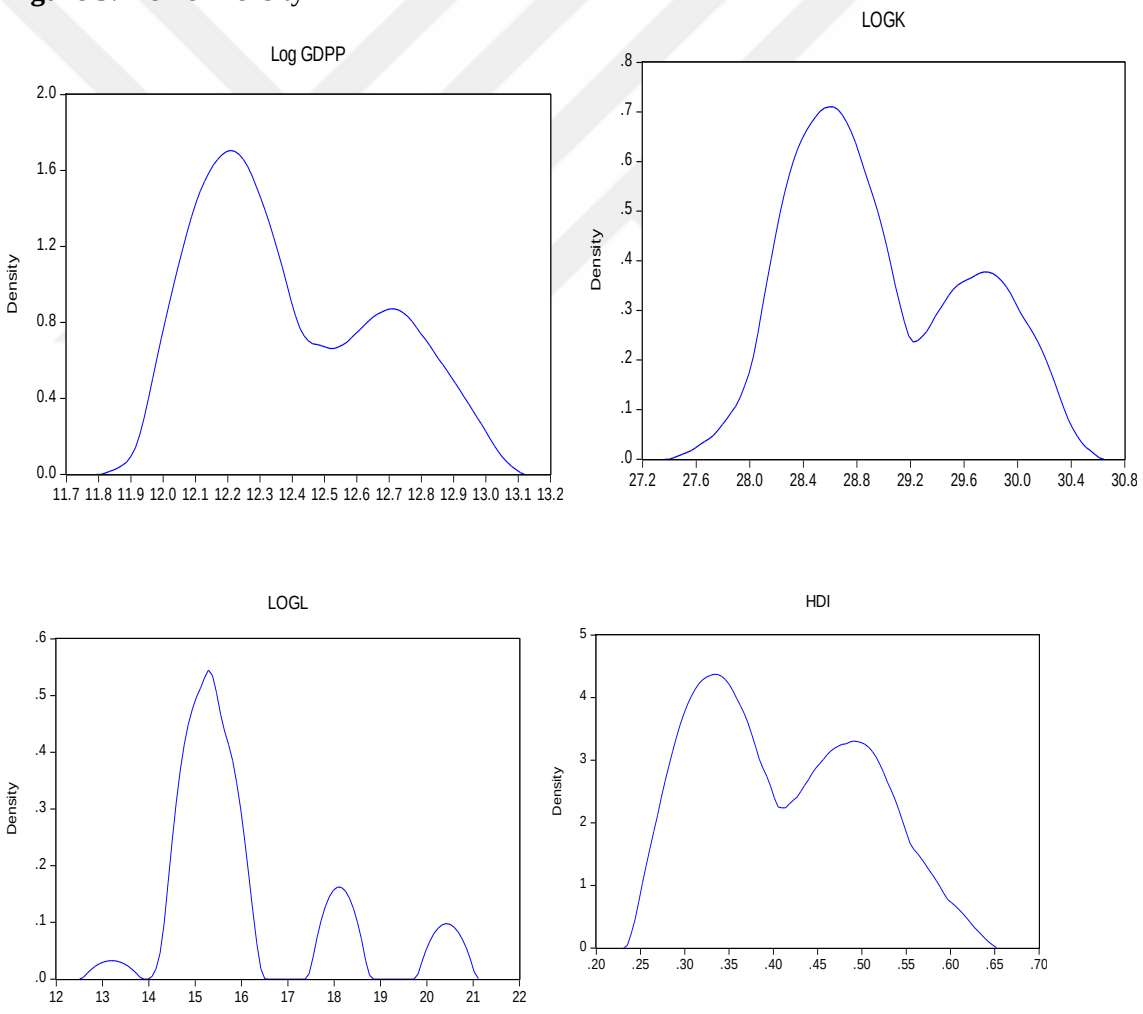
From Table 3, it is observed that there is high level of consistency displayed by the series as their mean and median fall within the minimum and maximum values of the series. For instance, the mean value of economic growth (logGDP) is 12.399 with standard deviation of 0.261. The series on HDI which represents poverty (HDI) is the most consistent variable with lowest standard deviation followed by GDP, contribution of road transport to GDP (logTRACON) and capital (logK) in having low fluctuations. It is also observed that logK has the highest maximum value of 30.039 followed by labour (logL) while POV has the least minimum value of 0.316 followed by length of road transport (logX).

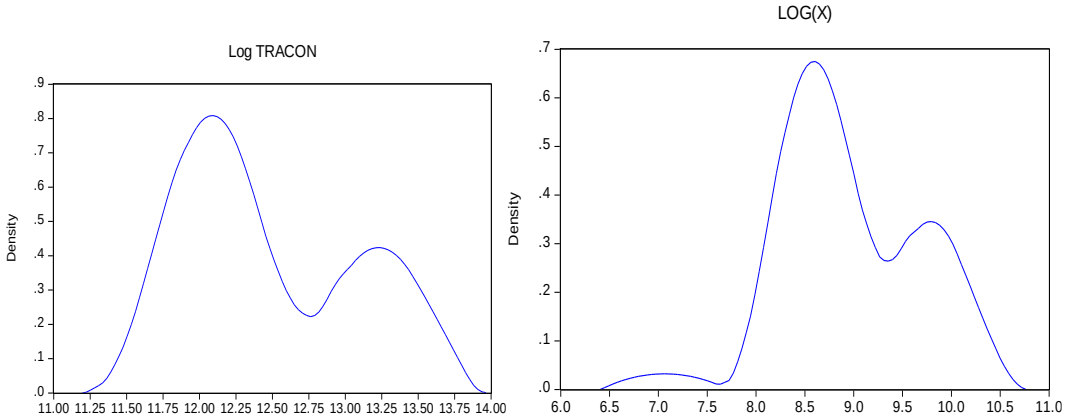
The Jarque_Bera is a test for normality of the distribution was also presented in Table 3. The null hypothesis is that the distribution of the sample is a normal. If the probability value of the Jarque_bera test is greater than 0.05, the null hypothesis is not

rejected and the alternative hypothesis which says that the sample is not normally distributed is rejected. From the results in Table 3, the Jarque_Bera test shows that the null hypothesis is strongly not rejected for all the distribution in our model, except labour (logL). The implication of this finding is that the time series used are appropriate for estimation.

To corroborate the Jarque_Bera normality test, kernel density distribution line was constructed for each time series (see figures 3). These distribution graph show consistent distribution of all variables used in this thesis except labour (logL).

Figure 3: Kernel Density





4.2. THE UNIT ROOT

Before estimating the four models, unit root properties of the time series variables used in this study were tested. Unit root test is carried out to determine if the time series are stationary or not, and to determine their order of integration (i.e. number of times variables are to be differenced to achieve stationarity). This was to avoid spurious regression results. Also, it was claimed that any regression results obtained with non-stationary variables remain invalid (Ouattara, 2004). The Augmented Dickey Fuller test (ADF) test for unit roots and the Phillips Perron (PP) test were carried out for the time series employed in the study. The results are shown in table 4:

Table 4: Unit root tests

Variable	**ADF Statistic Level**	**PP Statistic Level**	**ADF Statistic 1st difference**	**PP Statistic 1st difference**	**Order of integration**	
					ADF	**PP**
lnGDP	-2.8493 -4.2436* -3.5443** -3.2047***	-2.8341 -4.2436* -3.5443** -3.2047***	-5.3268 -4.2529* -3.5485** -3.2071***	-5.3227 -4.2529* -3.5485** -3.2071***	I(1)	I(1)
lnK	-1.2611 -4.2433*	-1.1699 -4.2436*	-5.985 -4.2529*	-6.2439 -4.2529*	I(1)	I(1)

	-3.5443** -3.2047***	-3.5443** -3.2047***	-3.5485** -3.2071***	-3.5485** -3.2071***		
lnL	-1.853573 -4.2433* -3.5443** -3.2047***	-1.557338 -4.2436* -3.5443** -3.2047***	-8.164056 -4.2529* -3.5485** -3.2071***	-19.13022- -4.2529* -3.5485** -3.2071***	I(1)	I(1)
POV	-2.171280 -4.2436* -3.5443** -3.2046***	-2.140662 -4.2436* -3.5443** -3.2047***	-6.0046 -4.2528* -3.5484** -3.2071***	-6.009824 -4.2528* -3.5484** -3.2071***	I(1)	I(1)
LnX	-5.2011 -4.2436* -3.5443** -3.2047***	-5.5262 -4.2436* -3.5443** -3.2047***			I(0)	I(0)
lnTRACON	-2.171280 -4.2436* -3.5443** -3.2047***	-2.1199 -4.2436* -3.5443** -3.2047***	-6.5723 -4.2528* -3.5484** -3.2071***	-6.5009 -4.2528* -3.5484** -3.2071***	I(1)	I(1)

In Table 4 Notes: *(**) *** denote Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) statistic at 1%, 5% and 10% level of significance. Figures in brackets are the critical values of ADF and PP respectively.

Test result decisions were made by comparing statistical values from each table with critical values for variables in the same category. In the results in Table 4, of all the time series used, only length of road transport (lnX) is stationary at level. All other variables are stationary at first difference. lnX is stationary at level based on ADF and PP unit root tests since the calculated ADF and PP values are greater 5% critical values. For instance, the calculated ADF and PP value for economic growth (lnGDP) at level are -2.8493 and -2.8341 respectively. The absolute value of the calculated ADF and PP, however, fall below 5% critical values of each test statistic (-3.5443). But the

corresponding ADF and PP calculated values of lnGDP at first difference are greater than the 5% critical value, thus lnGDP is stationary at first difference but not at level.

The two-unit root tests are consistent. They show similar results of order of integration. All variables besides length of road transport (lnX) are integrated of same order one in both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) since the absolute value of the critical value in both is greater than the ADF and PP statistic at 1%, 5% and 10% for all these variables. The results show that the model stated in chapter three consists of variables that are integrated of order zero and one. As a result, we took the first difference for all variables and each series rejects the null hypothesis at 5% level. Thus, Auto Regressive Distributed Lag (ARDL) model can be used and bound co_integration test can be conducted when necessary.

4.3. OBJECTIVE 1 ESTIMATING THE LONG AND SHORT RUN IMPACT OF ROAD TRANSPORT ON ECONOMIC GROWTH

Following the clarification of the unit root properties of all the time series, the estimation of the Auto Regressive Distributed Lag (ARDL) model begins with verification of collinearity among regressors in equation 4 after which confirmation of existence of long run relationship between economic growth, road transport and all other variables included in equation 4 through Bound test for co_integration was conducted.

4.3.1. Test for Collinearity

Correlation among the explanatory or independent variables is undesired if the efficiency estimates are to be obtained. Collinearity among explanatory variables may give rise to unreliable standard error and as such leads to poor conclusions about the significance of estimates and a very high coefficient of determination (R^2) upon estimating the model. Therefore, there is need to ensure that the regressors are not correlated. Therefore, prior to estimation of the empirical models, correlation coefficients among the variables are estimated. A high correlation coefficient between any two variables shows

that the two variables are highly correlated thus justifying the elimination of one of the two variables out of the model

Table 5: Correlation Matrix

Covariance Analysis: Ordinary				
Sample (adjusted): 1980 2015				
Included observations: 35 after adjustments				
Correlation				
	logK	logL	logX	logTRACON
logK	1.000000			
	-----			
logL	-0.045153	1.000000		
	(0.7967)	-----		
logX	0.083100	-0.007387	1.000000	
	(0.6351)	(0.9664)	-----	
logTRACON	0.258885	-0.016347	0.632495	1.000000
	(0.1332)	(0.9257)	(0.0000)	-----

- P-value of correlation is enclosed in a bracket

Table 5 shows the Pair-wise correlation among the variables used in equation 4. The correlation between most of the variable is below 50% showing that our variables are jointly free from possible multi-collinearity, except in the case of length of road transport (logX) and contribution of road transport to GDP (logTRACON) for which correlation coefficient is higher than 50% and thus, indicates close relationship between the two variables. The results of collinearity among regressors in equation 4 can also be analyzed through the P-value reported in table 5. Correlation coefficient is significant if its P-value is less than 0.05. The table shows that only the P-value of correlation coefficient of the relationship between road length (logX) and road transport contribution to GDP

(logTRACON) is higher than 0.05, P-values of other coefficients are less than 0.05. Thus, it is advisable not to include the two variables in equation 4, given that length road transport (logX) is a stock, the variable is retained and contribution of road transport to GDP (logTRACON) removed.

