FULL COLOUR THINKING

GRADUATE SCHOOL OF BUSINESS
UNIVERSITY OF CAPE TOWN

The Impact of Public Spending on Roads Infrastructure on Malawi's Economic Growth

A Dissertation

presented to

Graduate School of Business
University of Cape Town

In partial fulfilment
of the requirements for the
Master of Commerce in Development Finance Degree

Alex Simeon Makhwatha
(MKHALE003)

Supervisor: **Dr Sean J. Gossel**

August 2014

DECLARATION

`I, the undersigned, hereby declare that the thesis *'The Impact of Public Spending on Roads Infrastructure on Malawi's Economic Growth'* is my own work which has not been submitted to any other institution for similar purposes. However, where other people's works have been used, acknowledgement has been duly given. I am solely responsible for all errors contained herein'.

Alex Simeon MAKHWATHA (MKHALE003)

Legal Name

Signed by candidate

Signature

18 August, 2014

Date

CERTIFICATE OF APPROVAL

I, the undersigned, certify that this thesis is from the student's own work and is submitted with my approval.

Dr Sean J. Gossel

Supervisor's Name

Signed by candidate

Supervisor's Signature

18 August, 2014

Date

DEDICATION

To my family and employers for their understanding, sacrifice and support.

ACKNOWLEDGEMENT

The completion of this thesis has been possible through the guidance and assistance from several individuals and organizations, either directly or indirectly. First and foremost, I would like to take this opportunity to express my gratitude to my supervisor, Dr Sean Gossel, and my course coordinator, Ms Candice Marais, who worked tirelessly to guide me in the course of writing this thesis.

I would also like to acknowledge the assistance of Gracious Hamuza for making available statistical packages that were used in the analysis of the data. I am also not forgetting the officials from Ministry of Finance, Ministry of Economic Planning, Ministry of Transport and Public Works, Reserve Bank of Malawi, National Statistical Office, Roads Authority and Roads Fund Administration for providing me with the required data used in this thesis. I say thank you all.

ABSTRACT

Public expenditure has been a cardinal objective of all successive governments since Malawi gained its independence in 1964. Successive administrations have on different occasions made attempts to direct government spending towards achieving objectives that have direct bearing on its populace. According to Keynesian view, the increase in public spending on socio-economic and physical structures is important and encourages economic growth. However, Classical economists on the other hand argue that the increase in public expenditure may shift resources from the productive private sector to public sector which they believe is unproductive and hence, crowd out overall performance of the economy. These views indicate that policymakers worldwide including Malawi are under debate whether increase in public spending helps or hinders economic growth. Applying ADF and KPSS tests, Johansen-Juselius co-integration multivariate procedure and TYDL Granger causality test, this study investigates the relationship between government expenditure on roads infrastructure and GDP in Malawi using time series data spanning from 1978 to 2010. ADF and KPSS tests indicate that the series under investigation are integrated of order one (i.e. I(1)). The results of the Johansen co-integration tests indicate a long-run relationship between the roads expenditure and economic growth. The TYDL test indicates the existence of unidirectional causality running from roads expenditure and economic growth which supports Keynes hypothesis that government spending affects economic growth. The study, therefore, concludes that government spending on roads infrastructure causes economic growth, which confirms the main goal of MGDS that aims at achieving economic growth through infrastructure development. Based on these results, the study recommends that government should ensure that both capital and recurrent expenditure are properly managed to accelerate economic growth. More so, Government should promote efficient resource allocation on human capital development by encouraging more private participation to ensure productivity for intensive economic growth.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
AICD	African Infrastructure Country Diagnosis
ARDL	Auto Regression Distributed Lag
CPI	Consumer Price Index
CRTS	Constant Return to Scale
DF	Dickey-Fuller
ECM	Error Correction Model
ERP	Economic Recovery Plan
FM-VAR	Fully Modified Vector AutoRegression
GCT	Granger Causality Test
GDB	Government Development Budget
GER	Government Expenditure in Roads
GDP	Gross Domestic Product
GIS	Geographical Information System
GNP	Gross National Product
HD	Harrod-Domar
HQIC	Hannan Quinn Information Criteria
ICOR	Incremental Capital Output Ratio

ILO	International Labour Organization
IMF	International Monetary Fund
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
LICs	Low Income Countries
MDGs	Millennium Development Goals
MGDS	Malawi Growth and Development Strategy
MICs	Middle Income Countries
MoF	Ministry of Finance
MoTPW	Ministry of Transport and Public Works
MWALD	Modified Wald
MWK	Malawi Kwacha
NRA	National Roads Authority
NSO	National Statistical Office
OECD	Organization for Economic Co-operation and Development
PPP	Public-Private Partnership
RB	Recurrent Budget
RBM	Reserve Bank of Malawi
RA	Roads Authority
RBM	Reserve Bank of Malawi
R and D	Research and Development

RFA	Roads Fund Administration
RF	Roads Fund
RONET	Road Network Evaluation Tool
SNM	Standard Neoclassic Model
SUR	Seemingly Unrelated Regression
TFP	Total Factor Productivity
TYDL	Tado Yamamoto Dolado Lutkepohl
USA	United States of America
VAR	Vector AutoRegression
VECM	Vector Error Correction Model
WDI	World Development Indicator

CHAPTER ONE: INTRODUCTION

1.1 Study Background and Motivation

The role of public infrastructure in the process of economic growth and development has been well documented in literature (Aschauer, 1989; Munnell, Baro, 1990; World Bank, 1994; Calderod and Serven, 2003; Estache, 2006; Sahoo and Dash, 2008, 2009). Keynesian economists and numerous empirical findings have proved that an increase in government spending on socio-economic and physical infrastructure encourages economic growth. Advocates of this view such as Mulhearn and Vane (1999) argued that government spending helps to undertake a massive effort to restore and upgrade deteriorating public infrastructure. However, according to the classical economists' view, increased government spending can exacerbate an economic concentration by shifting resources from private sector. Hence, this relatively higher resource allocation by government may have negative effects on the private sector and consequently on economic growth. Infrastructure development, both economic and social, is one of the major determinants of economic growth, particularly in developing countries like Malawi. For instance, direct investment in infrastructure creates (i) production facilities that stimulates economic activities; (ii) reduces transaction costs, road congestion and trade costs thereby improving competitiveness and (iii) provides employment opportunities to the poor. In contrast, lack of infrastructure creates bottlenecks for sustainable economic growth and poverty reduction (Sahoo, et al., 2009).

Over the period from 2000 to 2010, infrastructure investment contributed 1.2 percent to the annual per capita growth of Malawi's gross domestic product (GDP) (Foster and Shkaratan, 2010). In their paper, Foster and Shkaratan (2010) recommended that raising Malawi's infrastructure endowment to that of the region's middle income countries (MICs) could further boost annual growth by 3.5 percent per capita. The conventional wisdom is that public investment in infrastructure particularly in transport plays a crucial role in facilitating economic growth and international competitiveness. The development advocates tend to emphasize the importance of reliable and affordable infrastructure for reducing poverty and its contribution to the achievement of Millennium Development Goals (MDGs). Good transport linkages reduce costs, road congestion and promote industrial development throughout the country (Ashipala and Haimbodi, 2003). Poor infrastructure facilities especially in transport, communications and information technologies are regarded as one of the major impediments for investment and growth in many African countries (World Bank, 1994). Since the early 2000s, Malawi has spent nearly 4 percent of GDP per year on its road network (one of the highest ratios in Southern Africa). As a result, Malawi now has a road sector that is of a higher quality when benchmarked against its peers. However, despite this, road preservation expenditure still falls significantly short of what is needed to preserve the network in good condition. Based on the Road Network Evaluation Tool (RONET) analysis, Malawi's recent spending on road maintenance falls about 24 percent short of what is needed to sustain the infrastructure (GoM, 2010).

Infrastructure is a profound determinant of nationhood, a measure of a country's success on the world stage. Physical infrastructure may be viewed as the manifestation of a country's economic power; social infrastructure's measures are the social capital and standard of living of its citizens (ILO, 2010). A country's infrastructure capital may accumulate over generations or it may occur over a decade. A nation's physical infrastructure is generally taken to mean its public capital such as road networks. Infrastructure in all its commercial manifestations is viewed by governments as the means to attract substantial private sector investment. According to 2010 ILO report, although infrastructure development is not identified as a direct Millennium Development Goal (MDG) target or indicator, without it many of the targets will not be met and that sustainable infrastructure is not only an essential part in improving the livelihoods of the poor; it also provides opportunities for creating jobs during development, operation and maintenance (ILO, 2010). This research considers the interrelationships between road infrastructure development and economic growth in Malawi.

1.2 Infrastructure in Malawi

Malawi has made significant progress towards developing its infrastructure in the recent years, and it is one of the few countries in sub-Saharan Africa (SSA) to have already reached the Millennium Development Goals (MDGs) for water – almost a decade ahead of the target (Foster and Shkaratan, 2010). Despite all this, there are many challenges being faced such as unreliable and sustainable power sector, which is taking a significant toll on the economy due to significant underpinning and operational inefficiencies. According to AICD's country report on Malawi's infrastructure, Malawi has been spending a little under $0.2 billion per year, which is about 6 percent of the GDP on infrastructure and about half of this has been directed to transport sector. In Malawi like any other developing countries, government spending continues to be the main source of investment expenditure and in the current MGDS (MDGS II), total government expenditure is expected to reach an average of 26.4 percent of the GDP (GoM, 2010).

In order to keep up with the demands of sustained economic growth, the government of Malawi (GoM) has actively taken steps to address infrastructure needs through a number of, policies including the Malawi Growth and Development Strategy II (MGDS II), which is the overarching mid-term strategy from 2011 to 2016 aimed at further reducing poverty through sustainable economic growth and infrastructure development. Infrastructure is one of the 9 priority areas in the MGDS II and one of the 5 pillars of the current government's economic recovery plan (ERP). The former president, Madam Joyce Banda highlighted the importance of infrastructure development by stressing the role that modern infrastructure mainly transport plays for any country's social economic growth and development. As a land locked country, the government recognizes that Malawi heavily depends on effective road, rail and air transport networks, which are crucial in supporting its key economic activities, including agriculture and tourism. Over the past decade, infrastructure has contributed 1.2 percent to the annual per capita growth of Malawi's GDP.

1.3 The Roads Infrastructure

Historically, in Malawi, many factors such as politics have triggered the development of road infrastructure besides it being purely economic (Mustajab, 2009). Road transport currently plays a major role in Malawi's domestic and international trade handling. Road transport accounts for more than 70% of the internal freight and over 90% of the country's international freight traffic (GoM, 2010). Historically, rail was the main mode for international freight transport, connecting Malawi with its southern neighbours of Mozambique, Zimbabwe and South Africa. However, the civil war in Mozambique from the mid-seventies cut off the two main rail arteries (the Nacala and Beira-Sena lines) and consequently, the importance of rail in Malawi's international freight movements declined.

Malawi has an extensive road network of 12,500 km that physically connects settlements and markets within the country. Main, secondary, and tertiary roads are evenly distributed with 3,400 kilometers, 2,800 kilometers, and 3,800 kilometers respectively. In addition, the country has over 79,000 km of feeder roads. However, a large majority of roads are unclassified feeder roads (86% of national road network).

An efficient transport system is a pre-requisite for sustained economic development. It is a key infrastructure input for the growth process. The road transport plays an important role in promoting the development of the backward regions and integrating them with the mainstream economy by opening through to trade and investment. Roads are crucial mode of transport which connects long distances and also remote areas in any country like Malawi. Moreover, roads connection is also essential for other modes of transport such as railways, airways and inland waterways and complements the efforts of these modes in meeting the needs of transportation. An efficient and well-established network of the roads is desired for promoting trade and commerce in any country and also fulfills the need of sound transportation system for sustained economic development. There are some studies (such as those of Dercon and Hoddinott, 2005; Stifel and Minten, 2008) that showed that connecting rural and remote areas is helpful in reducing poverty and improve economic growth. Development of roads contributes to economic growth by promoting marketing of products, flows of goods and services and people.

Malawi has been spending heavily on its road networks in recent years. For instance, during the mid-2000s, Malawi spent close to US$200 million per year, about half of which went to the transport sector and nearly 4 percent to its roads infrastructure. This is one of the highest ratios in Southern Africa and as a result it has achieved better levels of road quality compared to its peers in the region. Table 1.1 shows Malawi's road indicators as benchmarked against Africa's low income countries (LICs) and middle income countries (MICs).

Table 1.1 Malawi's road indicator as compared to LICs and MICs

Variable	Unit	LICs	Malawi	MICs
Paved road density	km/1, 000 km^2 of arable land	86.6	**141.2**	507.4
Unpaved road density	km/1, 000 km^2 of arable land	504.7	**164.7**	1, 038.3
GIS rural accessibility	% of rural population within 2 km of all season roads	21.7	**26.2**	59.9
Paved road traffic	Average annual daily traffic	1, 049.6	**600.6**	2, 786
Unpaved road traffic	Average annual daily traffic	62.6	**44.5**	12
Paved network condition	% in good or fair condition	80	**85.5**	79
Unpaved network condition	% in good or fair condition	57.6	**89.4**	58.3
Perceived transport quality	% firms identifying roads as major business constraint	23	**16.4**	10.7

Source: Gwilliam et al., 2009

1.4 Roads Expenditure in Malawi

Malawi's economic growth plan is led by the Malawi Growth Development Strategy (MGDS), which aims at reducing poverty through heightened production, exports, and infrastructure provision. There are two main types of funds for roads in Malawi under the Roads Authority (RA). The largest part of the funds comes from the Government's Development Budget (GDB), including development partner grants and loans, and is used mainly for major road improvements, new roads, upgrading unpaved roads to paved, and rehabilitation and periodic maintenance. The second source is the Recurrent Budget (RB) funded by the Roads Fund (RF), which raises revenue from fuel levy, transit fees and various other minor sources, and provides this money to finance the maintenance and rehabilitation of all public roads and surveys and monitoring related to such maintenance and rehabilitation. The RF may also be supplemented by Government subventions through the national budget (GoM, 2010).

At present, the GoM and development partners' project resources are administered separately, but considerations are being given to make the Roads Fund Administration (RFA) responsible for handling all road sector funds regardless of source. Until recently, the RF has not raised sufficient money for all necessary maintenance work. Table 1.2 shows expenditure in the road sector over the period 2002 to 2010.