4.3.2. Bounds Tests for Co_integration

The results of bounds testing approach for existence of a long run relationship between economic growth (logGDP) and length of road transport (logX) is presented in table 6. The calculated F-statistic of the model is significant at the 95% significance level and is greater than the Pesaran's critical lower bound value of 2.22 and upper bound values of 3.39. This implies that the null hypothesis of no co-integration between road transport and economic growth is rejected and, thus, it is concluded that there is indeed a long run relationship among the variables used in equation 4. The result, therefore, implies that long run relationship exist between the dependent variable (economic growth) and all independent variables (capital, labour, and length of road transport), consequently, an ARDL technique is feasible.

Table 6: Bound Co_integration Testing Approach

Dependent variable	AIC lags	F-statistic	Prob.	outcome
logGDP	1	3.4957	0.006	co_integration

4.3.3. LAG Selection Criteria

Table 7 presents the lag selection criterion result for the equation 4. After trying several lag specifications, the result revealed that the Sequential Modified LR criterion (LR), the Final Prediction Error (FPE), the Hannan-Quinn Information Criterion (HQ), the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC) suggest one lag for equation 4. Therefore, following the lag selection result as suggested by the

various lag selection criterion, we decided to use one lag because it is the most suggested lag.

Table 7: Var Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-85.29433	NA	0.002633	5.411778	5.593173	5.472812
1	22.50019	182.9240*	1.02e-05*	-0.151526*	0.755448*	0.153643*
2	29.63679	10.38052	1.83e-05	0.385649	2.018203	0.934954
3	46.98107	21.02337	1.91e-05	0.304178	2.662311	1.097618

* 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

4.3.4. Estimation of Long Run Effect of Road Transport on Economic Growth

The long run estimates of the effect of road transport on economic growth derived through an ARDL method are presented in table 8. In the regression analysis, the first difference of all the variables are used. Since majority of the variables are I(1), this implies that coefficient estimates obtained from using such data will be unbiased and efficient when OLS technique is employed. Various estimations of the empirical model are performed; however, the estimation that yielded the best result is reported in Table 8. The result corrected for possible presence of heteroscedasticity in the model by estimation equation 4 with Heteroskedasticity Consistent Covariance estimators which provides consistent estimates of the coefficient covariance in the presence of conditional heteroscedasticity of unknown form. This enables us to eliminate possibility of relying on biased results.

From the results the R-squared of 0.96 indicates that 96 percent variation in the Gross Domestic Product in Nigeria is caused by the independent variables. The adjusted R squared of the model is about 0.95 and implies that about 95 percent of variations in Gross Domestic Product are explained by all the included independent variables after taking note of degree of freedom. The F-statistic value of the long-run models is also significant. Its value is 162.88 with p-value of 0.000. This implies that all the independents variables included in the model are jointly significant in explaining variations in economic growth. It further shows that the model is adequate in explaining the behavior on growth of GDP in Nigeria. Breusch Godfrey LM test for serial correlation is also reported to show nonexistence of serial autocorrelation (see appendix for result).

Table 8: Estimated long run coefficients using the ARDL approach
Dependent Variable: LOGGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.726039	0.420616	1.726133	0.0946
LOGGDP(-1)	0.879739	0.039871	22.06474	0.0000
LOGK(-1)	-0.015201	0.007772	-1.955807	0.0599
LOGL(-1)	0.012325	0.007957	1.548848	0.1319
LOG(X(-1))	0.083793	0.011804	7.098700	0.0000
R-squared	0.955982	Mean dependent var		12.38407
Adjusted R-squared	0.950113	S.D. dependent var		0.263533
S.E. of regression	0.058861	Akaike info criterion		-2.695698
Sum squared resid	0.103940	Schwarz criterion		-2.473505
Log likelihood	52.17471	Hannan-Quinn criter.		-2.618997
F-statistic	162.8837	Durbin-Watson stat		2.005585
Prob(F-statistic)	0.000000			

Result from table 8 indicates a significant positive long run effect of road transport on economic growth in Nigeria. The coefficient of road transport (lnX) is 0.084 and it conforms to economic expectation of positive relationship between economic growth and road transport. The coefficient indicates that 1 percent change in length of road network would lead to about 0.084 percent increase in growth of GDP. This result conforms to the findings of Mamatzakis (2002), Montolio and Solé-Ollé (2009), Banerjee, Duflo and Qian (2009), Cheteni (2013), Ajiboye and Afolayan (2009) Nurudeen and Usman (2010) Nwakeze and Yusuff (2010), Precious (2011), Nyewe and Ugondah (2013) Nedozi, Obasanmi and Ighata (2014), Ogbonna and Hyacinth (2014), and Peter, Rita and Edith (2015) They all found a significant positive effect of road transport on economic growth. The implication of this finding is that road network complements and assists all other factors of production that are pre requisite for economic growth in the long run. That is why Anyanwu bet al., (1997) stated that road transport infrastructure, besides facilitating the direct provision of services to consumers, it also provides intermediate inputs that enter into the production of other sectors and raise factor productivity. Road transport promotes specialization, diversification and economic growth. The belief that road network would assist the country to take off to high level of growth and development in the future account for the huge financial resources the Nigerian government spent on road network across the nation during the National Development plan of 1975-1980.

In the result, past value of GDP is statistically significant and possess the right sign. This implies that there is tendency for growth to continue when it started on a positive note. The coefficient of one-year lag of GDP is 0.088. This indicates that one per cent increase in past GDP will on the average increase current GDP by about 0.1 per cent.

The coefficient of capital is statistically significantly at the 5% significance level but has a negative sign. This is contrary to theoretical expectation of a positive relationship between capital and economic growth. The result may imply that the borrowings by the government from the private sector crowd out investment and as such acts as a drag on the overall economy. The effects of labour force on GDP is positive but remain insignificant at 95% significance level.

4.3.5. Estimation of Short Run Effect of Road Transport on Economic growth

The results of the short-run coefficients associated with the long -run relationships obtained from the Error Correction Model version of ARDL equation is given in Table 4.7. The estimated short-run coefficients of error correcting parameter (ECM) for the model is statistically significant and have the correct sign. This is a further proof of the existence of stable long run relationship between GDP and the selected explanatory variables. The R squared of the model, just as in the long run estimates, is about 0.32. This indicates that about 32 percent of variations in GDP are explained by all the included independent variables. The low value of R squared may be due to data differencing. The F-statistic values of the short run models are also significant and imply that the short-run models are appropriate. The p-value of F-statistic is 0.040. Just as in the long run estimates, the short run result was corrected for possible presence of heteroscedasticity through estimation with Heteroscedasticity Consistent Covariance estimators which provides consistent estimates of the coefficient covariance in the presence of conditional heteroscedasticity of unknown form.

Table 9: Short Run Result for the Selected ARDL Model
Dependent Variable: D(LOGGDP)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002963	0.011999	-0.246904	0.8068
D(LOGGDP(-1))	1.095069	0.375068	2.919652	0.0068
D(LOGK(-1))	-0.008633	0.006112	-1.412529	0.1688
D(LOGL(-1))	0.005915	0.004808	1.230199	0.2289
D(LOG(X(-1)))	0.094308	0.037969	2.483788	0.0193
ECM(-1)	-1.261271	0.438337	-2.877402	0.0076
R-squared	0.326760	Mean dependent var		0.012865
Adjusted R-squared	0.206538	S.D. dependent var		0.066286
S.E. of regression	0.059045	Akaike info criterion		-2.662235
Sum squared resid	0.097618	Schwarz criterion		-2.392878
Log likelihood	51.25800	Hannan-Quinn criter.		-2.570377
F-statistic	2.717984	Durbin-Watson stat		2.100788
Prob(F-statistic)	0.040060			

The short-run estimation of the equation 4 is less robust and appropriate compared to the long run estimates in terms of number of significant estimates and conformity with theoretical expectations. In the short run result of the road transport network, just as in the long run, has a significant positive effect on economic growth but the marginal effect on growth of the short run estimate is higher. Based on the result in Table 9, current road transport network has about 0.09 percent marginal effect on GDP. That is, one percent increase in current road construction will improve GDP by 0.09 per cent. This may imply that the effect of road transport is stronger in the short run than in the later period, and that the growth effect of road transport in the long run dwindles. Road transport investment does impact economic growth strongly in the short run. According to Leung (2006), accessibility and mobility effects are the major influence of road transport which instantly create and facilitate further investments in an economy. These effects encourage movement of human capital and goods from one place to another and hence ensure optimal allocation of resources.

Similarly, the short result indicates that the past value of GDP is statistically significant at the 5% significance level and possess the right sign. Just as in the long run result, it implies that there is tendency for growth to continue when it started on a positive note. The short run coefficient of one-year lag of GDP is 1.095. This indicates that 1 per cent increase in past GDP will on the average increase current GDP by than 1.095 per cent.

The coefficients of capital and labour are similar to the long run result. Capital is statistically significantly at 5 percent significance level but has a negative sign. The effect of labour force on GDP is positive but remain insignificant at 5 per cent significance level.

In summary the results show that road transport contributes significantly to economic growth of Nigeria both in the short and long run. Although, effect of road network on economic growth dwindles over some periods, road network still remains viable investment over the long time. This results are consistent with hypothesis 1 that road transport has a significant effect on economic growth.

4.4. OBJECTIVE 2

4.4.1. Estimating Impact of Road Transport on Poverty Level

In this section, the estimates of impact of road transport on poverty level is derived and interpreted. The section proceeds by examining the possibility of existence of co_integration between poverty, proxied as human development index, and road transport.

4.4.2. Bounds Tests of Co_integration

The results of bounds testing approach presented in Table 10, indicate lack of co_integration between road transport and poverty level. The calculated F-statistic of the model is significant at 5 percent critical level and is less than the Pesaran's critical lower bound value of 2.22 and upper bound values of 3.39. This results implies that road transport is not synonymous with poverty reduction in Nigeria and there is no direct link between poverty and road transport in Nigeria, consequently, an ARDL technique is not feasible.

Table 10: Bound co_integration testing Approach for objective II

Dependent variable	AIC lags	F-statistic	Prob.	outcome
HDI co_integration	1	0.7856	0.58886	no

Based on this result, Ordinary Least Square (OLS) estimation technique was used to estimate the impact of road transport and poverty level in Nigeria. The OLS result is presented in Table 11,

Table 11: OLS result of effect of Road Transport on Poverty level

Dependent Variable: HDI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.227756	0.403243	-3.044704	0.0046
LOGGDP	0.062960	0.040089	1.570519	0.1258
LOG(X)	0.095912	0.015397	6.229114	0.0000
R-squared	0.796982	Mean dependent var		0.410654
Adjusted R-squared	0.784678	S.D. dependent var		0.088063
S.E. of regression	0.040864	Akaike info criterion		-3.477485
Sum squared resid	0.055105	Schwarz criterion		-3.345525
Log likelihood	65.59474	Hannan-Quinn criter.		-3.431428
F-statistic	64.77375	Durbin-Watson stat		0.692825
Prob(F-statistic)	0.000000			

Based on the result, the effect of economic growth (logGDP) on poverty alleviation (human development index) is positive but statistically insignificant. This could be seen from the P-value of the coefficient of logGDP (0.1258) which is less than 0.05. This result could imply that it takes more than economic growth to alleviate poverty. It is economic growth coupled with equitable distribution of wealth and social justice that leads to poverty alleviation.

From the result, road transport has significant positive effects on poverty alleviation (human development index) in Nigeria. The significance of the effect of road transport on poverty alleviation is indicated by the low value of the P-value of the coefficient of road transport (P-value < 0.05). The value of the coefficient of road transport indicates that 1 percent increase in road length will on the average lead to about 0.1 percent decrease in poverty level.

4.5. OBJECTIVE 3

4.5.1. Estimation Road Stock Threshold Stock (The Maximum Limit) For Which Income Is Not Significantly Affected.

In this section, our interests are to test the statistical significance of squared of road transport length (X^2) in equation16, and also determine the value of length of road that maximizes GDP. The ordinary least square was used to estimate of parameters of equation 16 and differential calculus was used to obtain the value of X.

Table 12 presents the results the threshold stock of road transport length (km) at which economic growth will not be significantly affected by further road investment in Nigeria. The model is adequate and robust based on the value of coefficient determination (R^2) and F-statistics. From the table, the linearity hypothesis of the equation 16 is strongly not accepted since the coefficient of $(\log X)^2$ is statistically significant at 5 percent critical level. This first result confirms the non-linearity of the equation 16, and shows the presence of strong threshold effects determined by length of road.

Table 12: Regression Analysis for objective III
Dependent Variable: LOGGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.00416	2.237390	13.41034	0.0000
LOGK	0.017229	0.011105	1.551432	0.1309
LOGL	-0.039976	0.017183	-2.326565	0.0267
LOG(X)	-4.203662	0.489973	-8.579376	0.0000
LOG(X)^2	0.253882	0.028751	8.830238	0.0000
R-squared	0.934561	Mean dependent var		12.38984
Adjusted R-squared	0.926118	S.D. dependent var		0.262039
S.E. of regression	0.071226	Akaike info criterion		-2.317678
Sum squared resid	0.157266	Schwarz criterion		-2.097745
Log likelihood	46.71821	Hannan-Quinn criter.		-2.240916
F-statistic	110.6813	Durbin-Watson stat		0.702081
Prob(F-statistic)	0.000000			

Given the non-linearity of equation 16, calculation of threshold road length is feasible. However, to confirm whether the function is U-shaped or an inverted shaped, the sign of log(X) is paramount. Given that the sign of log(X) is positive the equation 16 is U shaped and we are dealing with amount of road length that is consistent with minimum GDP level and above which income will increase. Based on optimization principle as explained in chapter three, the threshold road length that is consistent with minimum level of GDP in Nigeria, on the average, is about 190,009,405 Km. The implication of this finding is that at initial low level of road construction across the country, income will decline as resources is being diverted from other productive sectors to road and probably due to inconvenience and obstruction of movement caused by road construction. Another reason could be long gestation of road transport investment. All these factors affect production negatively during construction period and as a result drag down economic growth. This trend continues as more and more road is constructed until it get to certain level which is the threshold. After this threshold, any increase in road construction will directly increase GDP. Since previous road investment is yielding return and alternate roads have been constructed.

4.6. OBJECTIVE 4

4.6.1. Estimating causality between road network and economic growth

In order to test the causal relationship between road stock infrastructure and economic growth, a causality test is adopted. Granger causality test examines to what extend the change in past value of one variable explains the variations in another variable. In order words, assessment of the direction of effect between transport infrastructure investment and growth could be examined through Granger causality test. The variance autoregressive model has often been used to confirm the causal relationship between two or more variables. In Granger causality test, null hypothesis is that no causality between road transport and GDP. Null hypothesis is rejected if the probability of F-statistic given in Granger causality result is less than 0.05 for 5 percent critical level.

Table 13: Causality Test
Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG(X) does not Granger Cause LOGGDP	34	4.17342	0.0255
LOGGDP does not Granger Cause LOG(X)		2.66161	0.0868
LOG(TRACON) does not Granger Cause LOGGDP	34	4.94479	0.0142
LOGGDP does not Granger Cause LOG(TRACON)		5.77528	0.0077

Table 13 presents the results of Granger causality test carried between transport infrastructure investment and growth. Going by 5 percent significant level, it can be seen from the table above that there is unilateral causality between GDP and length of road (km) in Nigeria. The causality runs from length of road to GDP since the null hypothesis that road length does not Granger cause GDP is rejected at 5 percent significance level. The direction of causality will only be assumed to be bidirectional if 10 per cent significance level is used. Based on this argument, it is safe to state that development of length of road precede economic growth and development. This result is consistent with that of Fernald (1999) who revealed that the causality between road and productivity is more likely to be former to the latter, rather than the other way around since construction of more roads stimulates productivity and growth in the industries that use road more intensively.

Using another measure of road transport (contribution of road transport to output) yield similar but interesting result. The result indicates a bidirectional causality between GDP and contribution of road transport to output. Based on this results, it is evidenced both road and economic growth complement and facilitate each other. This is also consistent with finding of Badalyan, Herzfeld and Rajcaniova (2014) who found that a bidirectional causality exists between economic growth and road in Armenia, Georgia and Turkey.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the major findings of this thesis and presents the conclusion and recommendations based on these findings. The study's contributions to knowledge and the suggestions for future research in the scope of this study are also discussed in the chapter.

5.1. SUMMARY OF THE STUDY

The study evaluates the impact of road transport infrastructure on economic growth in Nigeria between 1980 and 2015. This thesis was motivated by the paucity of literature that Nigeria, like many other developing countries, recognizes the importance of and need to develop an efficient transport system to facilitate growth and development. This is evident as the country disposed huge financial and material resources towards road network in her third National Development Plan of 1975 to 1980. However, the state road network is yet to be developed due to corruption, lack of political will, lack of continuity among government etc. The average road density in Nigeria is 21.0 km which relatively lower than that of Ghana, Mauritius, Seychelles and South Africa whose road density are 24.0 km, 99 km, 110 km and 30 km respectively (World Bank, 2015). The country road network was ranked 127th out of 144 countries by The Global Competitive Index (GCI). With this situation, it was quite surprising when most empirical studies of the road network and economic growth reported a positive effect of former on latter. This is quite surprising given the level of poverty in the country.

The thesis has four main specific objectives. Each objective dealt with gaps found in the existing literature on road transport in Nigeria. Objective one deals with the evaluation of the short and long-run impact of road transport infrastructure on GDP growth. As stated in the problem statement, despite substantial works of literature on transport and economic growth in developed countries, studies in this area are limited in Nigeria. Most studies on road transport in Nigeria are descriptive in Nature (e.g Adesanya

1995; Eboh, 2005; Anyanwu, Adebusuyi, and Kukah; 2003 etc). Only a handful of studies relied on sound inferential statistics and econometric foundation to push forward their arguments. The findings from existing empirical studies in Nigeria which use inferential tools are inconclusive. While some authors found a positive effect of road transport on economic growth (Nurudeen and Usman (2010), Nwakeze and Yusuff (2010), Nedozi, Obasanmi and Ighata (2014) etc), others reported a negative effect of road transport on economic growth (Kayode et al., 2013; Oladipo and Olomola (2016). Authors such as Chukwuemeka, Nyewe, and Ugondah (2013) found no link between road transport and GDP growth. Hence, objective one contributes to the existing discourse on road transport-growth nexus by using an ARDL approach.

Objective two examines how road transport affects poverty level in Nigeria. Based on my review, only one study has looked into the role road transport in poverty reduction in Nigeria. This study, however, focuses only on simple measure of poverty; consumption expenditure and ignore the fact that poverty is multidimensional in nature and requires a multiple composite indexes for its salient features to be adequately captured. Thus, this objective fills this gap by using composite index of poverty. This objective was achieved with Ordinary least squares estimation technique. In the estimation, human development index was regressed on GDP and road infrastructure, after taking note of unit root properties of each variable.

Objective three focuses on testing the non-linearity relationship between road transport and economic growth in Nigeria in order to estimate the threshold road stock that is consistent with minimum or maximum income. The existence of non-linearity has been carried by authors including Barro, 1990; Shi, Guo and Sun, 2015; Ding, 2013; Simon and Natarajan, 2017. It was found that the relationship between road network and economic growth is inverse U shaped in these study. This implies that road transport has limited growth effect to certain stock level of road. By this, a certain threshold of road infrastructure exists for sustainable economic growth. Any investment on infrastructure capital beyond this threshold will become unproductive and hence lead to "crowding out" of private capital and reduced economic growth. No study in Nigeria has estimated the threshold road infrastructure for the country. The importance of conducting threshold

analysis lies in it fact that, it would preempt waste of resources and potential crowding out of private investment. It would also show the deficit level of road network required and act as a guide for policymakers. By estimating road thresholds, this thesis contributes significantly to existing state knowledge. Ordinary least square was used to confirm the existence of a non-linear relationship between road stock and GDP. After the estimation of parameters, differentiation technique was applied in order to calculate the road threshold.

The last objective of this thesis dealt with causality between road transport and economic growth. As with objective one, the direction of causality between road transport infrastructure and economic growth is still debatable. Lack of consensus on the direction of causality emanates from the dual nature of road transport in economic development. According to Gramlich (1994), the direction of causation from transport infrastructure to economic growth or vice-versa is unclear. The result depends on the measurement of road adopted, functional specification, and method of estimation and level of development of an economy. Thus, this thesis tried to establish a causal link between the road and economic growth by using the technique of Variance Autoregressive model which involve examination of how change in past value of one variable explains the variations in another variable. The VAR approach makes unnecessary the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous and exogenous variables in the system of equation thus forming a vector.