Table 1.2: Malawi's Roads Expenditure

Period	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**2009/10**
Source of income									
Fuel Levy	1.34	1.48	1.53	1.82	2.31	2.41	2.19	3.82	7.84
Grants	2.95	2.47	2.09	2.30	3.97	4.06	9.77	14.24	18.53
Total Income (MWK bn)	**4.29**	**3.95**	**3.62**	**4.12**	**6.28**	**6.47**	**11.96**	**18.06**	**26.37**
Total Income (US$ mn)	**55.90**	**40.50**	**33.20**	**43.10**	**46.20**	**46.10**	**85.10**	**129.00**	**188.40**
Expenditure									
Operations	1.19	1.46	1.53	1.40	2.15	2.58	2.35	4.50	6.94
Utilization of Grants	3.12	2.48	2.10	2.30	4.16	4.00	8.33	10.82	18.57
Administration	0.07	0.11	0.20	0.20	0.13	0.15	0.17	0.19	0.86
Depreciation	0.01	0.02	0.03	0.03	0.03	0.03	0.05	0.26	0.00
Grants to MoTPW	0.03	0.02	0.02	0.02	0.03	0.02	0.01	0.00	0.00
Public Works Programme	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Expenditure (MWK bn)	**4.42**	**4.09**	**3.88**	**3.95**	**6.50**	**6.78**	**10.91**	**15.77**	**26.37**
Total Expenditure (US$ mn)	**57.60**	**42.00**	**35.60**	**33.33**	**47.80**	**49.40**	**77.60**	**112.60**	**188.40**

Source: NRA and RA Annual Report and RA Financing Agreement (FA)

1.5 Malawi's Economic Growth

Malawi is a landlocked, densely-populated country in Southern Africa where per capita annual income currently stands at around $290 (IMF, 2010). Furthermore, unlike many of its neighbors, Malawi has not benefited from significant mineral endowments, and its export corridors to the ports in Mozambique have yet to be repaired from the damage done by that country's civil war.

Growth performance has been strong in recent years. GDP grew at 6.7% in 2006, 8.6% in 2007 and 9.7% in 2008. Growth was projected to fall to around 6% in 2009 and 2010. While recent performance is good by any standards, Malawi's growth has a history of volatility, and recovery from the recession of the 1980s was slow compared to other countries in the region (World Bank, 2010). Furthermore as a small, low income landlocked economy, export growth is vital if Malawi is to achieve the sustained increases in GDP needed to reduce poverty. Again, until very recently Malawi's export growth performance has been sluggish by regional standards. Figure 2.2 gives an economic performance of some selected countries in Africa from 1978 – 2006.

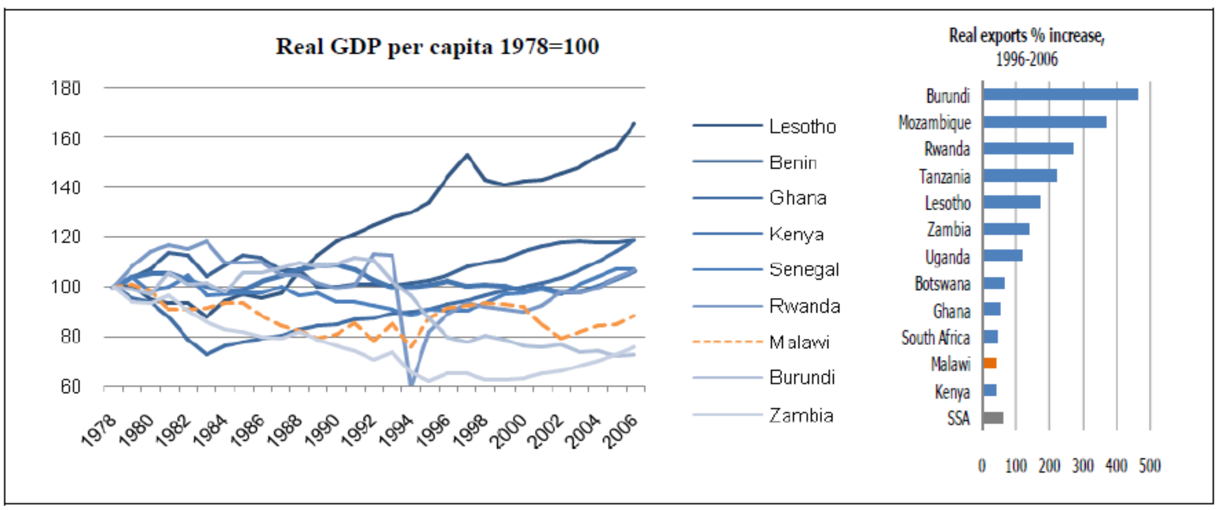
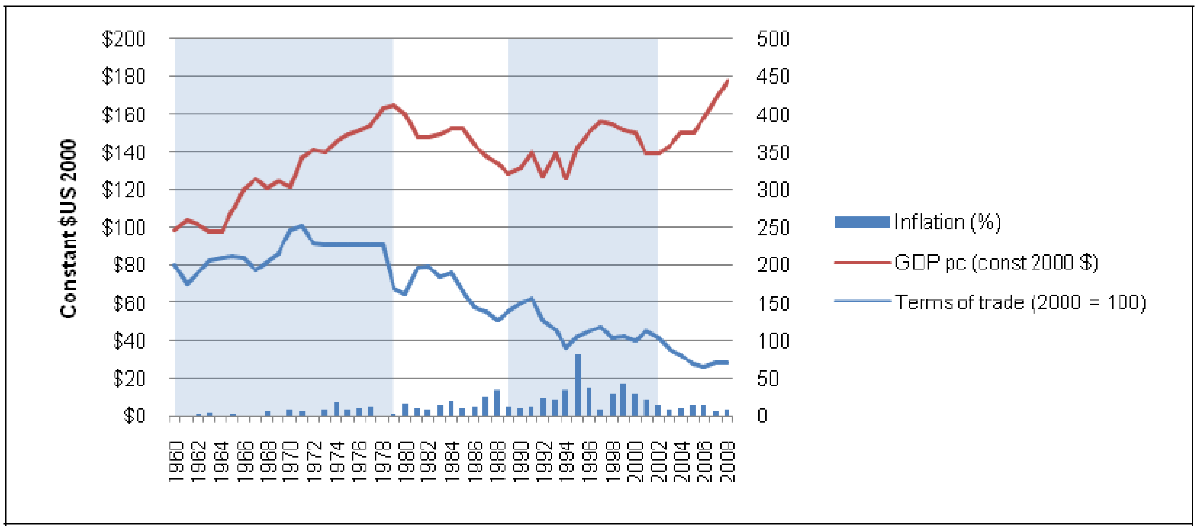


Figure 1.1: GDP and Export Growth Context

(Source: World Development Indicator, 2008)

The history of growth in Malawi since 1960 can be characterized by four distinct phases: (a) 1960-79 estate-based growth; (b) 1979-89 decline; (c) 1989-02 stagnation due to shocks and transition to smallholder led growth; and (d) 2002-08 recovery. Stagnation and recovery are discussed below. The evolution of per capita GDP from 1960 to 2006 is plotted in Figure 2.3. It shows a period of strong growth between 1960 and 1979 followed by a decline in standards of living until 1989. Macro-instability and external shocks created volatility and stagnation in the period to 2002, and growth resumes in the most recent phase 2002-08 (IMF, 2010).



Sources: GDP per capita - WDI 1960-1993, NSO 1994-2008, using population from WDI; Inflation: WDI 1960-1979 (from GDP deflator), IMF 1980-2008 (from CPI); Terms of trade: WDI rebased to 2000=100

Figure 1.2 Phases of GDP per capita in Malawi

Volatility and Transition to Smallholder Growth: 1989-02

Agricultural reform began in the early 1990s and dismantled many of the constraints imposed on smallholders by the estate-led model. The repeal of the Special Crops Act made it legal for smallholders to grow export crops bringing about a dramatic shift in the sector - from nearly nothing in 1990, smallholders now produce around 70% of the tobacco crop. However growth was volatile in the face of increasing macro-instability and exacerbated by various external shocks: droughts in 1992 and 1994; an increased influx of Mozambican refugees and, suspension of all Western non-humanitarian aid in 1992/93 (Harrigan, 2003).

Inflation reached 83% in 1995 and was only brought under control to around 10% in 2003. The much needed liberalization of the exchange rate in 1994 was not accompanied by fiscal discipline (partly explained by the electoral cycle) and hence higher import prices immediately fed through into the CPI. Excessive government borrowing financed by domestic treasury bills resulted in real interest rates exceeding 20% between 2000 and 2004. For part of this period Malawi had the notoriety of having real interest rates among the highest in the world. Private investment was crowded out, growth was damaged.

Stabilization and Recovery: 2002-08

The change of government in 2004 brought about a rapid turnaround in government finances. In extremely difficult fiscal circumstances, and for the first time since 1994, the government stayed within the budget approved by parliament (Whitworth, 2005). As a result government expenditure stabilized and the fiscal deficit improved dramatically. In 2007 after 28 years, income per capita recovered their level of 1979. The deterioration of the terms-of-trade and infrastructure damage in Mozambique clearly played a large part in this collapse, yet incomes have recovered without an accompanying recovery in the terms-of-trade. Over the 28 years, the economy has moved from export orientated estate-agriculture to being led by smallholder production.

Growth in Malawi is dominated by agriculture, and recently has seen an increasing contribution from domestic services. Between 1995 and 2003 agriculture accounted for nearly three-quarters of all economic growth (see Table 1.3). After 1995, there is a general pattern of falling growth rates until reaching a low point during the drought of

2001/02, followed by a gradual resumption output growth. However growth since 2004 has been structurally different, being composed of increasingly important contributions from distribution, finance, construction and manufacturing. The headline data on trade also shows an equivalent change in dynamic: whilst exports have stayed within the region of 20 percent of GDP, the trade deficit has significantly worsened and since 2003 has exceeded 10 percent of GDP.

Table 1.3: GDP and sources of Growth

	95	96	97	98	99	00	01	02	03	04	05	06	07
National Account ($US m)													
GDP ($US m)	1,925	3,149	3,669	2,451	2,447	2,402	2,365	2,665	2,425	2,625	2,755	2,917	3,324
Exports, fob ($US m)	444	510	539	539	447	402	427	414	433	499	509	543	706
Imports, fob ($US m)	508	588	697	497	573	460	471	595	684	810	1,006	1,055	1,182
Trade ratios (as percentage of GDP)													
Exports (fob)	23.1	16.2	14.7	22.0	18.3	16.7	18.0	15.5	17.9	19.0	18.5	18.6	21.2
Imports (fob)	26.4	18.7	19.0	20.3	23.4	19.2	19.9	22.3	28.2	30.9	36.5	36.2	35.6
Trade balance	-3.3	-2.5	-4.3	1.7	-5.1	-2.4	-1.9	-6.8	-10.3	-11.8	-18.0	-17.6	-14.3
Growth in GDP (factor cost)	**13.8**	**10.0**	**6.6**	**3.0**	**1.6**	**0.8**	**-3.9**	**1.9**	**3.9**	**5.1**	**2.2**	**8.6**	**9.2**
Agriculture	9.8	7.8	0.0	5.3	1.6	2.0	-2.4	1.0	2.3	1.1	-3.5	4.3	3.5
Mining, quarrying	0.0	1.5	-0.4	0.1	0.0	0.1	0.1	-0.6	0.2	0.5	0.8	-0.5	0.0
Manufacturing	0.9	-0.1	0.1	0.2	0.2	-0.4	-1.8	0.0	0.4	0.8	0.9	0.7	1.0
Electricity, water	0.0	0.0	0.1	0.1	0.0	0.1	-0.1	0.1	0.0	0.1	0.1	0.1	0.1
Construction	0.1	0.2	0.1	0.0	0.3	0.0	-0.1	0.3	0.3	0.3	0.4	0.4	0.9
Distribution	0.6	-0.2	3.7	-1.6	-0.4	-0.1	0.2	0.3	-0.2	1.4	2.8	1.8	1.3
Transport, communications	0.9	-0.4	0.4	0.0	0.2	-0.2	0.1	0.6	0.4	0.4	0.5	0.4	1.3
Financial, professional	0.7	1.3	2.5	-0.7	0.0	0.2	-0.2	0.5	0.5	0.8	0.7	1.7	1.1
Ownership of dwellings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
Government services	1.0	-0.3	0.2	-0.5	-0.2	-1.0	0.1	0.0	0.2	0.2	0.1	0.3	0.6

Source: NSO 1994 series of accounts. GDP is from 2002 series back-adjusted using the 1994 series rates of growth.

Despite continued falls in the terms of trade, growth and exports began to recover in 2003, and by 2007 GDP per capita had regained its level achieved in 1979. The recovery had taken 28 years. This study attempts to identify if the current economic growth is partly as a result of increased public spending on roads.

1.6 Problem Statement

Although a number of empirical studies report evidence supporting the significant contribution of infrastructure to economic growth and development, it is a puzzling and disputing question of whether road transport infrastructure is the cause of economic growth or vice versa. Following the endogenous growth models, transport infrastructure leads economic growth and development while the Wagner's law regards the increase in GDP as a main drive for public investment. Economic theory argues that government spending has both beneficial and detrimental impacts on economic growth. In traditional Keynesian macroeconomics, many forms of public expenditures, even of a recurrent nature, can contribute positively to economic growth, through multiplier effects on aggregate demand. On the other hand, government consumption may crowd out private investment, dampen economic stimulus in the short run and reduce capital accumulation in the long run. Strictly, crowding-out is due to fiscal deficits and the associated effect on interest rates (Diamond, 1989). Studies based on endogenous growth models distinguish between distortionary or non-distortionary taxation and between *productive* or *unproductive* expenditures (Kweka and Morrissey, 2000). Expenditures are categorized as *productive* if they are included as arguments in private production functions and *unproductive* if they are not (Irmen and Kuehnel, 2008).

Empirical evidence on the government spending-growth relationship is diverse, mostly based on cross-sectional studies that often include a sample of both advanced and developing countries. The main conclusion in most of these studies is that government consumption spending has a negative impact on growth (Grier and Tullock, 1989; Barro, 1990; Easterly and Rebelo, 1993). In contrast, studies such as Romp and De Haan, (2005) argue that increasing government expenditure promotes industrial growth. A summary of recent literature by Romp and De Haan (2005) has concluded that although not all studies confirm that public capital has a growth enhancing effect, there is now greater consensus than in the past that public capital promotes economic growth.

However, the impact reported by recent studies (such as those of Fedderke and Garkick, 2008; Jiwattanakulpaisarn, 2008; Sahoo, 2010; Jerome, 2011; Leduc and Wilson, 2012) is not as big as studies mentioned above had suggested. The reasons are associated with externalities and market failures, lack of well-developed financial and product markets, and worsening terms of trade and market domination (Joseph, 2012).

Since many of these negative effects beset the economies of developing countries such as Malawi, the extent to which market mechanisms alone can perform all the adjustment functions needed in the economy is of interest to be investigated. Following endogenous growth models, transport infrastructure leads economic growth while the Wagner's law regards the increase in GDP as a main drive for public investment. Under some conditions, it is even possible to observe a negative or non-significant growth impact of public investment. Thus, it is expected that the relationship between infrastructure investment and output exhibits two-way causality. As the direction of causality is theoretically unclear, one should investigate this issue from empirical investigation. Hence, this study seeks to address the following primary research question:

Does public expenditure on roads in Malawi have a significant and positive causal relationship with economic growth?

In addition, the following related secondary questions are applicable:

1. Is the causal relationship between roads expenditure and economic growth unidirectional or bidirectional?
2. Does the possible causal relationship lead directly from roads expenditure to economic growth, or indirectly via some macroeconomic channel?
3. What are the economic implications of the relationship for policymakers?