Summary of major findings on the objectives of the study are:

i. Descriptive statistics results showed that there is high level of consistency in the series used by this thesis as their mean and median fall within the minimum and maximum values of the series. The Jarque_Bera is a test for normality of the distribution shows that all series, apart from log of labour, are normally distributed. Findings from the Jarque_Bera normality test was also corroborated by the kernel density distribution line was constructed for each time series.

ii. The unit root properties of time series used conducted through the Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) tests indicates that of all the time series used, only length of road transport (lnX) is stationary at level. All other variables are stationary at first difference. The two-unit root tests are consistent. They show similar results of order of integration.

iii. The preliminary correlation analysis conducted among explanatory variables used in achieving objective one, association among most of the variables was found to be weak showing that variables used are jointly free from possible multi_collinearity, except in the case of length of road transport (lnX) and contribution of road transport to GDP (lnTRACON) for which correlation coefficient is strong (higher than 50%) and thus, indicates close relationship between the two variables. Thus, contribution of road transport to GDP (lnTRACON) was removed from the empirical analysis.

iv. The results of bounds testing approach for existence of a long run relationship between economic growth (lnGDP) and length of road transport (lnX) that long run relationship exist between the dependent variable (economic growth) and all independent variables (capital, labour, and length of road transport), making the use of an ARDL technique justifiable.

v. After trying several lag specifications, the result from the Sequential Modified LR criterion (LR), the Final Prediction Error (FPE), the Hannan-Quinn Information Criterion (HQ), the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC) suggest one lag for equation for achieving objective one.

vi. Road transport was found to a significant long run positive effect on economic growth in Nigeria. One percent change in length of road network would lead to about 0.084 percent increase in growth of GDP. The result corroborates existing studies in Nigeria such as Nwakeze and Yusuff (2010), Precious (2011), Nyewe and Ugondah (2013) Ogbonna and Hyacinth (2014), and Peter, Rita and Edith (2015) which argued for positive effect of road transport on economic growth.

vii. The short-run effect of road transport on economic growth was also positive and significant but the marginal effect on growth of the short run estimate is higher than that of the long run estimate. Road transport has about 0.09 percent marginal effect on GDP. This may imply that the effect of road transport is stronger in the short run than in the later period, and that the growth effect of road transport in the long run dwindles.

viii. It was found that road transport has a significant positive effects on poverty alleviation (human development index) in Nigeria. The value of the coefficient of road transport indicates that 1 percent increase in road length will on the average lead to about 0.1 percent decrease in poverty level.

ix. The existence of non-linear relationship between road transport and economic growth was confirmed in the analysis. This shows the presence of growth threshold effects determined by length of road. However, unlike in other studies such as Barro, (1990); Shi, Guo and Sun, (2015); and Simon and Natarajan, (2017), it was found that the relationship between growth and road network in Nigeria is U shaped and as such what this implies is that we are dealing with amount of road length that is consistent with minimum GDP level and above which income will increase.

x. The threshold road length that is consistent with minimum level of GDP in Nigeria, on the average, is about 19 million Km. The implication of this finding is that an initial low level of road construction across the country, income will decline as resources is being diverted from other productive sectors to road and probably due to inconvenience and obstruction of movement caused by road construction. Another reason could be long gestation of road transport investment. All these factors affect production negatively during construction period and as a result drag down economic growth.

xi. The Granger causality test indicates that there is unilateral causality between GDP and length of road (km) in Nigeria. The causality runs from length of road to GDP since the null hypothesis that road length does not Granger cause GDP is rejected at 5 percent significance level.

xii. Using another measure of road transport (contribution of road transport to output) yield similar but interesting result. The result indicates a bidirectional causality between GDP and contribution of road transport to output. Based on this results, it is evidenced both road and economic growth complement and facilitate each other.

CONCLUSION

The study evaluates the effects of road transport on economic growth in Nigeria between 1980 and 2015. The study is road transport effects is important in advising and guiding the behavior of public and investors in infrastructures. The study reveals the paucity of empirical studies on the road interaction among road transport, poverty and economic growth. It also introduced the need for confirming the existence of non-linearity between road transport and economic growth and went ahead to calculate the road stock threshold consistent with high or low income which could preempt excessive and duplication of road network. Based on the findings summarized above, the study therefore concluded that;

First, the existing road network is underdeveloped, inefficient and requires a huge investment in Nigeria. The maintenance of the road network has long been overdue. This explains the reason for low marginal effect of road transport on economic growth and poverty reduction in Nigeria. The found that effect of road transport on these variables is positive but very small both in the long run and short run.

Second, the effect of road transport on economic activities is stronger in the short run than in the long run. The growth effect of road transport in the long-run, dwindles as a result of lack of maintenance. One new road is constructed, it instantly creates accessibility and mobility effects, facilitates new investments and ensures optimal allocation of resources in the country.

Third, the relationship between road transport and economic growth is not linear. It was U shaped. This implies that at road transport is a drag on growth when the level of road construction is low. The positive growth effects of road network begin at road length of about 190 million Km.

Lastly, the causality between GDP growth and road transport is inconclusive. The result is sensitive to measurement of data and choice significance level and probably to lag length structure. Going by 5 percent significant level, causality runs from the length of road to GDP. However, the direction of causality became bidirectional when 10 percent

significance level and different measure of road transport (contribution of road transport to output) was used.

RECOMMENDATIONS

Based on the findings and conclusions drawn from this study and the need to strengthen and improve road transport and economic performance in Nigeria, the following recommendations are spelled out:

i- The challenges facing the road transport system in Nigeria include lack of maintenance and poor investment. It is, therefore, necessary for stakeholders to increase the amount of budget allocation to road network. This will have deep impact on economic growth by encouraging commodity flow, internal and regional trade, and economic development of the country.

ii- Road transport has the potential of indirectly reducing poverty level through harmonization of federal and state roads. Connectivity and linkages among these roads will accelerate accessibility and mobility of physical and human resources which further improve economic growth and reduce poverty.

iii- The result from this thesis shows that relationship between road transport and economic growth is not direct and linear. It also suggests that road investment will continue to drag down economic activities until certain level of investment is made. Although, the length of road in the country is above this threshold, however, the difference is marginal (5 km). Hence, to accelerate economic growth, huge private and public investment is required. Financial resources for this investment could be sourced through public-private sector partnership.

iv- The road transport, although received great attention of the government in the 70s, has been overused and misused at all levels. The road network is affected by poor quality of road construction, poor supervision of construction work, faulty and inappropriate designs, abandonment during construction, and inadequate administrative capacity for maintenance. These have significantly accounted for the low yield of the system and have led to inordinate misuse of

road system and to proportional high road traffic accidents. Hence, policymakers should ensure timely completion of road projects, monitor quality road and put in place swift and proper maintenance system.

v- The major areas of the directional policy shift should be the harmonization of different and all level of government's road transport policies. Road transport investments by all levels of government has been disjointed. Newly elected government don't usually follow up the previous ones' policy plan. This always contributes to abandonment of projects, corruption and poor road network. Hence, it is imperative to set up road policy transition committee which will ensure smooth execution of road projects and continuity of road policies without interferences of political differences.

CONTRIBUTION TO KNOWLEDGE

The study revealed the importance of road transport in poverty reduction and enhancement of productivity in Nigeria. This thesis introduced two aspects that have not been explored by the existing literature on road transport infrastructure and growth in Nigeria- threshold analysis and poverty reduction. This makes this thesis original and informative.

This study examines the existence of a non-linear relationship between road transport and economic growth. No study in Nigeria has estimated the threshold road infrastructure for the country. The importance of conducting threshold analysis lies in it fact that, it would pre-empt waste of resources and potential crowding out of private investment. It could also show the deficit level of road network required and act as a guide for policymakers.

Furthermore, the thesis's contribution to knowledge is also notable stem from its examination of linkage between road network and poverty reduction in Nigeria. The convention among authors in Nigeria is to link road transport and economic growth. This set of studies are abundant with most reporting a positive correlation between road and

economic growth. However, road impact on economic growth is not direct. Road network affects variables that are closely related to poverty than overall economic wellbeing. Thus, focusing on growth-road linkage will not reveal the clear picture at an individual or social level. This thesis corrected this view and carefully explored the relationship between poverty reduction and road transport infrastructure using a multidimensional measurement of poverty. This thesis, by this endeavor, is thought to be helpful to the government and policymakers who aim at reducing poverty level in the country through creating of social infrastructure.

SUGGESTIONS / DIRECTION FOR FURTHER RESEARCH

Although this study made significant contributions to knowledge on road transport-growth linkage, there are some areas not covered by the scope of this study that needs more investigation. These include; concentration on estimation and comparison of the impact other modes of transport such as rail, water, and air transport on economic growth.

Given the inconclusive result of causality between road and GDP, different measures of road transport can also be identified and used in ascertaining the direction of causality between road transport and economic growth.

SUMMARY

S/N	Objective	Hypothesis	Findings	Comments
1	To investigate the short and long-run effect of road transport on GDP growth	There is a significant relationship (short-run and long-run) between road transport and economic growth in Nigeria.	Road transport has to a significant short run and long run positive effect on economic growth in Nigeria. However, the marginal effect on growth of the short run estimate is higher than that of the long run estimate.	Road transport is prerequisite for economic growth and development. It enhances productivity of other factors of production and thus, promotes growth and development
2	To examine the effect of road transport on poverty level	There is a significant relationship between road transport and poverty level in Nigeria	Road transport has a significant positive effect on poverty alleviation (human development index) in Nigeria.	Road transport is vital for poverty reduction programme as it links the rural markets with urban markets and improves the mobility and accessibility of scarce resources
3	To compute the threshold stock of road transport for which income is not significantly affected	There exists a threshold level of transport infrastructure after which the impact on income is not significant.	The relationship between road transport and economic growth in Nigeria was found to be non-linear. It shows a possible presence of growth threshold effects determined by the length of road. However, growth – road transport function is U shaped and the amount of road length that is consistent with minimum GDP level and above which income will increase, on the	The implication of this finding is that an initial low level of road construction across the country, income will decline as resources is being diverted from other productive sectors to road and probably due to inconvenience and obstruction of movement caused by road construction. Another reason could be long gestation of road

			average, is about 190 thousand Km.	transport investment. All these factors affect production negatively during the construction period and as a result drag down economic growth.
4	To inspect the direction of causality between investments on road transport and GDP growth	Causality exists between road transport and economic growth in Nigeria	The direction of causality between GDP and length of road (km) in Nigeria is unilateral. The causality runs from length of road to GDP. However, using another measure of road transport (contribution of road transport to output) yield similar but interesting result. The result indicates bidirectional causality between GDP and contribution of road transport to output.	Based on this finding, it is evidenced both road and economic growth complement and facilitate each other.

REFERENCES

Adekanye, T.O. (1971). The Marketing and Consumption of Rice in Egba Division, Western Nigeria; Unpublished M.Phil Thesis, University of Nottingham, UK.

Adesanya A. (1998). An overview of the Nigerian transport sector. *Quarterly Magazine of the Chartered Institute Transport in Nigeria*, 11, 1-12.

Ahman, M. (2004). Road freight transport in Sweden– Are there any signs of a decoupling? *Naturvardsverket report* 5370.

Ahukannah, L.I., Ndinaechi, G.I., &Arukwu, O.N. (2003). Commerce *for Senior Secondary Schools*. Onitsha: Africana-First Publishers Limited.

Ajiboye, A.O. &Afolayan, O. (2009). The Impact of Transportation in Agricultural Production in a Developing Country: A Case of Kolanut Production in Nigeria. *International Journal of Agricultural Economics and RuralDevelopment, 2*(2), 47-57.

Aigbokan, B. E. (1999). Evaluating investment on basic infrastructure in Nigeria", Proceedings of the Eighth Annual Conference of the Zonal Research Units .Organised by Research Department, Central Bank of Nigeria, at Hamdala Hotel, Kaduna, 11 –15 June, 1999.

Ali,I. &Pernia,E.,(2003), Infrastructure and Poverty Reduction, What is the Connection?Economics and Research Department, Policy Brief No.13, ADB, Manila

Aloba O. (1986). Rural Transportation In:Falola, SAOlarewaju (Eds.): Transport Systems in Nigeria.Syracuse University, Maxwell School of Citizenshipand Public Affairs. Series 42, 125-138.

Anyanwu, J.C., Oaikhena, H., Oyefusi, A. &Dimowo, F.A. (1997). *The Structure of the Nigerian Economy (1960-1977).* Onitsha: Joanne Educational Publishers Ltd.

Anyanwu, C.M., Adebusuyi, B.S. &Kukah, S.T.Y (2003), Highway Maintenance in Nigeria: 1essons from other countries. **A** Central Rank of Nigeria Research Department Occasional Paper No.27

Aschauer D.A. (1989). Is public expenditure productive? *Journal of Monetary Economics, 2*3(2):177-200.

Aschauer, D. A. (2000). Does public capital crowds out private capital? *Journal of Monetary Economics*, 24, 171-188.