1.7 Justification and significance of the study

Understanding the linkages between fiscal policies and economic growth has raised huge debates both at the theoretical and empirical framework. Public expenditure and national income have been at the focus of public finance, since the magnitude of public expenditure has been increasing over time in almost all the countries of the world. It is therefore necessary for governments to know the causal relationship between the two. This is crucial because it is a common belief that the government plays a significant role in the development of countries. The implication is that an increase in government expenditure will yield a positive increase in the growth of the economy by increasing the national income, especially when it is injected in development programs (Omoke, 2009).

Hence, the identification and analysis of infrastructure investment and its effect on economic growth and development is of considerable interest from a policy perspective. Understanding the inter-dependence between public investment in infrastructure and economic growth is relevant as it provides some guidance for policy actions. If the causality is from GDP to public investment then the latter cannot be used as a policy instrument. Contrary, if the causality runs from public investment to GDP the governments can use public investment to boost economic growth. Two strands on empirical literature have examined the relationship between public investment in transport infrastructure and economic growth.

The first strand adopts a production function approach and uses either cross-section or panel data techniques. The second one examines the issue for a particular country using time series techniques. This research contributes to this second strand of the literature. Studies that have used the production function do not take into account the issue of non-stationary time series, which can result in the meaningless statistical inference in the estimated relations. Another criticism of this strand of studies is that they have not adequately accounted for the problem of simultaneity of growth and public capital formation. We argue that an appropriate way to overcome these shortcomings is to use time series techniques by applying unit root, co-integration and causality tests in a VAR framework, which allows all variables to enter as endogenous within a system of equations. Apart from filling the gap in the empirical literature, the approach used in this study is an advanced – Johansen (1988) multivariate co-integration procedure. By utilizing some economic theory and empirical analysis the study will evaluate and analyzes the relationship between government spending on roads and economic growth in Malawi. The study provides guidance for policy makers and development partners and will also serve to back up policy decisions on allocating government investment and spending, enhancing the efficiency of the resource use.

1.8 Structure of the thesis

This thesis consists of five chapters, the order of which follows. Chapter 1 gives the study background and motivation, infrastructure (roads) development in Malawi, composition of road spending, the problems statement, justification of the study and objectives of the study. Chapter 2, a comprehensive literature survey, explores economic growth theories, infrastructure development mechanisms and how infrastructures are financed. Chapter 3 gives the study methodology that includes the study design, data collection, model formulation and analyses done. Chapter 4 gives the study results, findings, discussions and limitations of the findings. Finally, Chapter 5 wraps up the discussion by drawing conclusions from the findings of the previous chapters, conclusions drawn and policy implications.

CHAPTER TWO: LITERATURE REVIEW

This chapter reviews the research literature related to economic growth, the determinants of growth and the role taken by infrastructure in facilitating economic growth. The chapter begins with a brief exploration of the theories of economic growth. The definition and economic impact of public expenditure is then examined, and finally, the empirical literature on the topic is investigated.

2.1 Economic Growth Theory

Economic growth and its determinants are traditional sources for debate in economics. The problems of economic growth - its sources, forms and effects have been high on economists' agenda since the inception of systematic economic analysis at the time of classical economists such as Adam Smith, William Petty and David Rocardo. Early work in the genre was undertaken by Harrod (1948) and Domar (1946), who independently used a Keynesian model to analyze economic growth in a closed-economy framework, thus jointly producing the Harrod-Domar (HD) model. The HD model is based on three assumptions. First, the economy generates savings (S) at a constant proportion (c) of national income (Y):

$$S = cY \tag{2.1}$$

where c is the marginal and average saving ratio. Second, the economy is in equilibrium, that is, planned investments (I) equal planned savings (S):

$$I = S \tag{2.2}$$

Third, investment is determined by the expected increase in national income (ΔY) and a fixed coefficient v, known as Incremental Capital Output Ratio (ICOR):

$$I = v\Delta Y \tag{2.3}$$

By definition, economic growth rate (g_y) is the change in income per unit of income

$$g_y = \frac{\Delta Y}{Y} \tag{2.4}$$

Substituting the relationship in equations (2.2) and (2.3) gives an alternative definition of growth as:

$$g_y = \frac{c}{v} \tag{2.5}$$

Equation (2.5) implies that, if the underlying assumptions are fulfilled, then the economy grows at a rate determined by parameters c and v. However, at least two of these assumptions may not hold in practice. Firstly, the fixed ICOR implies that there is a fixed relationship between the amount of capital stock and the output. Secondly, since labour input is not introduced in the model, the assumption is made that the labour supply is elastic (Siggel, 2005, p.38) both of these assumptions are weak and thus unlikely to hold.

A later model derived by collaboration between Solow (1956) and Swan (1956) relaxed the assumptions of fixed ICOR and the labour usage in the HD model. The modified model is known as the Solow-Swan or simply the neoclassical growth model. The key aspects of the Solow-Swan model are the addition of labour as a factor of production and a time-varying technology variable distinct from the capital and labour factors. Moreover, the Solow- Swan model assumes constant returns to scale (CRTS), diminishing returns with respect to each input, and positive elasticity of substitution between the inputs.

Shortly after, Solow's (1957) study showed that technological change accounted for almost 90 per cent of the US' economic growth in the late 19th and early 20th centuries. The increases in the factors of production (capital and labour) contributed relatively little to output growth, due to the law of diminishing returns. Therefore, the researcher argued, technological progress or total factor productivity is the major determinant of growth and determined exogenously. Solow's findings suggest that technological progress allows greater options for input combinations to improve efficiency, leading to a higher level of economic growth. However, Solow's model failed to explain how or why technological progress occurs. Arrow (1962) and Sheshinski (1967) advanced the model structure further by incorporating 'learning by doing' behaviour to explain the increase in productivity due to technological progress. Their respective models explain that each technological discovery immediately spills across the entire economy and thus stimulates higher levels of economic growth.

Romer (1986) provided an alternative model with a competitive framework to determine an equilibrium rate of technological progress, but conceded that the result of growth rate would not be Pareto optimal[1]. However, the competitive framework will not hold if discoveries depend partly on research and development (R and D) and if a given innovation spreads only gradually to other producers. Under such a realistic environment, a decentralized theory of technological progress is required to accommodate the imperfect competition in the real economy.

Grossman and Helpman (1991) and Aghion and Howitt (1992) further developed the endogenous growth framework. In the endogenous growth model, technological advances result from R and D activity, and technological progress and knowledge accumulation are treated as endogenous variables. According to the model, the long-run growth rate depends on a stable business environment, government policies and taxation, law and order, provision of infrastructure services, protection of intellectual property rights, regulation of international trade, and financial markets. Hence, under endogenous economy the government shapes long-term growth (Barro, 1996). A crucial channel by which this is achieved is via public expenditure .

The economic growth theory is mainly divided between two extreme thoughts: the Wagner's law and the Keynes. To generate good understanding of the outcomes of

[1] Pareto optimal refers to a measure of efficiency.

economic growth models, there is a need to include a lot of macroeconomic variables such as national income, investment, savings, labour, taxation, etc.

2.2 Public Infrastructure

The brief summary of growth theory identifies three contributing factors: capital accumulation, human capital (including education and learning), technical innovation (R and D). However, Stern (1991) argued that these factors need to be extended to include three additional determinants: Organizational management (because well managed organizations increase output by minimizing waste and improving efficiency whilst poor management restrains productivity), resource allocation (because economic distortions can prevent optimum resource distribution, which then impedes economic growth and social equity), and adequate infrastructure (especially transport infrastructure).

Public infrastructure refers to a large scale civil constriction which directly or indirectly promotes economic development (Barro, 2003). Definitions in the literature for infrastructure in its private production guise and as a socio-economic public benefit are now almost generic in their breadth. Among the earlier definitions was one developed by Nurske (1953), to the effect that infrastructure comprised of elements that provide services for production capacity.

Whilst the nature of infrastructure commonly appears to have a fundamental cross-sector aspect; that is, providing structure by the government or management to achieve a goal or desired outcomes (production, distribution, communication, health, education), there is acceptance among economists that infrastructure investment has a strong public involvement. Argy *et al*., (1999) and Prud'homme (2004) define the nature of economic infrastructure in terms of six components: (i) It is a long life construction with a long pay-back period; (ii) It is a capital intensive and cannot be directly consumed; (iii) Its genesis is associated with market failure; (iv) There is a relatively high level of government involvement; (v) It has a location, as it is generally immobile; and (vi) It provides a service for both households and private enterprises.

However, social infrastructure for education and health are not included in this list of characteristics on the grounds that social infrastructure input improves the quality of labour for private sector, and is not capital input. However, in this study, the socio-economic effects of public and private infrastructure are considered to be interlinked. By its scale, public investment impacts economic growth. Government may use investment as a budgetary measure to encourage private investment or to dampen demand. In the Keynesian paradigm, the effects of government expenditure can ‘crowd in’ or “crowd out” private investment. Majority of public investments have a crowding out effect on the level of private investment because they stimulate economic growth by increasing national income which in turn induce the private sector to increase investment (Aschauer, 1989b). However, Agenor and Montiel (1996) stated that in the case of developing countries, government budget deficits have a minimal effect on interest rates and the crowding out effect is thus minimized. In growth theory, the impact of infrastructure investment on GDP depends on its net effect on private investment. If the crowding out effect prevails, then the growth multiplier of infrastructure investment is negative. The reverse is applicable; if infrastructure investment produces a crowding in effect, then there is a positive result for the economy.

Bougheas, et al., (1995), demonstrated that infrastructure may promote specialization and long-term growth, using a cross-country growth model and instrumental variable estimation. They conclude that there is a positive correlation between core infrastructure and production specialization and they emphasized the importance of infrastructure accumulation, especially for poor countries. Felon *et al*. (2001) used a cross-sectional data from 83 countries and 30 provinces in China to assess the effect of transportation infrastructure and electricity on agricultural production and productivity. In accordance with economic theory, it is suggested that the density of roads and the availability of electricity predicts production on agricultural production and productivity. The results of the analysis suggested that access to transportation infrastructure and electricity are crucial in modernization of Chinese agriculture.

The type of economic theory being followed by any government, either Keynesian or Wagner, has an effect. This can be in form of crowding in or crowding out. In either case, public investment has a tangible effect as reported by most researchers. It is, therefore, important for any government to heavily invest in infrastructures so as to reap the fruits no matter how long it takes.

2.3 Public Infrastructure Investments and Economic Growth and Development

The relationship between public infrastructure investments and development outcomes is one of the most popular topics for debate in economic literature (Munnel, 1992; Gramlick, 1994; Kessides, 1996). Applied neoclassical growth models, fiscal variables such as taxes and public spending can affect the long-run output level but not the long-run output growth. This is so as the steady-state output growth is determined by exogenous factors such as population growth and technological progress, while fiscal policy can affect only the transition path of this steady-state. Hence, fiscal policy differences among countries may only explain the observed differences in income levels but not in long-run growth rate. Contrary to this, the endogenous growth theory produced growth models in which public investment in human and physical capital can have long-term or permanent growth effects and consequently there is much more scope in these models for at least some elements of government expenditure to play a role in the growth process (Barro, 1990; Kneller et al., 1999).

Public investment is seen as a driving force for private investment and services rendered by infrastructure, lower production costs (transportation and communication services), expand market opportunities that positively affect competitiveness, stimulate private investment and lead to economic growth (Aschauer, 1989; Agenor and Moreno-

Dodson, 2006; Fourie, 2006). Straub (2008) added economies of scale and scope as an additional channel through which infrastructure investment may cause growth effect. He argued that better transport infrastructure lowers the cost of transportation and leads to economies of scale and better management.

The theoretical literature on the relationship between infrastructure and growth has been substantially influenced by the work of Barro (1990). He showed that the benefits of infrastructure investments may be offset by the negative impact of additional distortionary taxes to finance them. The negative effects of public spending on growth arise from the distortions to choice and disincentive effects (Helms, 1995; Mendoza et al., 1997). There is a competition between public and private sector activities in the use of scarce resources and this drives their prices up. Especially, if public investments are financed by domestic borrowing, market interest rates are increased and capital becomes more expensive. The increase in interest rates discourages private investments and spending. Since private investments contribute more to growth, and increase in the size of the public sector at the expense of private sector also hinders economic growth. The crowd-out effect reduces the ability of the government to influence economic activity through fiscal measure.

The empirical research looking at the growth effects of public investment like many economic questions does not conclusively support the conventional belief. The results are mixed across countries, data and methodologies, with some finding a positive impact, while others find little or no significant growth effect. Empirical work by Aschauer (1989) on the United States has provided evidence of a strong and positive relationship between public investment and growth over the period 1949 to 1985. He asserted that the decrease in public investment may be crucial in explaining the US economy's relatively poor economic performance between 1970s and 1990s. This finding has been confirmed in some subsequent studies but challenged in others. As an example, using cross-country data, Easterly and Rebelo (1993) found a positive effect of investment in transport and communication on economic growth.

The empirical argument supporting infrastructure development's positive effects on growth in developed economies is also relevant for emerging economies. Canning and Fay (1993) showed that infrastructure variable is significant in developing countries and positively correlated with economic growth.

They investigated the contribution to economic growth from transportation networks, measured as aggregated kilometers of paved roads, and of railway lines. The study showed that a 0.10 output elasticity of transportation infrastructure, implying a relatively high rate of return for developing countries.
A 1994 World Development Report by World Bank found that a large range of empirical results on the importance of infrastructure on economic growth, with estimates ranging from no effect to rates of return in excess of 100 percent per annum. Sanchez and-Robles (1998) also found a positive impact of road length and electricity generating capacity in explaining subsequent economic growth. Aschauer (2000) found that the stock of public infrastructure capital is a significant determinant of aggregated total factor of productivity and that investments in public sector not only improve the quality of life but also increase economic growth and returns for private investments.

The findings of Demetriades and Mamuneas (2000) indicated that public infrastructure capital has significant positive long-run effects on both output supply and input demands in 12 OECD countries. Calderon and Serven (2004) found that indicators of telecommunication and energy infrastructure have positive and significant effects on 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 sampled cases, the analysis concluded that transport capital has been a contributor to the economic progress of these countries. The results of Seethepalli *et al.*, (2008) also proved that infrastructure is important for promoting growth in East Asia. Zou *et al.*, (2008) analyzed data from China and found that the higher economic growth levels come to a greater extent from better transport infrastructure and that public investment on road construction in poor areas is crucial to growth and poverty alleviation. The results obtained by Montolio and Sole-Olle (2009) supported the idea that productive public investment in road infrastructure has positively affected relative provincial productivity performance in Spain. In contrast, Tatom (1991, 1993), Holtz-Eakin (1994), Holtz-Eakin and Schwartz (1995) and Garcia-Mila *et al.*, (1996) suggested that there is little evidence of an effect from infrastructure to income growth in a panel of US state level data, particularly when fixed effects are included in the analysis.

It is interesting to note that even though the relationship between transport infrastructure and economic growth has attracted a lot of research effort and attention from economists, policy makers and politicians in early 1990s (Gamlich, 1994), it remains essentially unclear whether the direction of causation is from transport infrastructure to economic growth or vice versa or both. Kessides (1996) noted that one of the main shortcomings of research on the economic impact of transportation infrastructure is that it has so far not adequately accounted for simultaneity of effects i.e. economic growth can lead to development of transport system as well as result from it. Previous studies based on Cobb-Douglas production function could not confirm the direction of causation between the development of transport sector and economic growth. In addition, most of these studies have typically relied on cross-sectional or panel data regressions. A general problem associated with such studies is that they implicitly impose or assume cross-sectional homogeneity on coefficients that in reality may vary across countries because of differences in geographical, institutional, socio-economic structures. Hence, the overall results obtained from these regressions represent only an average relationship, which may or may not apply to individual countries in the sample (Bloch and Tang, 2003). Results obtained Canning and Pedroni, (2008) and Egart *et al.*, (2009) lend support to this view.

The 1994 World Development Report by World Bank noticed that as a country develops, an increasing proportion of the country would need to open up by construction of roads (1994). Research by Fernald (1999) provided evidence that increasing the road network induces faster productivity growth in those industries that use road network more intensively, implying that the causation is more likely to be from infrastructure investment to output growth, rather than the other way round. Based on a cross-regional study comparing infrastructure provision in Spain and the US, De la Fuente (2000) also concluded that causality flows from infrastructure investment to economic growth. Other studies used the VAR approach to solve the problem associated with the endogeneity of public investment in the production function approach.

Majority seem to agree with the theoretical postulation that public investment has a positive effect on output. Among these are Queiroz and Gautam (1992) who found road infrastructure to be a significant factor of economic growth and development. Sturm et al., (1999) found strong evidence of a positive impact of investments in transport infrastructure such as roads, canals and railways on the output level of Dutch economy in the second half of the nineteenth century. Furthermore, they found that transport infrastructure positively Granger-causes GDP whereas GDP negatively Granger-causes transport infrastructure. Mittnik and Neumann (2001) also established that public investment has a positive influence on GDP. However, there was no significant causal link running from GDP to public investment. Their results provided evidence for a contemporary relationship between public and private investment.

Using time series data for the US economy and co-integration analysis, Lau and Sin (1997) rejected the endogenous growth model for the US economy. Looney (1997) analyzed the effects of several types of public infrastructure in Pakistan and found that public infrastructures have not been instigating private sector expansion but have been rather a response to the needs of the sector. Kweka and Morrissey (2000) in Tanzania found that increased productive expenditure (physical investment) has a negative impact on growth but consumption expenditure has a positiveimpact. The expenditure on human capital investment was insignificant while aid appears to have a positive impact on growth in Tanzania.

Mamatzakis (2002) found 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 found that causal relationship is from public infrastructure to productivity. Calderon and Chong (2004) used Generalized Method of Moments (GMM) dynamic panel estimation model to capture the role of the volume and quantity of infrastructure (particularly in energy, railway, roads and telecommunications) on income distribution in a set of 101 countries over the period of 1960 – 1995. Their study revealed a negative relationship between the level of infrastructure development and income inequality.

Canning and Pedroni (2008) investigated the consequence of various types of infrastructure provision in a panel of countries. They showed that while infrastructure does not tend to cause long-run economic growth, there is substantial variation across countries. Ashipala and Haimboli (2008) looked at the relationship between public investment and economic growth in South Africa, Botswana and Namibia using VECM methodology. They found that the effect of public investment on growth is not significant. However, it had a correct sign. On the other hand, private investment showed to have a long–run impact in South Africa and Namibia. However, they found evidence indicating a reverse causality from GDP growth to public investment. The causality was negative in Botswana suggesting that as the economy grows investment in public goods decline, which is contrary to both Keynesian theory and Wagner's law.

Isaksson (2009) adopted a panel data regression model using ordinary least squares (OLS), both fixed and random effects and instrumental variables to analyze a group of 57 advanced and developing countries over 1970 – 2000. The results found that public capital has a relatively strong impact on industrial development and that public capital growth has the strongest impact on rapidly growing and high income economies.

Nketia-Amphonsah (2009) in Ghana showed that aggregated government expenditure retarded economic growth, but expenditures on health and infrastructure promoted economic growth while expenditure on education had no significant impact in the short run.

Nurudeen and Usman (2010) used co-integration and error correction methods to analyze the relationship between government expenditure and economic growth in Nigeria. Their results revealed that government total capital expenditure, total current expenditure and government expenditure on education have negative effects on economic growth. In contrast, raising government expenditure on transport and communication resulted in an increased economic growth. Pradhan (2010) explored the nexus between transport infrastructure (road and railway), energy consumption and economic growth in India over the period 1970-2007. He found evidence of unidirectional causality from transport infrastructure to economic growth. Zhai (2010) used a global CGE model and found that regional infrastructure investment in developing Asia would raise global income by US$1.8 trillion by the year 2020, with 90 percent of the gains accruing to the region. Moreover such investment would help boost global and regional trade.

Arslanalp *et al*., (2011) used a production function with estimated public capital in 48 advanced and developed economies over the period of 1960 – 2001. They found that an increase in the stock of public capital is associated with economic growth, with advanced economies registering stronger short-run effects and developing economies having greater long-run effects. Gupta *et al*. (2011) adopted a production function approach with GMM estimation. They used efficiency adjusted public capital stock data of 52 developing economies and found that this type of public capital has a significant effect on output. Dissou and Didic (2011) used a CGE model with heterogeneous agents and public capital in a multi-sector and inter-temporal environment calibrated to the economy of Benin. They showed that increasing public investment has a short-run effect, which is offset by increased productivity capacity in the long-run, and that higher public infrastructure spending benefits non-constrained agents more than constrained agents, and that the short-run private sector investment response depends on how the public infrastructure is financed.

Straub and Terada-Hagiwara (2011) examined the state of infrastructure in five developing Asian countries over the period of 1971 to 2006. Using growth regressions to analyze the link between infrastructure, growth and productivity they found that infrastructure development provides both the final consumption services to households and to key intermediate consumption items for production. Hence, they concluded that infrastructure development plays an important role in enhancing economic growth through both direct and indirect channels. The direct channel deals with infrastructure capital stock which serves as a production factor such that an increase in the stock of infrastructure directly impacts the productivity of the other factors. The indirect channel deals with the improvement in technology and its effects on infrastructure progress through labour productivity and improved information and communication technologies.

Loto (2011) applied co-integration and error correction model and showed that in the short-run, expenditure on agriculture and education were negatively related to economic growth. However, expenditure on health, national security, transportation, and communication were positively related to economic growth. Udoh (2011) examined the relationship between public expenditure, private investment and agricultural sector growth in Nigeria over the period 1970-2008 using the bounds test and autoregressive distributed lag model and error correction model. He found that an increase in public expenditure has a positive influence on the growth of the agricultural output. However, foreign investment has insignificant impact in the short run on agricultural output. Usman et al (2011) in Nigeria using OLS regression showed that expenditure on administration, education, and transport and communication have negative impact on economic growth in the short run, while expenditure on health and other services and FDI have positive impacts on economic growth. Finally, Keho and Echui (2011) investigated the relationship between transport infrastructure investment and sustainable economic growth on Cote d'Ivoire using co-integration and causality analysis over the period 1970-2002. They found that public investment in transport does not have a causal impact on economic growth. However, in contrast, they found economic growth Granger-caused transport investment.

With all these aforementioned studies having found different results, it still remains that the gap of misunderstandings between the Keynes and Wagners is still wide and the consensus is far from being reached. This might be as a result of the choice of explanatory variable, the definition of infrastructure and methods involved. Whatever the case, one has to choose whether to belong to Wagner or Keynes camp.

2.4 Empirical approaches in analysing the impact of public investment on economic growth

Empirical studies have used various approaches to investigate the role of public investment in the process of economic growth. Using production function approach, Enert (1986), Costa, et al., (1987) and Deno, (1988) found public investment to be complementary, rather than substitutes. Milbourne, et al., (2003), using an extension of Minkiw, Romer and Well's (1992) augmented Solow-Swan growth model, examined whether public investment has as distinct role as a determinant of economic growth. The study considered both the predictions of the model in steady state and in transition to steady state. For the steady state model, there is no significant effect from public investment on the level of output per worker. Using standard ordinary least squares (OLS) methods for the transition model, it observes a significant contribution to economic growth from public investment. When instrumental variables methods are used, however, the associated standard errors are much larger and the contribution of public investment is statistically insignificant. In an influential study, using annual data for the period of 1949 to 1985 for the United States of America, Aschauer (1989a) found a strong positive relationship between productivity and the ratio of the public to private capital stock.

Aaron (1990) and Tatom (1991) questioned the findings of Aschauer on the basis of non-stationarity of the TS data which may yield spurious correlation between the public capital stock and output growth. Sturm and De Haan (1995) argued that if Aschauer's model is estimated in first differences – which are necessary as the variables used are neither stationary nor co-integrated – the model produces only ambiguous results. However, as pointed out by Munnel (1992), first differencing also has its problems as it does not allow the estimation of the underlying long-term relationship between production and factor inputs. Duggal, *et al.*, (1995) argued that first differenced equations generate a priori implausible labour and capital output elasticities, and that this is enough to question the ability of first differenced equations to capture the long-run relationships.

Recent developments in econometrics have allowed the researchers to not only examine the extent to which variables are non-stationary, but also whether they grow together over time and converge to their long-run relationship, that is, whether they are co-integrated. This approach was followed by Lynde and Richmond (1993a, 1993b). They applied an error correction model (ECM) to capture the non-stationarity of the data. Using an ECM approach assumes that all endogenous variables adjust to their equilibrium level within one period, which is implausible. Furthermore, Sturm and Kuper, (1996) reported severe autocorrelation using the standard behavioural approach, and showed that this can be overcome by adopting an ECM representation within a translog cost function.

Khan (1996) explored the relative importance of public and private investments in promoting economic growth for a large group of developing countries. The results of the study showed that private and public investment have a differential impact on economic growth, with private investment having a much larger impact than public investment. Also, significant regional variations are found in terms of the effects of public and private investments. Devarajan, Swaroop and Zou (1996) focused on the composition of public expenditure and showed that whereas current public expenditure has a positive and significant growth effects, the effect of capital component of public expenditure on per-capita growth is negative.

A number of empirical studies have adopted a vector auto-regressive (VAR) approach to examine the relationship between government investment and economic growth. By imposing as little economic restrictions as possible, this modeling technique tries to solve some of the problems inherent in the production and behavioural approaches. As advantage of VAR models is, for instance, that no a priori causality directions are imposed or other identifying conditions derived from economic theory are needed. Indirect effects of public investment are also taken into account. Using the VAR approach, Sturm (1998) found that infrastructure investment positively influences output in the Netherlands. Using the same approach to analyze the dynamic effects of public investment for six industrial countries, Mittnik and Neumann (2001) established that public investment tends to exert a positive influence on GDP. Furthermore, they found no crowd-out effect between public and private investment. Navy (2002) examined the relationship between economic growth, public and private investment using VAR methodology. Based on annual TS data for Pakistan, the analysis suggested that public investment has a positive impact on private investment and that economic growth drives both private and public investment as predicted by the accelerator-based models.

Despite all these findings, the debates on the proper econometric modeling have tended to dominate the disagreements among academics and other researchers on how much infrastructure matters. The discussion covered poor choice of explained variable (GDP level or growth, measured in physical or in monetary terms, …), functional forms (Cobb-Douglas, translog, log, linear or log-linear, …), data stationarity issues and untreated endogeneity (how certain are we that the model accounted for the two way causality between growth and infrastructure?) (Estache and Garsous, 2012). Comparability of the results is also a challenge when interpreting this literature.

In analyzing the impact of infrastructure on economic growth, the definition of infrastructure is another obstacle in the debate as the level of the impact of infrastructure on the level of GDP and its long term impact on the economy. Others use physical stocks or their valuation, with more relying on the stocks of public capital or specific subsectors as proxies for infrastructure due to the availability of data compared to the valuation criteria. Using public capital as a proxy to infrastructure, Romp and de Haan (2007) in their critical survey of the impact of public capital on economic growth, they concluded that public capital positively affect economic growth though the impact seemed to be lower than expected. Bom and Lighthart (2009 focusing on research on the output elasticity of public capital, they conduct a meta-analysis of all comparable studies and found it to average across studies at around 0.08—i.e. a 1% increase in the stock of public capital would lead to a 0.08% increase in GDP, keeping in mind that this is an average that hides much higher sector specific payoffs achieved in some of the subsectors, in particular in infrastructure only, the elasticity of growth is 2.5 times what it averages out to be for total public capital.

2.5 Chapter Summary

This chapter reviewed the literature related to the aspects under study. It starts by giving the definition of economic growth and theories attached it from fathers of economics to the modern time economists. The general observation from all these reviews is that there is no consensus on the definition of public infrastructure, how to analyze its impacts on economic growth and the source and direction of the impact. With these in mind, the gap between the two major economic thoughts: the Wagner's law and the Keynesian hypothesis still remains wide. As one of the disputing facts of this disagreement is the methods of how to analyze, the following chapter gives the methodological aspects to be followed in this study.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

A methodological research approach is a framework that binds research together so that the research questions can be analyzed effectively (Edmunson and McManus, 2007). Identification of a suitable research method is important because it makes the collection of data easier and gives a clear idea about the required information (Trochim and Donnelly, 2006). Hence, this chapter gives a detailed exposition of the data and methodological approach that has been followed to answer the primary and secondary research questions.

3.2 Study Design

This is a retrospective study that takes a quantitative approach in observing the direction of the relationship between government spending on roads infrastructure and economic growth. Punch (2005) states that quantitative research is typically directed at theory verification and related to numerical data. It uses times series data which is best for a country specific research and this can avoid some of the econometric and sampling problems (Kweka and Morrissey, 2000). A time series study of a country is potentially more informative, though the findings cannot be generalized to other countries. This study uses this approach as it involves an empirical exploration of quantitative aspects of public expenditure on road infrastructure against the GDP in Malawi.

3.3 Data

The data that is used to conduct the empirical investigation are aggregates of annual time series, at current prices, and cover the period from 1978 to 2010. Gross Domestic Product (GDP) is used as a proxy for economic growth and as the explained variable, while the explanatory variables are public investment on roads (RE), private investment (PI) and public consumption (PC). Both PI and PC capture physical capital formation which is considered as one of the most important determinants of economic growth (Kormendi, 1985; Aaron, 1990; Fischer, 1993; Duggal, *et al.*, 1995). The disaggregation of investment into public and private components not only allows estimation impact of the two types of investments on economic growth, but also sheds light on the question of whether or not public investment crowds out private investment. This question has received wide attention in the literature.

In line with a number of earlier studies on economic growth, most notably Kormendi and Miguire (1985) and Grier and Tullock (1989), PC is also included in the analysis. It is generally argued that PC can either promote or impede the process of economic growth depending on the nature of such expenditures. For instance, expenditure on the provision of public goods would foster growth only if it does not divert resources from other productive uses. All data series in this study are transformed to natural logarithms so that their first differences approach the growth rates. From an economic point of view, this transformation also allows us to interpret the coefficient estimates in term of elasticity. Table 3.1 gives the descriptive statistics of the variables used in the analysis.