Ashipala J, &Haimbodi N (2003). The impact of public investment on economic growth in Namibia. NEPRU Working Paper No. 88. [Online] Available:www.unhabitat.org/pmss/getElectronicVersion.

Asian Development Bank (ADB). 2002. 2002. Handbook for Integrating Risk Analysis in the Economic Analysis of Projects. Manila: ADB.

BabatundeI. R.(2012), Evaluating Intra-Urban Transportation and Gender Travel behaviour in Ilorin, Nigeria, Global Journal of Human Social Science, Arts & Humanities. 12(14), 1-13

Badalyan, G, Herzfeld, T. &Rajcaniova, M. (2014), Transport infrastructure and economic growth: Panel data approach for Armenia, Georgia and Turkey, Paper presented at the 142nd EAAE Seminar Growing success, Agriculture and rural development in an enlarged EU, Convinus University of Budapest, May 29-30, 2014.

Banerjee, A, Duflo, E, & Qian, N. (2012). On the road: access to transportation infrastructure and economic growth in China. National Bureau of Economic Research, 2012.

Barro, R.J. (1990). Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, 98, 103-125.

Bloch H, T& Tang SHK (2003). The role of financial development in economic growth. *Progress in Development Studies*, 3(3):243-251.

Boopen S (2006). Transport infrastructure and economic growth: evidence from Africa using dynamic panel estimates. *The Empirical Economics Letters*, 5(1),37-52.

Brown, D.M. (1999*). Highway Investment and Rural Economic Development: An Annotated Bibliography*. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Bibliographies and Literature of Agriculture No. 133.

Camemark C (1979). Some Economic, Social and Technical Aspects of Rural Roads. Dhaka: ESCAP Workshop on rural Roads. www.scribd.com/doc/2423416/Role-of-Transport-in-Economic-Development.

Canning D, &Pedroni P (2008). Infrastructure, long-run economic growth and causality tests for cointegrated panels. *The Manchester School*, 76(5),504-527.

Casaburi, Lorenzo, Rachel Glennerster, and TavneetSuri (2013). Rural Roads and Inter-Mediated Trade: Regression Discontinuity Evidence from Sierra Leone. Working Paper,MIT.

Cheteni, P. (2013). Transport Infrastructure Investment and Transport Sector Productivity on Economic Growth in South Africa (1975-2011). *Mediterranean Journal of Social Sciences***,** *4(1), 761-772*

Chukwuemeka, A., Nyewe, A. N. &Ugondah, N. C. (2013). Public Spending on Transport Infrastructure and Economic Growth in Nigeria, 1981-2010, *Journal of Sociological Research***,** 4(2),

Dakyes, S. P. &Ogbuli, L.N. (2012). The Impact of Transportation on the socioeconomic Development of Rural Areas of Gwagwalada Area Council, Nigeria, *Confluence Journal of Environmental Studies*, 7,112-117

De la Fuente A (2000). "Infrastructures and productivity: A survey. Barcelona, Institute de AnálisisEconómico, CSIC, Working Paper. [Online] Available: http://pareto.uab.es/wp/2010/83110.pdf.

Demetriades, P. O., &Mamuneas, T. P. (2000), Intertemporal Output and Employment Effects of Public Infrastructure Capital: Evidence from 12 OECD Economies. *The Economic Journal*, 110, 687-712.

Dodgson, J, 1997, "Issues in evaluating the long-term global impacts of transport policy" International Journal of Environment and Pollution 7 293–304

Easterly W, &Rebelo S (1993). "Fiscal policy and economic growth", Journal of Monetary Economics, 32 :417-458.

Eberts, R. W., &McMillen. D. P. (1999). Agglomeration Economies and Urban Public Infrastructure. Handbook of Regional and Urban Economics3: 1455–1495.

Eboh, E. C. (2005). "A Review of roads and Rail Transport Infrastructure in Nigeria", In PromotingNon-Oil Private Sector Evidence and Recommendations. Enugu African Institute for Applied Economics for the Better Business Initiative, 2005.

Egart B, Kozluk T, & Sutherland D (2009). Infrastructure and growth: Empirical evidence. OECD Economics Department Working Paper 685.

Faridi, Z. M., Malik, S. M. & Bashir, F. (2011). Transportation, Telecommunication and Economic Development in Pakistan. *Interdisciplinary Journal of Research in Business,1*(7), 45 -5

Fernald G. J. (1999). Roads to prosperity? Assessing the link between public capital and Productivity, *The American Economic Review*,619-637

Filani, M.O (2012). 'Transport systems in Nigeria,' Lead Paper presented at the International Colloquium on Thirty Years of Social Services and Management in Nigeria, in honour of Professor Emeritus Andrew Onokerhoraye, at Precious PalmRoyal Hotel, Benin City, Nigeria, 26th – 28th March, 2012.

Food & Agriculture Organization (2002). *Comprehensive Africa Agriculture Development Programme: Improving Infrastructure and Trade-Related Capacities for Market Access*. New Partnership for Africa'sDevelopment (NEPAD).

Fosu, O. E. & Magnus, J. F. (2006). Bounds Testing Approach to Cointegration: An Examination of Foreign Direct Investment Trade and Growth Relationships. *American Journal of Applied Sciences* 3(11): 2079-2085.

Frischmann, B.M. (2005), An Economic Theory of Infrastructure and Commons Management, in *Minnesota Law Review*, 89(917): 917-1030

Garcia-Mila T, McGuire TJ, &Porter RH (1996). The effect of public capital in state-level production functions reconsidered. The Review of Economics and Statistics, :177-180.

Gramlich EM (1994). Infrastructure investment: A review essay. Journal of Economic Literature, 32(3):1176-1196

Holtz-Eakin D, Schwartz AE (1994). Infrastructure in a structural model of economic growth. NBER Working Paper No. W482K.

Howe, J. & Richards, P. (1984) Rural roads and poverty alleviation. London: Intermediate Technology Publications.

Ivanoova, E. &Masarova, J. (2013). Importance of Road Infrastructure in the Economic Development and Competitiveness, *Economics and Management*. 18 (2): 263-274

Jahan S. &McCleeryR. (2005). Making InfrastructureWork for the PoorSynthesis Report of Four Country StudiesBangladesh, Senegal, Thailand and Zambia. United NationDevelopment Programme

Kayode O., Onakoya, A. B., &Folawewo, A. (2013). An Empirical Analysis of Transport Infrastructure Investment and Economic Growth in Nigeria. *Social Sciences,* 2(6), 179-188.

Kessides C (1996). "A review of infrastructure‟s impact on economic development", In: Batten D, Karlsson C (Eds.), Infrastructure and the Complexity of Economic Development, Chapter 12:213–230

Khadaroo, J. and Seetanah, B. (2007) Transport Infrastructure and Tourism Development. *Annals of Tourism Research*, 34, 1021-1032.

Leung, J. (2006). A literature review of theory and evidence in transportation and economic growth. Paper presented to the New Zealand Association of Economists Conference.Wellington.

Lombard, P. &Coetzer, L. 2007. The Estimation of the Impact of Rural Road Investments on Socio-Economic Development.International seminar on sustainable development road financing and investment, Arusha: Tanzania, 16-20 April 2007.

Looney RE (1997). Infrastructure and private sector investment in Pakistan. *Journal of Asian Economics*, 8(3):393-420.

Mabogunje, A. L. (1971), Crisis in Rural Development Planning in Nigeria"Research for Development,*NISER* 1(1):1-10

Mamatzakis EC (2002). Public infrastructure and private output? An application to Greece. *Journal of Economic Development*, 27(2):143-160.

Mbaye A. &Moustier, P. 2000. Market-oriented urban agricultural production in Dakar. In: N. Bakker; M. Dubbeling; S. Gündel.; U. Sabel-Koschella; H. de Zeeuw. Growing cities, growing food: urban agriculture on the policy agenda. A reader on urban agriculture. DSE/ETC, Feldafing, Allemagne, pp. 235-257.

Montolio, D. &Solé-Ollé, A. (2009). Road Investment and Regional Productivity Growth: The Effects of Vehicle Intensity and Congestion. *Papers in Regional Science.* 88 (1), 99-118.

Mittnik S, Neumann T (2001). Dynamic effects of public investment: Vector autoregressive evidence from six industrialized countries. *Empirical Economics*, 26(2):429-446.

Musa, I.J &Ndawayo, B. A. (2012). The Role of Transportation in the Development Of Tourism In Nigeri**a,** *An International Multidisciplinary Journal Of Tourism* ,6,(1), 297-305

Nnanna O. J., Odoko F. O., Alade S. O.(2003). Highway Maintenance in Nigeria, Lessons from other countries, Research Department Occasional Paper Series, Central Bank Of Nigeria

National Transport Policy, 2010. Federal Government of Nigeria Draft National Transport Policy August, 2010

Nedozi F.O., Obasanmi, J. O. and Ighata J. A. (2014). Infrastructural Development and Economic Growth in Nigeria: Using Simultaneous Equation, Journal of Economics, 5(3): 325-332 (2014) 325-332

Nistor, F. and Popa, C. (2014). The Role of Transport in Economic Development, "*MirceacelBatran" Naval Academy Scientific Bulletin* 2(17), 25-26

Nurudeen A, & Usman A. (2010). Government expenditure and economic growth in Nigeria. 1970-2008: A disaggregated analysis..*Business and Economics Journal*. 4,1-11.

Nwakeze, M. N. and A. Y. Mulikat. 2010. Transportation and economic growth in Nigeria. *Journal of research in national development*. 8(2).

Nworji,I.D., &Oluwalaiye,O.B (2012).Government Spending on Road Infrastructure and itsImpact on the Growth of Nigerian Economy.*IJMBS*,2,

Ogunsanya, A.A. (1998); "Moving the Urban Masses: Two Steps Forward one Backwards" in Dange, M; I.V. Chikolo and A.A. Ogunsanya (ed) Issues in Transport Planning and Management. Published by NITT, Nigeria.

Oladipo, S.O. &Olomola, P.A. (2015). A Multivariate Causal Relationship among Road Transport Infrastructure Development, Economic Growth and Poverty Level in Nigeria. International Journal of Economics and Financial Research, 1(4), 57-64

Olamigoke, E. A. & Emmanuel, A. A. (2013). The Role of Road Transportation in Local Economic Development: A Focus on Nigeria Transportation System, *Developing Country Studie*s, 3(6), 46-53

Olubomehin, O.O. (2012). Road Transportation as Lifeline of the Economy in Western Nigeria, 1920 to 1952. *African Journal of History and Culture, 4*(3), 37-45.

Onakomaiya, S.O. (2008) "Transport Research and Capacity Building in Nigeria: Ebenezer by a Poor Teacher Turned Professor". Valedictory Lecture at OlabisiOnabanjo University, Ago-Iwoye.

Onyeocha. O.U A., Nnaji, L., Anyanwu, L. A., Ajoku, S. T., Opoola, A., Faith, E. Y, &Maduakolam, C. C. (2015) The impact of road transportation infrastructure on tourism development in Nigeria, *Pearl Journal of Management, Social Science and Hu*manities, 1 (2), 48-55

Pesaran, M.H., Shin Y. &Smith R.J., (2001). Bounds testing approaches to the analysis of level relationships.*Journal of Applied Econometrics*., 16, 289-326.

Peter, S., Rita, E. & Edith, M. (2015). The Impact of Road Transportation Infrastructure on Economic Growth in Nigeria. *International Journal of Management and Commerce Innovations*,3(1), (673-680

Pinard, M.I. & Greening, P.A.K., (2004). Sustainable Provision of Low-Volume Sealed Roads. September 2004. In Lombard, P. &Coetzer, L (n.d.) The Estimation of the Impact of Rural Road Investments on Socio-Economic Development.