Table 3.1: Descriptive statistics of the dataset.

Variables	N	Range	Mini-mum	Maxi-mum	Mean	Std. Deviation	Jarque-Bela
LGDP	33	2.984	2.904	5.888	4.265	0.996	2.88(0.2366)
LRE	33	3.867	0.441	4.308	2.045	1.314	4.24(0.1198)
LCE	33	3.069	2.804	5.873	4.249	1.039	2.95(0.2286)
LPI	33	3.413	7.678	11.091	9.127	1.133	2.74(0.2535)

Note: Figures in brackets are p-values

Table 3.1 gives a summary of all variables. These summaries are sample mean standard deviation, sum, minimum, maximum, range and jarque-bera. During the period under study, LGDP had a mean of US$4.265 million while the maximum was US$5.888 million with a standard deviation of US$0.996 million. This signifies a very high variability and a sign that it has been growing considering the range which has a minimum of US$2.984 million and a maximum of US$5.888 million. Expenditure on roads (RE) had a mean of US$2.045 million while the maximum was US$4.308 million and minimum of US$3.867 million with a standard deviation of US$1.314. This is also a sign of high variability though there is a sign of increasing trend. Private investment (LPI) had a mean of US$9.127 million and a maximum of US$7.678 million and a minimum of US$3.413 million with a standard deviation of US$1.133 million. There is also a sign of variability within this variable during the period under consideration. Public consumption expenditure (LCE) had a mean of US$4.249 million, a maximum of US$5.873 million and a minimum of US$2.804 with a standard deviation of US$1.039 million. A sign of variability is also evident in this variable. However, all variables are normally distributed as their respective Jarque-Bela (J-B) (Jarque and Bera, 1980) test statistics show the existence of normality at 5% significance level as they are all above 0.05. The null hypothesis for J-B test for normality is that a variable is normally distributed versus no normality alternative. The testing rule is that we reject the null hypothesis if p-value is less than 0.05. In this case there is no enough evidence to reject the null hypothesis at 5% significance level.

3.4 Methodology

Most empirical studies on economic growth measures the impact of the infrastructure through the standard production function where factors are gross complements. Hence, an increase in the stock of infrastructure capital should have a direct, increasing effect on the productivity of the other factors. These approaches measure the impact of infrastructure capital in terms of some estimates of output elasticity. However, recent studies such as those of Romp and de Haan (2005); Bom and Ligthart (2008); Straub (2011); Estache and Garsous, (2012) pointed out a number of weaknesses in the methodology and estimation of these approaches on measuring the impact of infrastructure capital on economic growth. These weaknesses include the presence of likely potential reverse causality between output and infrastructure investment, which can generate an upward bias in the estimated coefficients. This study shall employ investigative and empirical methods to analyze the relationship between government spending on roads infrastructure and economic growth in Malawi in the period that span from 1978 to 2010. The causal link between government expenditure and economic growth is derived from the Keynesian concept of growth resulting from increased expenditure. Thus, the study uses the Johansen multivariate approach for the analysis. The empirical methodology to be followed in this study involves the following three step procedures. We begin by performing an integration analysis using unit root tests.

Non-stationarity of econometric variables involved in an analysis leads to violation of classical assumption of standard regression methods and to spurious estimates. The possible endogeneity of regressors is a problem not well handled by ordinary least squares (OLS) methods. Mostly, the sample sizes available for data analysis are small leading to small sample bias estimates. Classical regression properties hold for cases where variables are stationary (integrated of order 0) while by contrast most economic variables are integrated of order 1 or higher (and hence do not satisfy these assumptions), but that where the error correction mechanisms or long-run relationships exist, certain combinations of $I(1)$ variables are likely to be $I(0)$ and hence amenable to OLS estimation. Where this is so, the variables are said to be co-integrated and OLS estimates of such co-integrated variables may be super consistent in the sense of collapsing to their true values more quickly than if the variables have been stationary.

Seminal work by Granger and Newbold (1974) casts doubt on empirical evidence based on regression analysis using non stationary variables. Thus, to avoid the problem of spurious regression and failure to account for the dynamic specification, we follow most existing empirical studies by using the Augmented Dickey-Fuller (hereafter ADF) and Kwiatkowski, Phillips, Schmidt and Shin (hereafter KPSS). The second step tests for co-integration among the variables under study. The third step examines the temporal causality between the variables.

Time series data consist of observations, which are considered as a realization of random variables that can be described by some stochastic processes. The concept of "stationarity" is related to the properties of this stochastic process. In this study, the concept of "weak stationarity" is adopted; meaning that the data are assumed to be stationary if the means, variances and covariances of the series are independent of time, rather than the entire distribution. Non-stationarity in a time series occurs when there is no constant mean μ, no constant variance σ_t^2, or both of these properties. It can originate from various sources but the most important one is the unit root.

3.4.1 Unit Root Tests

Implementing the Johansen's Co-integration method involves some initial testing of the time series to ensure I(1), in other words testing for unit roots. The unit root test has become a widely popular approach to test for stationarity. The first step is to perform an integration analysis to examine whether each variable is level stationary ($I(0)$) or difference stationary ($I(d)$) using the unit root tests so as to avoid the problem of spurious regression (Granger and Newbold, 1974). There are several ways of testing for the presence of a unit root: DF test, ADF test (Dickey and Fuller, 1979, 1981), PP test (Phillips and Perron (1988) and KPSS test (Kwiatkowski et al.,1992). When the number of observations is low, unit root tests have little power (Chebbi and Boujelbene, 2008) and ADF and PP test almost give similar results while ADF is an extension of DF. For these reasons, this study employs the ADF test and the KPSS test unit root tests to determine the existence of a unit root. The standard ADF and KPSS testing principles have different null hypotheses whereby ADF tests the null hypothesis of unit root and KPSS tests the null hypothesis of stationarity. A commonly applied formal test for the existence of a unit root in data is the DF test and its simple extension, the ADF test (Harris, 1985). The augmentation is the addition of lagged values (p) of the first differences of the dependent variable as additional regressors that are required to account for the possible occurrence of autocorrelation.

3.4.1.1 Augmented Dickey-Fuller (ADF) Test

Dickey (1976), and Dickey and Fuller (1979, 1981) developed a method for testing the stationarity of a time series variable by directly testing the null hypothesis of the unit root (non-stationarity). The original Dickey-Fuller (DF) test is based on a simple autoregressive of order one, AR (1) process with a white-noise disturbance. However, because the DF test regression does not include values of variables beyond one lag, the error terms may be serially correlated; results based on such tests may be biased and are not valid (Davidson and Mackinnon, 1999; Gujarati, 2004; and Kirchgassner and Wolters, 2007). The ADF test avoids this problem because it corrects for serial correlation by adding lagged-difference terms (Greene, 2003).

Generally, DF and ADF test (Dickey and Fuller, 1979) can be shown as follow:

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \varepsilon_t \qquad (3.1)$$

Where Δ is the first difference operation, ε_t is the stationary random error and y_t is $LGDP_t$, LRE_t, LCE_t, LPI_t . The null hypothesis for this test is $\delta = 0$. If the null hypothesis $\delta = 0$ is not rejected, then the dataset for y_t contains a unit root (not stationary).

$$\Delta y_t = \alpha_0 + \delta y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i-1} + \varepsilon_t \quad (3.2)$$

where p is autoregressive level that is AR(p) which is suitably selected based on the smallest Akaike Information Criterion (AIC) value. The hypothesis $\delta = 0$ will be rejected if δ is significant (negative).

After estimating the equations, the appropriate critical values to be used to test for the presence of a unit root are provided by the Dickey-Fuller test, in which the critical values are different for three regressions. After estimating the equations with OLS, the resulting '*t*' statistics are compared with the respective critical values given in the Dickey-Fuller tables. However, MacKinnon (1991) has implemented a much larger set of simulations than those tabulated by Dickey and Fuller. In addition, MacKinnon estimates the response surface using the simulation results, permitting the calculation of Dickey-Fuller critical values for any sample size and for any number of right-hand variables. Therefore, in this study, MacKinnon critical values are used for the unit root test. If the *t*-calculated value is less than the MacKinnon critical value, the null hypothesis of the presence of the unit root will not be rejected.

However, to perform Augmented Dickey-Fuller (ADF) test, firstly we need to specify whether to include a constant, a constant and a linear trend, or neither in the test regression. One approach would be to run the test with both a constant and a linear trend since the other two cases are just special cases of this more general specification. However, including irrelevant regressors in the regression will reduce the power of the test to reject the null hypothesis of a unit root. To overcome this problem, the form of test regression can be based upon the graphical inspection of a series (Verbeek 2004). If the plot of the data does not start from the origin, then the estimation equation should include a constant. If the plot of the data indicates the apparent upward or downward trend, then the trend term should be contained in the regression. The main criticism of the Augmented Dickey-Fuller (ADF) test is the power of the test is very low if the process is nearly non-stationary which means the process is stationary but with a root close to the non-stationary boundary (Brooks 2002).

3.4.1.2 Kwiatkowski-Philips-Schmidt-Shin Tests (KPSS)

The ADF test takes the existence of a unit root as the null hypothesis. This has been the subject of much criticism. For example, De Jong et. al., (1989) argued that the ADF test has low power against stationary alternatives that are nearly non-stationary. To overcome this major problem, KPSS (Kwiatkowski et al., 1992) propose a test of the null hypothesis that an observable series are stationary around a deterministic trend. The asymptotic distribution of the statistic is derived under both the null and alternative hypotheses that the series are difference stationary. The results of this can be compared with the ADF procedure to see if the same conclusion is obtained. For the conclusion to be robust both test conclude that the series is stationary or non-stationary, respectively. By testing both the unit root and the stationarity hypotheses, we can distinguish series that appear to be stationary, series that appear to have roots and series for which data (or the test) are not sufficiently informative to be sure whether they are stationary or integrated. If the hypothesis of non-stationary of the individual series is rejected, then we cannot go any further. By contrast, if the hypothesis is not rejected, then it is correct and advisable to test for a unit root of the first difference of the series in question in order to exactly specify the order of integration.

KPSS test is the one-sided Lagrange multiplier test of the null hypothesis of trend stationarity that corresponds to the hypothesis that the variance of the random walk equals zero. The asymptotic distribution of the statistic is derived under the null and alternative hypotheses that the series is difference-stationary. The test is based on the regression:

$$y_t = x_t + \beta_t + \varepsilon_t \tag{3.3}$$

Where the tome series y_t is decomposed into: the sum of deterministic trend, t; ε_t is the error term and x_t is a random walk. Hence,

$$x_t = x_{t-1} + v_t \tag{3.4}$$

Here, the disturbance term $\mathrm{v_t}$ is i.i.d $(0, \sigma_\mathrm{v}^2)$. The stationary null hypothesis is $\sigma_\mathrm{v}^2 = 0$. If the null is accepted, then the error term disappears and $\mathrm{x_t}$ becomes a constant. This means that the time series, $\mathrm{y_t}$, is characterized by a deterministic trend. If the null is rejected, then the time series has a unit root with a constant. The critical values of the KPSS test are tabulated in Kwiatkowski et al., (1992).

3.4.2 Co-integration

Empirical research in economics like the one to be carried out in this study is based on time series. Therefore, it is standard to view time series as the realization of a stochastic process. Model builders can use statistical inference in constructing and testing the equations that characterize relationships between economic variables. The two central properties of many economic time series that have led to many applications in both economics and statistics are non-stationarity and time-volatility (Wei, 2006).

Non-stationarity is a property common to many applied time series. This means that a variable has no clear tendency to return to a constant value or linear trend. It is generally correct to assume that economic processes have been generated by a non-stationary process and follow stochastic trends. One major objective of empirical research in economics it to test hypotheses and estimate relationships derived from economic theory, among other such aggregated variables (Pfaff, 2006).

The classical statistical methods used in building and testing large simultaneous equation models, such as Ordinary Least Squares (OLS), were based on the assumption that the variables involved are stationary. The problem is that the statistical inference associated with stationary processes is no longer valid if time series are a realization of non-stationary processes. If time series are non-stationary it is not possible to use OLS to estimate their long-run linear relationships because it would lead to spurious regression. Spurious regression is a situation in which there appears to be a statistically significant relationship between variables but the variables are unrelated. A few decades ago the difficulty of non-stationarity was not well understood by model builders. However, this is no longer the case because the technique of co-integration has been introduced according to which models containing non-stationary stochastic variables can be constructed in such a way that the results are both statistically and economically meaningful.

Co-integration is an econometric concept which mimics the existence of a long-run equilibrium among economic time series. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then they are said to be co-integrated (Wei, 2006). Co-integration analysis was introduced by Engle and Granger in the early 1980s, with improvements and additions in subsequent years. It is a modeling process that incorporates non-stationarity with both long term relationships and short term dynamics. To examine time series in financial data using co-integration, the series in its level form should be non-stationary and integrated of order 1, written as I(1). Integration of order 1 means the series become stationary after differencing it once. Variables are to be co-integrated if they are I(1) and have a linear combination which is stationary without the need to differentiate the data.

Co-integration is the underlying methodology we have used to analyze the relationships between the economic growth and public expenditure on roads in the presence of other factors such as private investment and public consumption to determine possible positive effects. It allows us to identify co-movements between these variables where if co-integration exists, positive effects are realized. As per our literature review, co-integration is recognized as an acceptable method in analyzing co-movements. We should be concerned about co-integration because it is a possible solution to non-stationarity found in many economic time series, and if time series are non-stationary the assumptions upon which OLS estimation rest are violated, rendering its application inappropriate.

Previously, the usual procedure for testing hypotheses concerning the relationship between non-stationary variables was to run OLS regressions on data which had initially been differenced. Data are differenced in order to reduce non-stationary series to stationarity. Although this method is correct in large samples, it may give rise to misleading inferences or spurious regressions in small samples. Moreover, estimation of a single equation framework with integrated or non-stationary variables tends to create the following problems: non-standard distribution of the coefficient estimates generated by the process not being stationary, explanatory variables generated by the process that display autocorrelation, the existence of more than one co-integrated vector and tendency to weak exogeneity (Banerjee et al., 1993).

The remedy for problematic regressions with integrated variables is to test for co-integration and to estimate a vector error-correction model to distinguish between short-run and long-run responses, since co-integration provides more powerful tools when the data sets are of limited length. The technique of co-integration and the error-correction model have both been used before in modelling a number of studies, for example, in modelling Danish gasoline demand (Bentzen et al., 1995), the road transport energy demand for Australia (Samimi, 1995), demand for coal in India (Kulshreshtha and Parikh, 1999), coal demand in China (Chan and Lee, 1997) and the United Kingdom's final user energy demand (Fouguet et al., 1997). In these studies, the multivariate Johansen co-integrating framework was used to ascertain the co-integrating rank.

The infrastructure and economic growth theory in this study is based on the very same concept. The test is carried out by investigating the co-integration relationships between series of various factors (GDP, CE, PI, RE). There are at least three methods that can be used in analyzing the co-integration between and among variables in time series: Engle-Grange (1989) two step estimation procedure, Phillips-Ouliaris (1990) residual based test and Johansen's multivariate technique. Johansen's Maximum Likelihood Method using either the Trace Statistic and/or the Maximum Eigenvalue Statistic.

Our study uses the Johansen's Method due to reasons mainly relating to the shortfalls of Engle-Grangers Two Step Estimation Method and Phillips-Ouliaris residual based test. The Two Step Estimation Method is very easy to run, however it needs a larger sample size to avoid possible estimation errors and can only be run on a maximum of two variables (Brooks, 2008). It also doesn't allow for hypothesis testing on the co-integrating relationships themselves, unlike Johansen's method (Brooks, 2008). Since we are also examining a total of 5 variables, we want the ability to examine them in a multivariate framework, allowing for the possible discovery of more than one co-integrating vector, which the Engle-Granger and Phillips-Ouliaris methods cannot accomplish. In this situation, Johansen's method better suits the data, due to the fact that it can examine more than two test variables, and can treat all test variables as endogenous.

3.4.3 Multivariate Johansen-Juselius Co-integration Tests

After examining the stationarity conditions of the data, the second step of the analysis is to test for co-integration among the non-stationary variables. Recently, long-run linear relationships among variables in the presence of short-run deviations from the long-run equilibrium are checked, using co-integration test. In the face of non-stationary series with a unit root, the first differencing appears to provide the appropriate solutions to ensuring series are weakly stationary. The first differencing, however, does possess a major limitation in that it tends to ignore the long-run properties of the data. If two time series y_t and x_t are both integrated of order d (i.e. $I(d)$), then, in general, any linear combination of the two series will also be I(d); that is, the residuals obtained on regression y_t on x_t are I(d). If, however, there exists a vector b, such that the disturbance term from the regression ($\varepsilon_t = y_t + \beta_t$) is of a lower order of integration

I(*d*-*b*), where b>0, then Engle-Granger (1987) define y_t and x_t as co-integration of order (*d, b*).

The concept of co-integration, first introduced into the literature by Granger (1987), is relevant to the problem of the determination of long-run or "equilibrium" relationships in economics. Co-integration is the statistical implication of the existence of a long-run relationship between economic variables (Thomas, 1993). In other words, from a statistical point of view, a long-term relationship means that the variables move together over time so that short-term disturbances from the long-term trend will be corrected (Manning and Andrianacos, 1993). The basic idea behind co-integration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989). A lack of co-integration suggests that such variables have no long-run relationship: in principal they can wander arbitrarily far away from each other (Dickey *et. al*., 1991).

There are several methods that can be applied in estimating co-integration models such as Engle-Granger (1989) two-step estimation, the autoregressive distributed lag (ARDL) Pesaran and Shin (1999), the Phillip-Ouliaris (1990) residual based and the Johansen-Juselius multivariate approach. This study follows the methodology developed and used by Johansen (1988, 1991) and Johansen and Juselius (1990) to identify the long-run relationship among the variables in a multivariate model. This is so as more variables are included in the model, the possibility of multiple co-integration vectors cannot be ruled out. This procedure accommodates the possibility of multiple co-integrating vectors (Brooks, 2002). Thus the Johansen and Juselius (1990) approach has the advantages over the Engle-Granger and the Phillips-Ouliaris methods in that it can estimate more than one co-integration relationship if the data set contains two or more time series. It also permits the estimation of the model without priority restricting the variables as endogenous and exogenous. It is used to determine how each endogenous variable responds over time to a shock in that variable and in every other endogenous variable.

The main feature of Johansen-Juselius approach to testing co-integration is taking the rank of the Π matrix. This rank is equal to the number of independent co-integration vectors. Evidently, if the rank of $\Pi = 0$, i.e. the matrix is null, it would indicate a usual VAR model in the first difference. However, if the matrix has a rank $\Pi = 1,$ then there is a single co-integrating vector and the expression Πx_{t-1} represents the error correction vector (ECV).

Johansen (1990) proposed two tests that can be used to identify the co-integrating rank. The first test is based on the maximum likelihood estimation (MLE) towards k dimensional vector auto-regression (VAR) at level p,

$$\Delta Z_t = \mu + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{k+1} \Delta Z_{t-p+1} + \Pi Z_{t-1} + \varepsilon_t \qquad (3.5)$$

where Z_t is k x 1 stochastic variable vector, μ is k x 1 constant vector, ε_t is k x 1 random vector, Π and $\Gamma_1, \dots, \Gamma_{k+1}$ is k x k parameter matrix. Meanwhile, if the coefficient matrix Π has reduced level, $r < k$, therefore the matrix can be simplified to $\Pi = \alpha\beta'$. This test involves level testing for matrix Π by examining whether the eigenvalue for Π is significantly different from zero. There are some conditions where it might be true, which are: (i) $r = k$ meaning that Z_t is stationary at the level, (ii) $r = 0$ meaning that Z_t is the autoregressive vector, (iii) $0 < r < k$ which means that there is r linear combination towards Z_t which is stationary or co-integrated.

The second test is based on Trace likelihood ratio which is given as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p-2} \ln(1 - \hat{\lambda}_i) \qquad (3.6)$$

where $\hat{\lambda}_{r+1}, \ldots., \hat{\lambda}_p$ is the smallest eigenvalue on the estimated $p - r$. The null hypothesis for the Trace eigenvalue test is where there are almost r co-integrating vectors. Meanwhile L-max can be calculated as:

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{3.7}$$

The null hypothesis for Maximum eigenvalue that the *r* co-integrating vector is tested compared to alternative hypothesis on co-integrating vector r +1. If the Trace eigenvalue and Maximum eigenvalue tests result in different decisions, then the decision result of Maximum eigenvalue test should be used because the force of Maximum eigen value test is bigger when compared to Trace eigenvalue test (Johansen and Juselius 1990). However, if these tests fail to justify the existence of a co-integrating vector, then only the short-run relationship in first difference should be modelled, including all appropriate lags using OLS.

3.4.4 Causality Testing - TYDL Procedure

The final step is to examine the temporal causality between variables. Once the variables are found to be co-integrated, then there must be Granger cause in at least one direction to hold the existence of long run equilibrium relationship. After specifying the unrestricted system, the causal relationship between and among the variables are assessed using Granger concept of causality. Granger causality testing (GCT) was pioneered by Granger (1969). GCT is a technique for determining whether one variable is significant in forecasting another. The standard GCT seeks to determine whether past values of a variable helps to predict changes in another variable (Granger, 1988). The definition of GCT states that in the conditional distribution, lagged values of *Y* add no information to explanation of movements of *X* itself (Green, 2003).

Suppose we have two variables $Y$and X. This technique says that *Y* is Granger caused by *X* if *X* assists in predicting the value of *Y*. If this is true then it means that lagged values of *X* are statistically significant in explaining *Y*. The null hypothesis (H_0) that we test in this case is that *X* does not granger cause *Y* and *Y* does not granger cause *X*. In summary, X_i is said to granger cause Y_i if the lagged values of X_i can be used to predict Y_i and *vice versa*. The test in this study is based on the following regressions:

$$Y_t = \beta_0 + \sum_{k=1}^{M} \beta_k Y_{t-k} + \sum_{l=1}^{N} \alpha_l X_{t-l} + \varepsilon_t \tag{3.8}$$

$$X_t = \gamma_0 + \sum_{k=1}^{M} \gamma_k Y_{t-k} + \sum_{l=1}^{N} \delta_l X_{t-l} + \upsilon_t \tag{3.9}$$

where Y_t and X_t are variables to be tested, and ε_t and υ_t are mutually uncorrelated errors, and *t* denotes the time period and *k* and *l* are the number of lags. The null hypothesis to be tested is:

$H_0: \alpha_l = \delta_l = 0$ for all l (X does not granger cause Y). (3.10)

The alternative hypothesis is:

$H_a: \alpha_l \neq 0 \; and \; \delta_l \neq 0$ for at least some l (X granger causes Y). (3.11)

After the analysis, if the coefficients α_l are significant but δ_l are not, then *X* Granger causes *Y*. In reverse case, *Y* causes *X*. But if both α_l and δ_l are significant, then the causality runs both ways. The null hypothesis is tested by using the standard *F*-test of joint significance. The *F*-test is given as follows:

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)} \tag{3.12}$$

Where RSS_R and RSS_{UR} are the restricted and unrestricted residual sum of squares respectively. *M* is the number of lags, *n* is the number of observations and *k* is the number of parameter in the unrestricted equation. If the computed *F*-value exceeds the critical *F*-values at the chosen level of significance, the null hypothesis is rejected. In this study, this would imply that macroeconomic variable(s) granger cause or improve(s) the prediction of the economic growth and vice versa.

However, a general problem that emerges when testing for Granger causality in TS analysis is the possible existence of stochastic trends in the variables. Sims et al., (1990) and Toda and Phillips (1993) reported that the traditional *F*-test and Wald tests used in to determine whether the VAR parameters are stable and jointly zero are not valid for *I*(1) processes because the test statistics do not have standard distributions. In addition, Giles and Mirza (1999) argued that pretesting for unit root and co-integration may induce an over-rejection of the non-causal null hypothesis because unit root and co-integration tests tend to suffer from size distortion. Furthermore, in common practice, when the variables are co-integrated, the error correction model (ECM) and VECM can be used to examine the causal relationship. However, Rambaldi and Doran (1996) argued that both ECM and VECM specification for testing the causal relationship are cumbersome and sensitive to the values of nuisance parameters in particular when the sample size is relatively small (see also Zapata and Rambaldi, 1997). Yamada and Toda (1998) conducted a Monte Carlo simulation study to examine the performance of three causality tests in small sample. The simulation results indicated that among the three causality tests, TYDL is the most stable approach. Furthermore, the ECM and Fully-Modified VAR (FM-VAR) causality approaches tend to have larger size distortion than the TYDL approach.

In order to overcome these short comings, Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) referred to as TYDL hereafter, recommended a lag-augmented test for non-causality within VAR system to verify the causal relationship between econometric variables. Co-integration is only able to indicate whether or not a long-run relationship exists between the variables; it does not provide information on the direction of causal relationships. The TYDL is applicable irrespective of integration and co-integration properties of the model. Therefore, we prefer to use the TYDL causality test in this study.

The TYDL procedure basically involves estimation of an augmented VAR ($k+d_{\max}$) mode, where k is the optimal lag length in the original VAR system and $d_{\max}$ is the maximal order of integration of the variables in the VAR system. The Granger causality test employed in TYDL procedure utilizes a modified Wald (MWALD) test statistics to test restrictions on the parameters of the VAR(k) model. The remaining $d_{\max}$ autoregressive parameters are assumed zero and ignored in the VAR(k) model. The reason for ignoring the $d_{\max}$ parameter is that it helps to overcome the problem of non-standard asymptotic properties associated with standard Wald test for integrated variables. Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) suggested over-fitting the VAR order and ignoring the extra parameter ($d_{\max}$) in testing for Granger causality. Rambaldi and Doran (1996) showed that using MWALD standard for testing Granger causality can be made computationally simple by using a seemingly unrelated regression (SUR) framework. Two steps are involved in the implementation procedure.

The first step in testing the causality includes the determination of the lag length (k) and the maximum order of integration (d) of the variables in the system. Measures such as the Akaike Information Criterion (AIC) and Hannan-Quinn Information Criterion (HQIC) can be used to determine the appropriate lag structure of the VAR. Given that the VAR(k) is selected, and that the order of integration d is determined, a level VAR can then be estimated with a total of $p = [k+d_{\max}]$ lags. The second step is to apply standard Wald tests to the first k VAR coefficient matrix (but not all lagged coefficient) to conduct inference on Granger causality.

The advantages of using TYDL approach to assess the causal relationships between PI, CE, RE and GDP are that the estimation procedure guarantees the asymptotic Chi-Square distribution of the Wald statistic without requiring the knowledge of the co-integrating properties of the system (Toda and Yamamoto, 19995, 225; Zapata and Rambaldi, 1997) and since equation (3.16) includes the relevant variables in the VAR based on the “new growth theory”, all of the variables are treated as endogenous within a simultaneous system (Gujarat, 2003). However, TYDL has some weaknesses as well.

Some of the weaknesses are that the approach is inefficient and suffers some loss of power since the VAR model is intentionally over-fitted (Toda and Yamamoto, 1995: 247). Kuzozumi and Yamamoto, (2000: 212) also warned that for small sample size, the asymptotic distribution may be a poor approximation to the distribution of the test statistic. Full details of the theory behind TYDL procedures have been discussed in details in other papers such as Dolado and Lutkepohl (1996) and Rambaldi and Doran (1996).

In this study, the TYDL test could be easily conducted on estimates of the following augmented-VAR system.

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \phi_t \, y_{t-1} + \psi w_t + u_t \qquad (3.13)$$

Where y_t is a (nx1) vector of endogenous variables, t is the linear time trend, α_0 and α_1 are (nx1) vectors, w_t is a (qx1) vector of endogenous variables and u_t is a (nx1) vector of unobserved disturbances where $u_t \sim N(0, \Omega)$ for $t = 1,2, \ldots., T$. The following null hypotheses are going to be tested and examined.

M1 = H0: GDP does not Granger cause RE

M2 = H0: RE does not Granger cause GDP

M3 = H0: GDP does not Granger cause CE

M4 = H0: CE does not Granger cause GDP

M5 = H0: GDP does not Granger cause PI

M6 = H0: PI does not Granger cause GDP

M7 = H0: RE does not Granger cause CE

M8 = H0: CE does not Granger cause RE

M9 = H0: RE does not Granger cause PI

M10 = H0: PI does not Granger cause RE

M11 = H0: CE does not Granger cause PI

M12 = H0: PI does not Granger cause CE

3.5 Model Estimation

To begin with, the exact functional relationship between the dependent variable and independent variables in logarithmic form (L) where y_t a function of is x_{it} can be specified using mathematical expression as follows:

$$y_t = f(x_{it}) \tag{3.14}$$

Or in a linear form

$$y_t = \alpha_0 + \beta_i x_{it} \tag{3.15}$$

Where $y_t = LGDP$ at time t, $x_{it} = LRE, LPI, LCE$ at time t, $i = 1,2, \dots, n,$ and where α_0 and β_i are unknown parameters of the model.

The purely mathematical model of the economic growth function given in equation (3.2) is of limited interest to the most researchers, for it assumes that there is an exact or deterministic relationship between LRE, LPI, LCE and LGDP. But relationships between economic variables are generally inexact because, in addition to LRE, LCE, LPI, other variables may affect economic growth. Thus, to allow for the inexact relationship between economic variables, this can be modified using the deterministic economic growth function as follows:

$$y_t = \alpha_0 + \beta_i x_{it} + \varepsilon \tag{3.16}$$

where, known as the disturbance, or error term, is a random (stochastic) variable that has well defined probabilistic properties. The disturbance term ε may well represent all those factors that affect economic growth but are not taken into account explicitly. The choice of the existing model is based on the fact that it allows for generation and estimation of all the parameters without resulting into unnecessary data mining. Normality and serial correlations have been used to test for normality of the model.