Pradhan, R., 2010, 'Transport infrastructure, energy consumption and economic growth triangle in India: Cointegration and causality analysis', *Journal of Sustainable Development* 3(2), 167–173.

Sanchez-Robles B (1998). "Infrastructure investment and growth: Some empirical evidence. Wiley Online Library, 16(1):98-108.

Seetanah, B. (2007) Transport infrastructure and economic growth: Evidence from Africa using dynamic panel estimates, The Empirical Economics Letters, 5(1),

Shioji, E. (2001), 'Public Capital and Economic Growth: A Convergence Approach', *Journal of Economic Growth*,6(3): 205–27.

Sieber, Niklas (1998): Appropriate Transport and Rural Development, *Journal of Transport Geography*, 6, 69-73.

Simon, N. S., and *P. Natarajan*, P. (2017) Nonlinearity between Infrastructure Inequality and Growth *Review of Market Integration*, 9(1-2), 66-82

Solow, R. M. (1956) "A Contribution to the Theory of Economic Growth" *Quarterly Journal of Economics*, 71: 65-94.

Taaffe, E. J., R. L. Morrill, and P. R. Gould.1963. Transport expansion in underdeveloped countries: A comparative analysis. *Geographical Review*, 53: 503-529.

Tripathi, S. &Gautam, V. (2010). Road Transport Infrastructure and Economic Growth in India,*Journal of Infrastructure Development, India Development Foundation*, 2(2), 2135-151

.

Tunde, A. M., &Adeniyi, E. E. (2012). Impact of Road Transport on Agricultural Development: A Nigerian Example. *Ethiopian Journal of Environmental Studies and Management*,5 (3), 232-238.

Uma, K., Ogbonna, B. M. & Hyacinth, A. N. (2014). Does Transportation Sector have any impact on Economic Development? A time series assessment with Nigeria in focus. *International Journal of Economics, Commerce and Management*, 2(8), 1 -15

Wallis, I. (2009). Economic Development Benefits of Transport Investment. New Zealand Transport Agency Research Report 350. Auckland: Booz and Company Limited.

Wane, H.R. (2001). Urban Mobility and Emissions: Towards Accurate Standards for Sub-Saharan Africa. A Research Program and Results on a Sahelian Case: The District of Bamako. At the Session on Air Pollution, Accra, Ghana, April 18-20, 2001. Retrieved November 03, 2008 http://www.worldbank.org/transport/utsr/accra/wane.pdf

World Bank (2001). Roads Economic Decision Model (RED) for Economic Evaluation of Low Volume Roads. March 2001. In Lombard, P. &Coetzer, L (n.d.) The Estimation of the Impact of Rural Road Investments on Socio-Economic Development.

World Bank (2016), World Development Indicators

APPENDIX

Appendix 1: DATA FOR REGRESSION ANALYSIS

year	GDP(million naira)	Gross capital formation	Secondary school gross enrolment	HDI	Length of road (in hundred km)	Contribution of road transport to GDP (thousand naira)
1980	294148.032	8457840000000	2393243	0.32	1168.2	172112.2963
1981	248688.0941	8657920000000	2473673	0.328	6718.5	222110.9939
1982	239747.1931	6298590000000	2880280	0.316	5085.2	168113.5197
1983	221939.8476	4172140000000	3334644	0.318	4000.1	132241.3278
1984	212022.206	2367280000000	3402665	0.32	3857.8	127536.0778
1985	223857.4443	2583110000000	2995578	0.328	4946	163512.017
1986	199011.8647	2602270000000	3094349	0.32	4378.7	144758.1474
1987	173011.8764	1679290000000	2934349	0.321	4431.3	146495.0011
1988	181230.0235	1439070000000	2997464	0.32	4484.39	148253.2145
1989	187975.1195	1949410000000	2723791	0.322	4574.10	151218.5595
1990	206575.0964	2735490000000	2901993	0.319	4665.60	154243.1016
1991	200138.6202	2718150000000	3123277	0.328	4852.3	160413.0209
1992	196002.1614	2652470000000	3600620	0.328	5620.89	170037.729
1993	195153.0784	3069500000000	4150917	0.332	5400.60	178539.5239
1994	192079.7808	2736980000000	4500000	0.345	5481.60	181217.4275
1995	186781.043	2019070000000	5084546	0.354	5536.39	183029.3455
1996	191288.6608	2381140000000	539619	0.368	5467.10	186689.7981
1997	191816.4427	2591430000000	5578255	0.354	5816.4	192287.2759
1998	192178.7354	2462120000000	5795807	0.412	6020	199017.4313
1999	188330.5923	2391540000000	6056618	0.444	6200.6	204987.7894
2000	193442.432	2796850000000	6359449	0.445	6392.8	211342.6233
2001	196966.426	2183270000000	6995394	0.462	6667.7	220430.2201
2002	199331.6658	2626630000000	7485072	0.473	7910.3	261509.6341
2003	214460.7132	3941710000000	7091376	0.49	8003.7	264597.7228
2004	279563.6551	2996370000000	7091376	0.47	12580.6	415909.7409
2005	281813.2052	2683970000000	7125689	0.47	13385.9	442531.4747
2006	297095.3294	4275590000000	7125689	0.47	14319.5	473395.8813
2007	309138.7265	6058650000000	7258783	0.47	15323.4	506584.0152
2008	319934.3374	6015030000000	72431765	0.47	16402.8	542196.8708
2009	333135.426	8104990000000	72764983	0.511	17534.51	579682.2703

2010	349791.642	9591060000000	72863745	0.511	18728.76	619136.8606
2011	357204.0543	8831930000000	73015792	0.511	19758.84	637003.7281
2012	362648.1497	9128670000000	73653928	0.5423	20845.57	601854.8412
2013	372130.0412	9842210000000	738789101	0.5564	21992.08	616125.6302
2014	385227.6188	11120400000000	743625891	0.56742	23201.64	639304.7669
2015	385141.964	10949700000000	746539862	0.56742	24477.74	667810.5992

Appendix 2: Descriptive Statistics

	LOGGDP	LOGK	LOG(TRACON)	LOGL	LOG(X)	HDI
Mean	12.38984	28.97537	12.46809	16.04561	8.949302	0.410654
Median	12.27017	28.64870	12.21593	15.55352	8.717622	0.390000
Maximum	12.86159	30.03980	13.41176	20.43096	10.10552	0.567420
Minimum	12.06112	27.99502	11.75615	13.19862	7.063219	0.316000
Std. Dev.	0.262039	0.611061	0.573728	1.746968	0.682246	0.088063
Skewness	0.588438	0.480502	0.556407	1.365652	-0.018204	0.332370
Kurtosis	1.789681	1.806886	1.657016	4.053739	2.964582	1.602002
Jarque-Bera	4.274867	3.520572	4.562938	12.85558	0.003870	3.594415
Probability	0.117957	0.171996	0.102134	0.001616	0.998067	0.165761
Sum	446.0342	1043.113	448.8514	577.6419	322.1749	14.78354
Sum Sq. Dev.	2.403261	13.06884	11.52075	106.8164	16.29109	0.271431
Observations	36	36	36	36	36	36

Appendix 3: UNIT ROOT TEST
AUGMENTED DICKEY FULLER TEST

LOG(GDP) AT LEVEL

Null Hypothesis: LOGGDP has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.849334	0.1904
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGGDP)

Method: Least Squares

Date: 01/12/18 Time: 10:52

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGDP(-1)	-0.146549	0.051433	-2.849334	0.0076
C	1.718504	0.622199	2.761983	0.0094
@TREND(1980)	0.005719	0.001269	4.505481	0.0001

R-squared	0.388177	Mean dependent var	0.007701
Adjusted R-squared	0.349939	S.D. dependent var	0.072098

S.E. of regression	0.058130	Akaike info criterion	-2.770452
Sum squared resid	0.108131	Schwarz criterion	-2.637136
Log likelihood	51.48291	Hannan-Quinn criter.	-2.724431
F-statistic	10.15138	Durbin-Watson stat	1.815545
Prob(F-statistic)	0.000385		

LOG(GDP) AT FIRST DIFFERENCE

Null Hypothesis: D(LOGGDP) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.326793	0.0006
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGGDP,2)

Method: Least Squares

Date: 01/12/18 Time: 10:54

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(LOGGDP(-1))	-0.912690	0.171340	-5.326793	0.0000
C	-0.032940	0.024997	-1.317759	0.1972
@TREND(1980)	0.002439	0.001259	1.936995	0.0619

R-squared	0.485015	Mean dependent var	0.004931
Adjusted R-squared	0.451790	S.D. dependent var	0.083669
S.E. of regression	0.061949	Akaike info criterion	-2.640903
Sum squared resid	0.118969	Schwarz criterion	-2.506224
Log likelihood	47.89534	Hannan-Quinn criter.	-2.594973
F-statistic	14.59796	Durbin-Watson stat	1.944777
Prob(F-statistic)	0.000034		

LOG(K) AT LEVEL

Null Hypothesis: LOGK has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 3 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.261120	0.1143
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGK)

Method: Least Squares

Date: 01/12/18 Time: 10:56

Sample (adjusted): 1984 2015

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGK(-1)	-0.283454	0.190237	-1.261120	0.1143
D(LOGK(-1))	0.242990	0.158229	1.535688	0.1367
D(LOGK(-2))	-0.439454	0.139412	-3.152205	0.0041
D(LOGK(-3))	0.265515	0.157234	1.688664	0.1032
C	7.807880	2.519795	3.098617	0.0046
@TREND(1980)	0.020737	0.006457	3.211830	0.0035

R-squared	0.529747	Mean dependent var	0.030153
Adjusted R-squared	0.439314	S.D. dependent var	0.237204
S.E. of regression	0.177616	Akaike info criterion	-0.451025
Sum squared resid	0.820234	Schwarz criterion	-0.176199
Log likelihood	13.21640	Hannan-Quinn criter.	-0.359928
F-statistic	5.857876	Durbin-Watson stat	1.784860
Prob(F-statistic)	0.000942		

LOG(K) AT FIRST DIFFERENCE

Null Hypothesis: D(LOGK) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 2 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic		-5.985453	0.0011
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGK,2)

Method: Least Squares

Date: 01/12/18 Time: 11:00

Sample (adjusted): 1984 2015

Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGK(-1))	-0.867946	0.3630212	-5.985453	0.0011
D(LOGK(-1),2)	0.124669	0.227686	0.547547	0.5885
D(LOGK(-2),2)	-0.335367	0.179402	-1.869365	0.0725
C	-0.101852	0.108257	-0.940831	0.3551
@TREND(1980)	0.006589	0.005332	1.235788	0.2272

R-squared	0.628413	Mean dependent var	0.012388
Adjusted R-squared	0.573363	S.D. dependent var	0.313415
S.E. of regression	0.204715	Akaike info criterion	-0.191796
Sum squared resid	1.131521	Schwarz criterion	0.037225
Log likelihood	8.068739	Hannan-Quinn criter.	-0.115882
F-statistic	11.41532	Durbin-Watson stat	1.882203
Prob(F-statistic)	0.000015		

LOG(L) AT LEVEL

Null Hypothesis: LOGL has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.853573	0.6568
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGL)

Method: Least Squares

Date: 01/12/18 Time: 11:10

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGL(-1)	-0.238764	0.128813	-1.853573	0.0730
C	3.162458	1.784363	1.772318	0.0859
@TREND(1980)	0.044601	0.020113	2.217535	0.0338