Data for analysis are those considered as relevant indicators of economic growth and the effect of government spending on critical factors in the system. Theoretically, the model says that growth rate of the economy depends on the disaggregated LER, LCE, LPI during the considered period. Thus the growth model in this study is expressed as:

$$\mathrm{LGDP} = f(\mathrm{LRE}, \mathrm{LPI}, \mathrm{LCE}) \tag{3.17}$$

Where LRE, LPI, LCE and LGDP are as defined above.

3.6 Chapter Summary

This gives the methodological aspects to be followed in this study. It starts by giving the study design, followed by variables to be included in this study that includes their source. The analysis plan to be followed in this study has also been presented such as the unit root tests (ADF and KPSS), Johansen-Juselius co-integration test, and TDYL causality test. There are several methods that have been used to analyze econometric data and the choice of the methods depends on the nature of the data and interpretability of the results. The approaches chosen in this study have fulfilled most of econometric assumptions of time series data, which are similar to the ones to be analyzed in this study. The application of these methods has resulted in what is presented in chapter four that follows.

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSIONS

4.1 Introduction

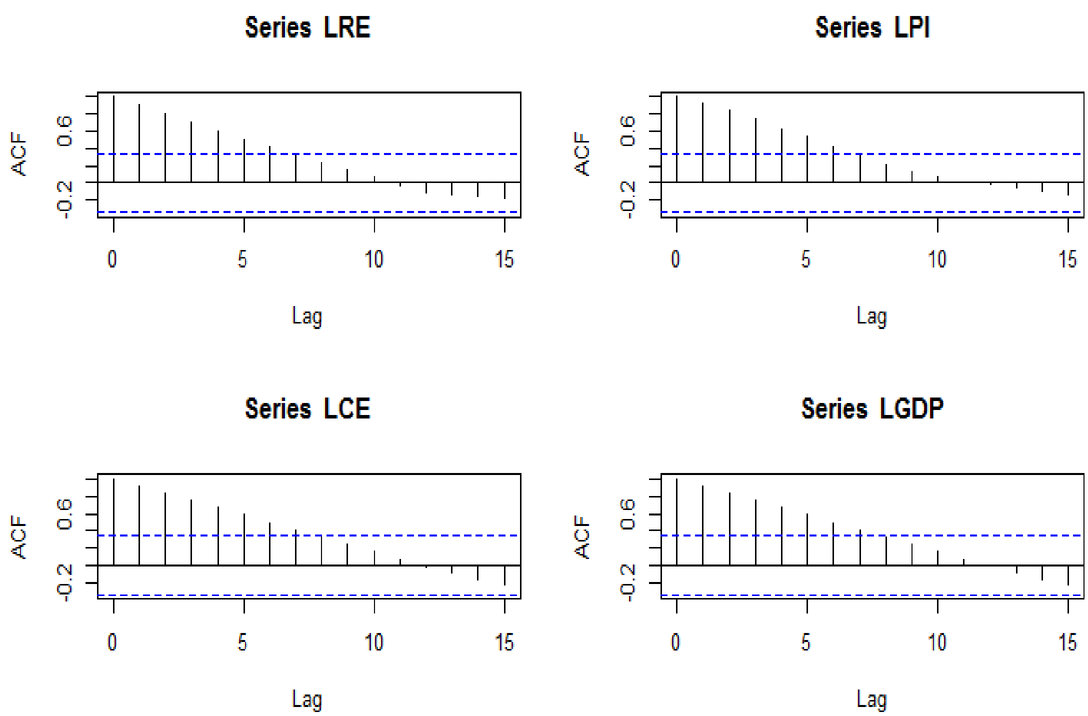
In the previous chapter the research methods were discussed. In this chapter, the data analysis, empirical findings and results and discussion of the results are presented. The chapter is structured according to the empirical procedures followed. Hence, the chapter starts with the results of the unit root tests. Thereafter, the results of the co-integration tests are presented. Having examined the stationarity and co-integrating properties of the data, the empirical model is then produced and the results of estimation tests are presented. Finally, the causality test results are presented and discussed.

The study was carried out to investigate the relationship between government expenditure on roads infrastructure and GDP in Malawi using time series data spanning from 1978 to 2010. Initially, the order of integration of the variables is investigated using standard tests for the presence of unit roots using ADF and KPSS test statistics. The second step involves testing for the integration order of variables involved through the application of Johansen-Juselius co-integration procedures. The third step involves determination of the direction of causality of the relationship of the involved variables following TYDL causality procedure.

4.2 Unit Root Test and Stationarity Results

As a first step before investigating the linkages between and among different economic variables in the study, the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test are applied to examine the stationary properties of the level series and differentiated series. However, the unit root tests were preceded by auto-correlation function (ACF) in order to gauge the number of lags that should be included in the ADF testing. Plots of the ACF's are presented in Figure 4.1 below and show that the variables have different levels of noise effects on their respective original signals. All variables (LGDP, LCE, LPI and LRE) seem to have 6 lags as their cut-off points. Thus, these cut-off points help to determine the number of lags that are to be included in respective ADF models. In addition, the unit root tests considered whether a variable has a trend or not.

Figure 4.1: ACF plots of variables



These results of the number of lags requires to be included in the ADF and KPSS and any further analysis have also been confirmed by both AIC and HQIC selection criterion.

The null hypothesis of ADF test is that the series has a unit root, whereas stationary is the null hypothesis in the KPSS test. Thus we perform KPSS test as confirmatory test of the results of ADF. But if two approaches are contradicted, KPSS is preferred. The unit root test results are presented in Table 4.1 below.

Table 4.1: Unit Root test results

	Test with intercept only				Test with intercept and trend			
	ADF test (5% CV = -3.55)		KPSS test (5% CV = 0.739)		ADF test (CV 5% = -3.50)		KPSS test (CV 5% = 0.146)	
Variable	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
LRGDP	-2.3237	-1.7871	1.7234*	0.3727	-2.3232	-2.9782	0.3098*	0.1301
LRE	-1.7688	-2.5634	1.5470*	0.0758	-2.1266	-3.0681	0.2554*	0.0598
LPI	-2.2891	-2.2639	1.6178*	0.0966	-2.4622	-2.9782	0.2449*	0.1351
LCE	-2.1215	-1.7073	1.726*	0.2293	-2.1618	-3.4646	0.2636*	0.1277

** denotes rejection of the null hypothesis at the 5% significance level*

The null hypothesis of ADF test is that a series does contain a unit root (non-stationary process) against the alternative of stationary. The null hypothesis of KPSS test is that a series is stationary process against the alternative of non-stationary process.

The trend analysis (ADF test) was conducted on variables with intercepts only and in the presence of both the intercepts and trends. This was also both on level and first differencing. The analysis was further done on variables with both the intercept and the trend and in levels as well as in difference status. Commenting on the test that included the intercept and trend, for both ADF and KPSS tests at 5% significance level, the results in Table 4.1 shows that *t*-test statistics of the ADF test for all variables in levels are lower than the critical values. For this reason, we do not have enough statistical evidence to reject the null hypothesis of presence of unit root. However, looking at the results, we have strong statistical evidence to reject the null hypothesis of presence of unit root in the first differences as the *t*-test statistics for the ADF tests are higher than the critical values.

The second test of stationarity process was conducted using KPSS tests. As it can be seen from Table 4.1, the *t*-test statistics for all variables under consideration are greater than critical values in levels. This is enough statistical evidence to reject the null hypothesis of stationarity. Contrary to this, the *t*-test statistics for KPSS in the first differences are lower than critical values. For this reason, we fail to reject the null hypothesis of stationarity. These results clearly show that all variables under investigation exhibit non-stationarity characteristics in levels both under ADF and KPSS tests. However, they become stationary in the first difference and for this reason, we treated all variables as $I(1)$ processes and thus $dmax = 1$ in the TYDL model. Having established this stationarity process, we proceeded to co-integration analysis and this follows in the next section.

4.3 Johansen Co-integration Test Results

As mentioned in Chapter Three, co-integration is used to ascertain the long run relationships between I(d) variables. To achieve this, Johansen co-integration procedure has been utilized (Johansen, 1988 and Johansen and Juselius, 1990). In this approach, there are two techniques used; the Trace test and the Maximum eigenvalue. Trace test tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of n co-integrating vector. If $r = 0$, it means that there are no relationship among the variables. The maximum eigenvalue test, on the other hand, tests the null hypothesis of r co-integrating vectors against the alternative hypothesis of (r+1) co-integrating vectors. Table 4.2 presents the results of both the Trace and Maximum eigenvalue test statistics.

Table 4.2: Johansen's Trace and Maximum Eigenvalue test results

Null Hypothesis	Alternative Hypothesis	Tests Statistic	Critical value at 5 %	Results
λ_{trace}				
$r \leq 3$	$r > 3$	7.02	9.24	Do not reject Ho
$r \leq 2$	$r > 2$	18.29	19.96	Do not reject Ho
$r \leq 1$	$r > 1$	33.93	34.91	Do not reject Ho
$r = 0$	$r > 0$	67.46	53.12	Reject Ho
λ_{max}				
$r = 3$	$r = 4$	7.02	9.24	Do not reject Ho
$r = 2$	$r = 3$	11.27	15.67	Do not reject Ho
$r = 1$	$r = 2$	15.63	22.00	Do not reject Ho
$r = 0$	$r = 1$	33.53	28.14	Reject Ho

The AIC and HQIC suggest six (6) lag length of VAR model. The trace test statistic tests the null hypothesis that the number of co-integrating vectors is less of equal to r where r = 0, 1, 2 and 3. In each case, the null hypothesis is tested against a general alternative. The maximum eigenvalue test statistic tests the null hypothesis that r = 0 against the alternative that r = 1, r = 1 against the alternative that r = 2, etc. As depicted by Table 4.2, the reported trace test statistic for the null hypothesis of no co-integration is 67.46, which is well above the critical value of 53.12 at 5% significant level. Thus, it rejects the null hypothesis of no co-integration in favour of the general alternative more than 1 co-integration vector. However, the null hypothesis of $r \leq 1$, $r \leq 2$ and $r \leq 3$ that the system contains one(1), two(2) and three(3) co-integrating vectors cannot be rejected at the 5% significant level since the reported trace statistic values of 33.93, 18.29 and 7.02 are less than their respective critical values of 34.91, 19.96 and 9.24. The test thus, concludes that there is only 1 co-integrating relationship among GDP, RE, CE and PI.

On the other hand, the maximum eigenvalue that test the null hypothesis of no co-integration is rejected at the 5% significance level as reported maximum eigenvalue of 33.53 exceeds the critical value of 28.14. The test, however, fails to reject the null hypothesis of $r = 1$, $r = 2$ and $r = 3$ as their reported maximum eigenvalues are 15.63, 11.27 and 7.02 are less than their respective critical values of 22.0, 15.67 and 9.24 at 5% significance level. This result provides additional evidence in favour of the above conclusion that there exists only 1 co-integration relationship among the four variables under investigation.

In essence, both test statistics – the trace and maximum eigenvalue reject the null hypothesis of no co-integration at the 5% significance level and suggest that there is as unique co-integration vector. Therefore, our yearly data from 1978 – 2010 appears to support the existence of long-run relationship among GDP, CE, RE and PI based on Johansen's co-integration procedure. Co-integration does not tell which series have a long-run relationship until we fit the model through equation 3.4. The next section presents the results of the long-run relationship test among the variables under investigation.

4.4 The Long-Run Relationship

Table 4.3 presents the normalized long-run relationship based on the model based on equation 3.4.

Table 4.3: Estimates of Long-Run relationship co-integration model (1978 – 2012)

Variables	Coefficients	*t*-test statistic	*p*-value
Constant	0.0312	0.302	0.765
LCE	0.8983	46.662	0.001
LRE	0.0124	1.071	0.293
LPI	0.0429	2.402	0.023

Dependent variable = LGDP, F = 1473.89, R-Sq = 0.99, p-value = 0.0001

The results of the modeling as shown in Table 4.3 shows that only consumption expenditure (CE) and private investment (PI) are significant in predicting the economic growth in Malawi during the period under investigation (1978 – 2010). The coefficients in the long-run relationship are long-run elasticities. Each coefficient measures the corresponding magnitude or extent of change in the dependent variable following a unit or percentage change in the independent variable. Measures of elasticity in both CE and Pi are elastic. This means that only CE and PI have the long-run relationship with GDP.

Now going further into the analysis of the direction of relationship between these variables, a causality test was done based on TYDL model. The results of this are presented in the following section.

4.5 Granger causality Test based on TYDL

According to Granger (1986), the existence of a co-integration relationship implies that there must be at least one direction to maintain the presence of the long-run relationship. In addition to that, verification of the causality direction also plays an important role in determining the effectiveness of policies. For example, if the causality evidence suggests that roads expenditure Granger causes economic growth, this reflects that policies prioritizing on encouraging infrastructure investment will stimulate economic growth. For these reasons, this study employed the TYDL causality test to verify the causal relationship between roads infrastructure spending and economic growth in Malawi. Prior to that, the optimal lag lengths in the VAR system must be determined as causality test is sensitive to the number of lags used (see Thornton and Batten, 1985; Xu, 1996). Both AIC and HQIC showed that 6 years lag of the VAR system in the best, therefore, the augmented-VAR with 7 lags has been performed for the causality test. The results of the VAR model for the four variables based on TYDL augmented lag method granger causality are estimated using SUR regression technique are presented in Table 4.4.

Table 4.4 Modified Wald Test Statistics of Granger causality based on TYDL procedure

Dependent Variable	CE	RE	PI	GDP
CE	-	3.2 (0.091)	0.7 (0.66)	7.4 (0.014)
RE	6.3 (0.000)	-	0.63 (0.71)	4.5 (0.043)
PI	1 (0.49)	2.3 (0.17)	-	0.7 (0.66)
GDP	2.7 (0.13)	2.7 (0.12)	0.79 (0.61)	-

NOTE: The $[k + d_{max}]th$ *order level VAR was estimated with* $d_{max} = 1$*, since the order of integration is 1. Lag length selection of k = 6 was based on AIC and HQIC test results. Reported estimates are asymptotic Wald statistics. Values in parentheses are p-values*

Twelve models were set as null hypotheses in trying to find which of the four variables Granger causes the others. There can be three causational results that can be found using these models can either be unidirectional, bi-directional or no causational at all. The results from fitting these models have shown only unidirectional relationships that exist between three variables. For instance, there was a unidirectional relationship that exists between consumption expenditure (CE) and economic growth (GDP) in that CE Granger causes economic growth (GDP) and the causality is significant at 5% level with Wald test statistic of 7.4 and *p*-value of 0.014. There is also a unidirectional causality between road expenditure (RE) and economic growth (GDP) with RE Granger causing GDP at 5% significance level with Wald test statistic of 4.5 and *p*-value of 0.043. Lastly, RE Granger causes CE at 1% significance level with Walt test statistic of 6.3 and *p*-value of 0.001. There were no relationships between these variables in the reverse direction. The coefficients of the three significant models M2, M4 and M6 are positive meaning that the causation is positive i.e. consumption expenditure positively Granger causing economic growth, public road expenditure positively Granger causing economic growth.