R-squared	0.133929	Mean dependent var	0.164080
Adjusted R-squared	0.079800	S.D. dependent var	0.773134
S.E. of regression	0.741645	Akaike info criterion	2.321924

Sum squared resid	17.60118	Schwarz criterion	2.455239
Log likelihood	-37.63366	Hannan-Quinn criter.	2.367944
F-statistic	2.474246	Durbin-Watson stat	2.359829
Prob(F-statistic)	0.100196		

LOG(L) ATFIRST DIFFERENCE

Null Hypothesis: D(LOGL) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.164056	0.0000
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGL,2)

Method: Least Squares

Date: 01/12/18 Time: 11:13

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGL(-1))	-1.369721	0.167775	-8.164056	0.0000

C	-0.184582	0.271010	-0.681089	0.5009
@TREND(1980)	0.022428	0.013213	1.697446	0.0996

R-squared	0.682593	Mean dependent var	-0.000857
Adjusted R-squared	0.662115	S.D. dependent var	1.267779
S.E. of regression	0.736933	Akaike info criterion	2.311457
Sum squared resid	16.83516	Schwarz criterion	2.446136
Log likelihood	-36.29476	Hannan-Quinn criter.	2.357386
F-statistic	33.33321	Durbin-Watson stat	2.177692
Prob(F-statistic)	0.000000		

POV AT LEVEL

Null Hypothesis: HDI has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.171280	0.4900
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(HDI)

Method: Least Squares

Date: 01/12/18 Time: 11:13

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HDI(-1)	-0.195837	0.090194	-2.171280	0.0374
C	0.052859	0.024353	2.170566	0.0375
@TREND(1980)	0.001875	0.000749	2.503859	0.0176

R-squared	0.172633	Mean dependent var	0.007069
Adjusted R-squared	0.120923	S.D. dependent var	0.015164
S.E. of regression	0.014217	Akaike info criterion	-5.586890
Sum squared resid	0.006468	Schwarz criterion	-5.453574
Log likelihood	100.7706	Hannan-Quinn criter.	-5.540869
F-statistic	3.338463	Durbin-Watson stat	2.019170
Prob(F-statistic)	0.048213		

POV AT FIRST DIFFERENCE

Null Hypothesis: D(HDI) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.004608	0.0001
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(HDI,2)

Method: Least Squares

Date: 01/12/18 Time: 11:15

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(HDI(-1))	-1.084518	0.180614	-6.004608	0.0000
C	0.000210	0.005625	0.037267	0.9705
@TREND(1980)	0.000403	0.000278	1.446758	0.1580

R-squared	0.537798	Mean dependent var	-0.000235
Adjusted R-squared	0.507979	S.D. dependent var	0.021908
S.E. of regression	0.015367	Akaike info criterion	-5.429073
Sum squared resid	0.007321	Schwarz criterion	-5.294394
Log likelihood	95.29424	Hannan-Quinn criter.	-5.383144
F-statistic	18.03512	Durbin-Watson stat	1.945465
Prob(F-statistic)	0.000006		

LOG(X) AT LEVEL

Null Hypothesis: LOG(X) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.201110	0.0009

Test critical values:	1% level	-4.243644
	5% level	-3.544284
	10% level	-3.204699

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(X))

Method: Least Squares

Date: 01/12/18 Time: 11:16

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(X(-1))	-0.736257	0.141558	-5.201110	0.0000
C	5.944613	1.116466	5.324490	0.0000
@TREND(1980)	0.039276	0.009150	4.292443	0.0002

R-squared	0.465995	Mean dependent var	0.086923
Adjusted R-squared	0.432620	S.D. dependent var	0.312418
S.E. of regression	0.235328	Akaike info criterion	0.026140
Sum squared resid	1.772130	Schwarz criterion	0.159455
Log likelihood	2.542555	Hannan-Quinn criter.	0.072160
F-statistic	13.96228	Durbin-Watson stat	0.551947
Prob(F-statistic)	0.000044		

LOG(TRACON) AT LEVEL

Null Hypothesis: LOG(TRACON) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.171276	0.4900
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(TRACON))

Method: Least Squares

Date: 01/12/18 Time: 11:19

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TRACON(-1))	-0.175622	0.080884	-2.171276	0.0374
C	2.020335	0.935695	2.159181	0.0384
@TREND(1980)	0.011297	0.004408	2.562550	0.0153

R-squared	0.172351	Mean dependent var	0.038739
Adjusted R-squared	0.120623	S.D. dependent var	0.122290
S.E. of regression	0.114678	Akaike info criterion	-1.411567

Sum squared resid	0.420831	Schwarz criterion	-1.278251
Log likelihood	27.70242	Hannan-Quinn criter.	-1.365546
F-statistic	3.331874	Durbin-Watson stat	1.923712
Prob(F-statistic)	0.048477		

LOG(TRACON) AT FIRST DIFFERENCE

Null Hypothesis: D(LOG(TRACON)) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.572297	0.0000
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(TRACON),2)

Method: Least Squares

Date: 01/12/18 Time: 11:19

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(LOG(TRACON(-1)))	-1.080165	0.164351	-6.572297	0.0000
C	-0.044304	0.041796	-1.060011	0.2973
@TREND(1980)	0.004312	0.002049	2.104964	0.0435

R-squared	0.584158	Mean dependent var	-0.006218
Adjusted R-squared	0.557329	S.D. dependent var	0.171314
S.E. of regression	0.113981	Akaike info criterion	-1.421469
Sum squared resid	0.402743	Schwarz criterion	-1.286791
Log likelihood	27.16498	Hannan-Quinn criter.	-1.375540
F-statistic	21.77373	Durbin-Watson stat	1.562545
Prob(F-statistic)	0.000001		

PHILLIP PERRON UNIT ROOT TEST

LOG(GDP) AT LEVEL

Null Hypothesis: LOGGDP has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.834122	0.1954
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.003089
HAC corrected variance (Bartlett kernel)	0.003175

Phillips-Perron Test Equation

Dependent Variable: D(LOGGDP)

Method: Least Squares

Date: 01/12/18 Time: 11:31

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGDP(-1)	-0.146549	0.051433	-2.849334	0.0076
C	1.718504	0.622199	2.761983	0.0094
@TREND(1980)	0.005719	0.001269	4.505481	0.0001

R-squared	0.388177	Mean dependent var	0.007701
Adjusted R-squared	0.349939	S.D. dependent var	0.072098
S.E. of regression	0.058130	Akaike info criterion	-2.770452
Sum squared resid	0.108131	Schwarz criterion	-2.637136
Log likelihood	51.48291	Hannan-Quinn criter.	-2.724431
F-statistic	10.15138	Durbin-Watson stat	1.815545
Prob(F-statistic)	0.000385		

LOG(GDP) AT FIRST DIFFERENCE

Null Hypothesis: D(LOGGDP) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.322744	0.0007
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.003499
HAC corrected variance (Bartlett kernel)	0.003071

Phillips-Perron Test Equation

Dependent Variable: D(LOGGDP,2)

Method: Least Squares

Date: 01/12/18 Time: 11:32

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGDP(-1))	-0.912690	0.171340	-5.326793	0.0000
C	-0.032940	0.024997	-1.317759	0.1972

@TREND(1980)	0.002439	0.001259	1.936995	0.0619

R-squared	0.485015	Mean dependent var	0.004931
Adjusted R-squared	0.451790	S.D. dependent var	0.083669
S.E. of regression	0.061949	Akaike info criterion	-2.640903
Sum squared resid	0.118969	Schwarz criterion	-2.506224
Log likelihood	47.89534	Hannan-Quinn criter.	-2.594973
F-statistic	14.59796	Durbin-Watson stat	1.944777
Prob(F-statistic)	0.000034		

LOG(K) AT LEVEL

Null Hypothesis: LOGK has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.169965	0.2589
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.041786
HAC corrected variance (Bartlett kernel)	0.020240

Phillips-Perron Test Equation

Dependent Variable: D(LOGK)

Method: Least Squares

Date: 01/12/18 Time: 11:27

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGK(-1)	-0.168530	0.118931	-1.169965	0.0202
C	4.641278	1.965017	2.361953	0.0244
@TREND(1980)	0.013571	0.003986	3.404617	0.0018

R-squared	0.284090	Mean dependent var	0.007378
Adjusted R-squared	0.239346	S.D. dependent var	0.245120
S.E. of regression	0.213783	Akaike info criterion	-0.165897
Sum squared resid	1.462498	Schwarz criterion	-0.032581
Log likelihood	5.903191	Hannan-Quinn criter.	-0.119876
F-statistic	6.349184	Durbin-Watson stat	1.849143
Prob(F-statistic)	0.004761		

LOG(K) AT FIRST DIFFERENCE

Null Hypothesis: D(LOGK) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.243902	0.0008
Test critical values:	1% level	-4.252879	

5% level	-3.548490
10% level	-3.207094

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.049833
HAC corrected variance (Bartlett kernel)	0.052292

Phillips-Perron Test Equation

Dependent Variable: D(LOGK,2)

Method: Least Squares

Date: 01/12/18 Time: 11:29

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGK(-1))	-0.933641	0.129354	--6.243902	0.0000
C	-0.169840	0.091555	-1.855066	0.0731
@TREND(1980)	0.009525	0.004481	2.125860	0.0416

R-squared	0.466421	Mean dependent var	-0.001143
Adjusted R-squared	0.431996	S.D. dependent var	0.310200
S.E. of regression	0.233786	Akaike info criterion	0.015273
Sum squared resid	1.694327	Schwarz criterion	0.149951
Log likelihood	2.740365	Hannan-Quinn criter.	0.061202
F-statistic	13.54912	Durbin-Watson stat	1.863825
Prob(F-statistic)	0.000059		

LOG(L) AT LEVEL

Null Hypothesis: LOGL has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.557338	0.7893
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.502891
HAC corrected variance (Bartlett kernel)	0.390686

Phillips-Perron Test Equation

Dependent Variable: D(LOGL)

Method: Least Squares

Date: 01/12/18 Time: 11:25

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGL(-1)	-0.238764	0.128813	-1.853573	0.0730
C	3.162458	1.784363	1.772318	0.0859

@TREND(1980)	0.044601	0.020113	2.217535	0.0338

R-squared	0.133929	Mean dependent var	0.164080
Adjusted R-squared	0.079800	S.D. dependent var	0.773134
S.E. of regression	0.741645	Akaike info criterion	2.321924
Sum squared resid	17.60118	Schwarz criterion	2.455239
Log likelihood	-37.63366	Hannan-Quinn criter.	2.367944
F-statistic	2.474246	Durbin-Watson stat	2.359829
Prob(F-statistic)	0.100196		

LOG(L) ATFIRST DIFFERENCE

Null Hypothesis: D(LOGL) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 33 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-19.13022	0.0000
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.495152
HAC corrected variance (Bartlett kernel)	0.043663

Phillips-Perron Test Equation

Dependent Variable: D(LOGL,2)

Method: Least Squares

Date: 01/12/18 Time: 11:26

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGL(-1))	-1.369721	0.167775	-8.164056	0.0000
C	-0.184582	0.271010	-0.681089	0.5009
@TREND(1980)	0.022428	0.013213	1.697446	0.0996

R-squared	0.682593	Mean dependent var	-0.000857
Adjusted R-squared	0.662115	S.D. dependent var	1.267779
S.E. of regression	0.736933	Akaike info criterion	2.311457
Sum squared resid	16.83516	Schwarz criterion	2.446136
Log likelihood	-36.29476	Hannan-Quinn criter.	2.357386
F-statistic	33.33321	Durbin-Watson stat	2.177692
Prob(F-statistic)	0.000000		

POV AT LEVEL

Null Hypothesis: HDI has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-2.140662	0.5063

Test critical values:	1% level	-4.243644
	5% level	-3.544284
	10% level	-3.204699

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000185
HAC corrected variance (Bartlett kernel)	0.000171

Phillips-Perron Test Equation

Dependent Variable: D(HDI)

Method: Least Squares

Date: 01/12/18 Time: 11:23

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HDI(-1)	-0.195837	0.090194	-2.171280	0.0374
C	0.052859	0.024353	2.170566	0.0375
@TREND(1980)	0.001875	0.000749	2.503859	0.0176

R-squared	0.172633	Mean dependent var	0.007069
Adjusted R-squared	0.120923	S.D. dependent var	0.015164
S.E. of regression	0.014217	Akaike info criterion	-5.586890
Sum squared resid	0.006468	Schwarz criterion	-5.453574
Log likelihood	100.7706	Hannan-Quinn criter.	-5.540869
F-statistic	3.338463	Durbin-Watson stat	2.019170
Prob(F-statistic)	0.048213		

POV AT FIRST DIFFERENCE

Null Hypothesis: D(HDI) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.009824	0.0001
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000215
HAC corrected variance (Bartlett kernel)	0.000205

Phillips-Perron Test Equation

Dependent Variable: D(HDI,2)

Method: Least Squares

Date: 01/12/18 Time: 11:24

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

D(HDI(-1))	-1.084518	0.180614	-6.004608	0.0000
C	0.000210	0.005625	0.037267	0.9705
@TREND(1980)	0.000403	0.000278	1.446758	0.1580

R-squared	0.537798	Mean dependent var	-0.000235
Adjusted R-squared	0.507979	S.D. dependent var	0.021908
S.E. of regression	0.015367	Akaike info criterion	-5.429073
Sum squared resid	0.007321	Schwarz criterion	-5.294394
Log likelihood	95.29424	Hannan-Quinn criter.	-5.383144
F-statistic	18.03512	Durbin-Watson stat	1.945465
Prob(F-statistic)	0.000006		

LOG(X) AT LEVEL

Null Hypothesis: LOG(X) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.526209	0.0004
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.050632
HAC corrected variance (Bartlett kernel)	0.125227

Phillips-Perron Test Equation

Dependent Variable: D(LOG(X))

Method: Least Squares

Date: 01/12/18 Time: 11:23

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(X(-1))	-0.736257	0.141558	-5.201110	0.0000
C	5.944613	1.116466	5.324490	0.0000
@TREND(1980)	0.039276	0.009150	4.292443	0.0002

R-squared	0.465995	Mean dependent var	0.086923
Adjusted R-squared	0.432620	S.D. dependent var	0.312418
S.E. of regression	0.235328	Akaike info criterion	0.026140
Sum squared resid	1.772130	Schwarz criterion	0.159455
Log likelihood	2.542555	Hannan-Quinn criter.	0.072160
F-statistic	13.96228	Durbin-Watson stat	0.551947
Prob(F-statistic)	0.000044		

LOG(TRACON) AT LEVEL

Null Hypothesis: LOG(TRACON) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.119972	0.5173
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.012024
HAC corrected variance (Bartlett kernel)	0.009282

Phillips-Perron Test Equation

Dependent Variable: D(LOG(TRACON))

Method: Least Squares

Date: 01/12/18 Time: 11:21

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TRACON(-1))	-0.175622	0.080884	-2.171276	0.0374
C	2.020335	0.935695	2.159181	0.0384

@TREND(1980)	0.011297	0.004408	2.562550	0.0153

R-squared	0.172351	Mean dependent var	0.038739
Adjusted R-squared	0.120623	S.D. dependent var	0.122290
S.E. of regression	0.114678	Akaike info criterion	-1.411567
Sum squared resid	0.420831	Schwarz criterion	-1.278251
Log likelihood	27.70242	Hannan-Quinn criter.	-1.365546
F-statistic	3.331874	Durbin-Watson stat	1.923712
Prob(F-statistic)	0.048477		

LOG(TRACON) AT FIRST DIFFERENCE

Null Hypothesis: D(LOG(TRACON)) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.500911	0.0000
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.011845
HAC corrected variance (Bartlett kernel)	0.013656

Phillips-Perron Test Equation

Dependent Variable: D(LOG(TRACON),2)

Method: Least Squares

Date: 01/12/18 Time: 11:22

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(TRACON(-1)))	-1.080165	0.164351	-6.572297	0.0000
C	-0.044304	0.041796	-1.060011	0.2973
@TREND(1980)	0.004312	0.002049	2.104964	0.0435

R-squared	0.584158	Mean dependent var	-0.006218
Adjusted R-squared	0.557329	S.D. dependent var	0.171314
S.E. of regression	0.113981	Akaike info criterion	-1.421469
Sum squared resid	0.402743	Schwarz criterion	-1.286791
Log likelihood	27.16498	Hannan-Quinn criter.	-1.375540
F-statistic	21.77373	Durbin-Watson stat	1.562545
Prob(F-statistic)	0.000001		

BOUND COINTEGRATION TEST

Dependent Variable: D(LOGGDP)

Method: Least Squares

Date: 01/12/18 Time: 11:45

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.427496	1.331039	1.072467	0.2938
LOGGDP(-1)	-0.201178	0.142483	-1.411947	0.1703
LOGGCF(-1)	-0.016818	0.012871	-1.306660	0.2032
LOGL(-1)	0.016989	0.020379	0.833666	0.4124
LOG(X(-1))	0.110929	0.065512	1.693259	0.1028
D(LOGGDP(-1))	0.010210	0.190430	0.053614	0.9577
D(LOGGCF(-1))	0.010735	0.015535	0.690998	0.4959
D(LOGL(-1))	-0.009265	0.018098	-0.511919	0.6132
D(LOG(X(-1)))	-0.007152	0.037607	-0.190187	0.8507

R-squared	0.508787	Mean dependent var	0.012865
Adjusted R-squared	0.428561	S.D. dependent var	0.066286
S.E. of regression	0.062233	Akaike info criterion	-2.493943
Sum squared resid	0.096823	Schwarz criterion	-2.089906
Log likelihood	51.39703	Hannan-Quinn criter.	-2.356155
F-statistic	3. 495749	Durbin-Watson stat	2.097478
Prob(F-statistic)	0.006481		

LAG LENGTH CRITERIA

VAR Lag Order Selection Criteria

Endogenous variables: LOGGDP LOGGCF

LOGL LOG(X)

Exogenous variables: C

Date: 01/12/18 Time: 11:50

Sample: 1980 2015

Included observations: 33

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-85.29433	NA	0.002633	5.411778	5.593173	5.472812
1	22.50019	182.9240*	1.02e-05*	-0.151526*	0.755448*	0.153643*
2	29.63679	10.38052	1.83e-05	0.385649	2.018203	0.934954
3	46.98107	21.02337	1.91e-05	0.304178	2.662311	1.097618

* 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

Estimated long run coefficients using the ARDL approach

Dependent Variable: LOGGDP

Method: Least Squares

Date: 01/12/18 Time: 11:55

Sample (adjusted): 1981 2015

Included observations: 35 after adjustments

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.726039	0.420616	1.726133	0.0946
LOGGDP(-1)	0.879739	0.039871	22.06474	0.0000
LOGGCF(-1)	-0.015201	0.007772	-1.955807	0.0599
LOGL(-1)	0.012325	0.007957	1.548848	0.1319
LOG(X(-1))	0.083793	0.011804	7.098700	0.0000

R-squared	0.955982	Mean dependent var	12.38407
Adjusted R-squared	0.950113	S.D. dependent var	0.263533
S.E. of regression	0.058861	Akaike info criterion	-2.695698
Sum squared resid	0.103940	Schwarz criterion	-2.473505
Log likelihood	52.17471	Hannan-Quinn criter.	-2.618997
F-statistic	162.8837	Durbin-Watson stat	2.005585
Prob(F-statistic)	0.000000		

Short run result for the selected ARDL model

Dependent Variable: D(LOGGDP)

Method: Least Squares

Date: 01/12/18 Time: 17:13

Sample (adjusted): 1982 2015

Included observations: 34 after adjustments

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002963	0.011999	-0.246904	0.8068
D(LOGGDP(-1))	1.095069	0.375068	2.919652	0.0068
D(LOGGCF(-1))	-0.008633	0.006112	-1.412529	0.1688
D(LOGL(-1))	0.005915	0.004808	1.230199	0.2289
D(LOG(X(-1)))	0.094308	0.037969	2.483788	0.0193
ECM(-1)	-1.261271	0.438337	-2.877402	0.0076

R-squared	0.326760	Mean dependent var	0.012865
Adjusted R-squared	0.206538	S.D. dependent var	0.066286
S.E. of regression	0.059045	Akaike info criterion	-2.662235
Sum squared resid	0.097618	Schwarz criterion	-2.392878
Log likelihood	51.25800	Hannan-Quinn criter.	-2.570377
F-statistic	2.717984	Durbin-Watson stat	2.100788
Prob(F-statistic)	0.040060		

Regression analysis on the effect of road Transport on Poverty Reduction

Dependent Variable: HDI

Method: Least Squares

Date: 01/12/18 Time: 17:21

Sample: 1980 2015

Included observations: 36

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.227756	0.581929	-2.109804	0.0425
LOGGDP	0.062960	0.065934	0.954899	0.3466
LOG(X)	0.095912	0.027678	3.465236	0.0015

R-squared	0.796982	Mean dependent var	0.410654
Adjusted R-squared	0.784678	S.D. dependent var	0.088063
S.E. of regression	0.040864	Akaike info criterion	-3.477485
Sum squared resid	0.055105	Schwarz criterion	-3.345525
Log likelihood	65.59474	Hannan-Quinn criter.	-3.431428
F-statistic	64.77375	Durbin-Watson stat	0.692825
Prob(F-statistic)	0.000000		

Regression Analysis on the Test of Linearity

Dependent Variable: LOGGDP

Method: Least Squares

Date: 01/12/18 Time: 17:23

Sample: 1980 2015

Included observations: 36

White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.00416	1.388874	21.60323	0.0000
LOGGCF	0.017229	0.011806	1.459408	0.1545
LOGL	-0.039976	0.017985	-2.222798	0.0337
LOG(X)	-4.203662	0.319164	-13.17084	0.0000
LOG(X)^2	0.253882	0.019254	13.18622	0.0000

R-squared	0.934561	Mean dependent var	12.38984
Adjusted R-squared	0.926118	S.D. dependent var	0.262039
S.E. of regression	0.071226	Akaike info criterion	-2.317678
Sum squared resid	0.157266	Schwarz criterion	-2.097745
Log likelihood	46.71821	Hannan-Quinn criter.	-2.240916
F-statistic	110.6813	Durbin-Watson stat	0.702081
Prob(F-statistic)	0.000000		

GRANGER CAUSALITY TEST

Pairwise Granger Causality Tests

Date: 01/12/18 Time: 17:36

Sample: 1980 2015

Lags: 2

Null Hypothesis:	Obs	F-Statistic
LOG(X) does not Granger Cause LOGGDP	34	4.17342
LOGGDP does not Granger Cause LOG(X)		2.66161
LOG(TRACON) does not Granger Cause LOGGDP	34	4.94479
LOGGDP does not Granger Cause LOG(TRACON)		5.77528
LOG(TRACON) does not Granger Cause LOG(X)	34	1.40445
LOG(X) does not Granger Cause LOG(TRACON)		4.35074