4.6 Economic Implication for Policy Makers

The results of fitted models show that there is unidirectional relationship that exists between the three variables. As there is a unidirectional causality between road expenditure (RE) and economic growth (GDP) with RE Granger causing GDP, Policy makers in Malawi can use this as a development tool. Policy makers should ensure that that recurrent and capital expenditure on road infrastructure is efficiently utilized, which is in support of Keynesian views.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study was set out to empirically investigate the growth impact of government sectoral expenditure on roads infrastructure on economic growth in Malawi using Johansen's multivariate approach. The study used annual time series econometric data covering the period of 33 years (1978 - 2010) collected from government ministries and departments. Four variables namely; GDP, CE, RE and PI are included in the analysis. GDP is used as a proxy to economic growth, which is the explained variable, RE captures government expenditure on roads, CE captures public consumption expenditure and PI captures private investment expenditure.

The main goal of this study was to investigate the impact of specific government expenditure on roads infrastructure on economic growth. In this respect, growth model was taken as a function of government expenditure. However, private investment expenditure (PI) was included in the analysis to capture physical capital formation, which is considered as one of the most important determinants of economic growth and helps to shed more light on whether or not public investment crowds out private investment. As it is argued that consumption behavior can either promote or impede economic growth process, CE was included to capture spill-over effects of public consumption behavior.

To avoid much variability within each variable was transformed using natural logarithm function. Descriptive statistical techniques were adopted to give a quantitative description of the pattern of the data and develop a general trend and summarize it. The empirical methodology followed in this study involves three step procedures. The stationarity analysis was done using ADF and KPSS unit root tests, the co-integration analysis was done by employing the Johansen and Juselius multivariate procedure and TDYL inferential statistical technique was also adopted to empirically infer on whether there is a causality relationship between public expenditure on roads (RE) and economic growth (GDP).

Public expenditure has been a cardinal objective of all successive governments since Malawi gained its independence in 1964. Successive administrations have on different occasions made attempts to direct government spending towards achieving objectives that have direct bearing on its populace. However, the attainment of this goal is subject to both endogenous and exogenous factors. ADF and KPSS Unit Root tests were conducted on the variables to investigate the stationarity property. From the Augmented Dickey-Fuller (ADF) test, we found that the variables were integrated of the order one, that is $I(1)$.

Having established the stationarity properties of the variables, the order of integration was next employing the Johansen-Juselius multivariate co-integration procedures. The Trace and Maximum eigenvalue test statistics were used to determine the integration order in this procedure. Economic growth and government expenditure on roads are having the long-run relationship, which means that these variables take longer time to reach equilibrium. The test of causality shows that government expenditure on roads infrastructure positively Granger causes economic growth. This impact is unidirectional; that is the relationship is from the expenditure to economic development and not the other way, which supports the Keynesian hypothesis that government expenditure affects economic growth.

Empirical literature on the relationship between public investment in infrastructure especially transport and communication and economic growth has reported a mixed picture, sometimes significant and positive, sometimes significant and negative and sometimes insignificant. The results of the analysis have shown that during the study period, though there have been three different administrations all of which inclining towards increased expenditure on infrastructure development such as roads as a means of developing the economy, and there is an evidence of influence of public spending on economic growth in a long-run. The study, therefore, concludes that government spending on road infrastructure results in economic growth, which confirms the main goal of MGDS of achieving economic growth through infrastructure development.

Hence, these results suggest that policy-makers should ensure that capital and recurrent expenditure are properly managed to accelerate economic growth. This can be achieved by promoting efficient and effective allocation of resources mainly on human capital development to encourage more private sector participation so as to ensure productivity to ensure intensive economic growth.

5.1 Limitations of the study results

As it was revealed in the literature review that there are growing misunderstandings among researchers, economists and policy makers on the actual role of infrastructure in an economy, the division between two extreme economic thoughts (Wagner's and Keynes) still remain intact. Among other disagreements are definitions of infrastructure, quantification, analysis methods. This study though it has established that the relationship between economic growth and public expenditure belongs to Keynesian group, there are several limitations that might have influences the results. Some of these limitations are:

1. Though there is a long-run relationship between economic growth and public expenditure on roads, the study did not establish the actual period when the effects start to be realized in the system.
2. The coverage in terms of variables was narrow to strictly observe the actual contribution to economic growth as there are several factors that collectively affect the economy.

5.2 Recommendations for Future Research

The research and analysis on the relationship between macroeconomic variables is a complex issue such that it is difficult to find all components of economic variables that are exhaustive and exclusive. This might be due to the nature, scope and aims of the study. The study recommends that in future, the choice of macroeconomic variables, which are mostly related should be expanded to accommodate more that can shed more light on the effects of the relationship.

REFERENCES

Aaron, H. J. (1990). Discussion in Alicia H. Munnell ed., Is There a Shortfall in Public Capital Investment? Boston: Federal Reserve Bank of Boston, 1990, pp. 51- 63.

Argy, F., Lindfield, M., Stimson, B. and Hollingsworth, P. (1999). Infrastructure and Economic Development. CEDA Information Paper Number, 60.

Arrow, K. J. (1962). The economic implications of learning by doing. Review of Economic Studies. 29: 155-73.

Agenor, P. R. and Montiel, P. (1996). Development Macroeconomic, Princeton, New Jersey: Princeton University Press.

Agenor, P. R. and Moreno-Dodson, B. (2006). Public Infrastructure and Growth: New Channels and Policy Implications. World Bank Policy Research Working paper 4064.

Aghion, P. and Howitt, P. (2006). Appropriate Growth Policy, Journal of the European Economic Association. 4:269 – 314.

Aghion, P. and Howitt, P. (2009). The Economics of Growth. MIT Press.

Al-Faris, A. F., (2002). Public Expenditure and Economic Growth in the Gulf Cooperation Council Countries, *Applied Economics*. 34, 1187 - 1193.

Ansari, M., Gordon, D. and Akuamoah, C., (1997). Keynes versus Wagner: Public expenditure and national income in three African countries. *Applied Economics*. 29: 543 - 550.

Arslanalp, S., Bornhorst, F. and Gupta, S. (2011). Investing in Growth. Finance and Development, 48(1), 34 - 37

Aschauer, D. A., (1989). Is public expenditure productive? *Journal of Monetary Economics*. 23, 177 – 200. http://dx.doi.org/10.1016/0304-3932(89)90047-0

Aschauer, D. A., (2000). Do states optimize? Public Capital and Economic Growth. *The Annals of Regional Science.* 34(3), 343 – 363. http://dx.doi.org/10.1017/s001689900016

Ashipala, J. and Haibodi, N. (2003). The Impact of Public Investment on Economic Growth in Namibia. *NEPRU Working Paper No. 88*. Accessed on 10th January, 2014 from:www.unhabitat.org/pmss/getElectronicVersion.asp?nr=2078&alt=1

Asufu-Adjaye D., (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy economics*, 22, 615 - 625.

Banerjee, A., Galbabraith, W., Dolado. J. J. and Hendry D. F., (1993). Cointegration, error-correction, and ecometric analysis of nonstationary data. London: Oxford *University Press.*

Barro, R. J., (1990). Government spending in a simple model of endogenous growth. Journal of Political Economy, 98(5), 103 - 125. http://www.jstor.org/stable/2937633

Barro, R. J., (1996). Determinants of economic growth: a cross-country empirical study, Working Paper No.5698, National Bureau of Economic Research, Cambridge, MA.

Barro, R. J. and Sala-i-Martin, X., (1992). Public finance in models of economic growth. Review of Economic Studies, Vol.59, No.4, pp.645-661.

Barro, R. J. (2003). Determinants of Economic Growth in a Panel of Countries, Annals of Economics and Finance, 4:231 - 274

Bhatia, H. L., (2002). Public Finance, 25th Edition, Vikas Publication House, PVT Ltd, India.

Belloumi, M., (2009). Energy consumption and GDP in Tunisia: Cointegration and causality analysis. Energy policy, 37:2745 - 2753.

Bentzen, J., (1995). An empirical of gasoline in Denmark using cointegration approach. *Energy Economics,* 17: 329 - 339.

Bird, R. M., (1971). Wagner's law of expanding state activity. Public Finance, 26: 1-26.

Bloch, H. and Tang, H. K. (2003). The Role of Financial Development in Economic Growth. Progress in Development Sudies, 3:243 - 251.

Bom, P. R. D. and Ligthart, J. E., (2008). How Productive is Public Capital? A meta-analysis. *CESIfo Working Paper 2206,* January.

Boopen, S., (2006). Transport Infrastructure and Economic Growth: Evidence from African Using Dynamic Panel Estimates. *The Empirical Economics Letters.* 5(1), 37 – 52. http://www.eel.my100megs.com/

Busatto, L. M., (2011). The quality of expenditure and its influence on economic growth: evidence from the State of Rio Grande do Sul.

Brooks, C., (2002). Introductory econometrics for finance (6th ed.). Cambridge: Cambridge University Press.

Canning, D. and Fay, (1993). The Effect of Transportation Network on Economic Growth. Working Paper, New york, Columbia University.

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

Calderon, C. and Serven, L., (2003). The output cost of Latin America's Infrastructure Gap. In Easterly. W., Serven, L., (ed). The Limits of Stabilization:

Infrastructure, Public Deficits and Growth in Latin America. Stanford University Press.

Calderon, C. and Serven, L., (2004). The Effects of Infratsructure Development on Growth and Income Distribution. *The World Bank Policy Research Working paper 3400.*

Chan, H. L. and Lee, S. K., (1997). Modeling and forecasting and demand for China. *Energy Economics,* 19, 149 - 168.

Christopoulos, D. K. and Tsionas, E. G., (2004). Convergence and regional productivity differences: Evidence from Greek prefectures. *The Annals of Regional Science*. Springer, 38(**3**), 387 - 396.

Costa, J., Ellson, R. W. and Martin, R. C. (1987). Public Capital, Regional Output and Development: Some Empirical Evidence. Journal of Regional Science, 27(**3**):419 – 437.

Davidson, R. and Mackinnon, J. G., (1999). Economic Theory and Methods. 590-630.

De Jong, M. G., Steenkamp, J. B. E. M., Fox, J. P., and Baumgartner, H. (2008).Using Item Response Theory to Measure Extreme Response Style in Marketing Research: A Global Investigation," Journal of Marketing Research, 45, 104-115.

De la Fuente, A., (2000). Infrastructure and Productivity: A survey. Barcelona, Instituto de Alalisis Economico, CSIC, Working Paper. www.pareto.uab.es/

Demetriades, P. O and Mamuneas, T. P., (2000). Intertemporal Output and Employment Effects of Public Infrastructure Capital: Evidence from 12 OECD Economies. *The Economic Journa,* 110(**465),** 687 - 712

Demirbas, S., (1999). Cointegration Analysis-Causality Testing and Wagner's Law: The case of Turkey, 1950 – 1990.

Deno, K. T. (1988). The Effects of Public Capital on US Manufacturing Activity: 1970 – 1978. Southern Economic Journal, 55(**1**):400 – 411.

Dercon, S., and J. Hoddinott. (2005). Livelihoods, growth, and links to market towns in 15 Ethiopian villages. *FCND Discussion Paper 194*, International Food Policy Research Institute, Washington DC.

Devarajan, S., Swaroop, V. and Zou, H., (1996). The Composition of Public Expenditure and Economic Growth. *Journal of Monetary Economics*, 37, 313 – 344.

Diamond, J. (1989). Government Spending and Economic Growth: An Emperical Investigation. International Monetary Fund Working Paper 89/45

Diamond, A. M. Jr., (1999). Does Federal Funding "Crowd in" Private Funding of Science? Contemporary Economic Policy, 17(**4**), 423 – 431.

Dickey, D. A., Jansen, D and Tronton, D., (1991). A Primer Cointegration with Application to Money and Income. Federal Reserve Bank of St. Louis, 73(**2**), 58 – 77.

Dissou, Y and Didic, S. (2011). Public Infrastructure and Economic Growth: A Dynamic General Equilibrium. Analysis with heterogeneous agents. Department of Economics, University of Ottawa.

Dolado, J. J. and Lutkepohl, K., (1996). Making Wald tests work for cointegrated VAR systems. *Econometric Reviews*, 15, 369 – 386.

Domar, E. D. (1946). Capital Expansion, Rate of Growth and Employment, Econometrica, 137 – 147.

Dritsaki, C. and Dritsaki, M. (2010). Government Expenditure and National Income: Causality Tests for Twelve New Members of E. E. *The Romanian Economic Journal*.

Duggal, V. G., Saltzman, C. and Klein, L. R. (1995). Infrastructure and Productivity: A Nonlinear Approach. Paper presented at the 7th World Congress of the econometric Society, Tokyo, Japan.

Ebert, R. W. (1986). Estimating the contribution of urban public infrastructure to regional growth. Federal Reserve Bank of Cleveland. Working Paper Number 8610.

Edmunson, A. C., and McManus, S. E., (2007). Methodological fit in management field research. Academy of Management Review, 32(**4**), 1155-1179.

Egart, B., Kozluk, T. and Sutherland, D. (2009). Infrastructure and Growth: Empirical Evidence. *OECD Economics Department Working Paper 685.* www.EconPapers.repec.org

Engle, R. F. and Granger, C. W. J., (1987). Co-integration and error correction representation, estimation and testing. Econometrica, 55(**2**): 251-76.

Enders, W., (1998). Applied Econometric Time-Series. New York. John Wiley and Sons.

Estache, A., (2006). Infrastructure: A survey of recent and upcoming issues. Washington D.C.: The World Bank

Estache, A. and Garsous, G. (2012). The Impact of Infrastructure on growth in developing countries. *IFC Economics Notes*, Note 1.

Easterly, W. and Rebelo, S. (1993). Fiscal Policy and Economic Growth: An Empirical Evidence Investigation. Journal of Monetary Economics. 32(3), 417 – 458.

Fedderke, J. and Garlick, R. (2008). Infrastructure Development and Economic Growth in South Africa: A review of Accumulated Evidence. Policy Paper No. 12. www.econrsa.org/sysyem/files/ publications/policy_papers/pp12.pdf.

Fedderke, J., Perkins, P. and Luiz, J. (2006). Infrastructure Investment and Long-Run Economic Growth: South Africa 1875 – 2001. World Development, 34(6), 1037 - 1059.

Fernald, J. G., (1999). Roads to Prosperity? Assessing the link between Public Capital and Productivity. *American Economic Review.* 89(**3**), 619 – 638.

Foster, V. and Shkaratan, M., (2010). Malawi Infrastructure: A Continental Perspective. Country Report. Accessed on 20th April, 2013 from: https://www.siteresources.worldbank.org/malawi_Country_Report_2011.01.pdf

Fourie, J., (2006). Economic Infrastructure: A Review of Definitions, Theory and Empirics. *South African Journal of Economics.* 74(3), 530 – 556.

Fouquest, et al., (1997). The future of UK final user energy demand. *Energy Polic*y. 25, 231 - 240.

Garcia-Mila, T., McGuire, T. J. and Porter, R. H. (1996). The Effects of Public Capital in State Level Production Functions Reconsidered. Review of Economics and Statistics. 78(1), 177 – 180.

Giles, J. A. and Mirza. (1999). Some Pretesting Issues on Testing for Granger Non-Causality. In Mimeo. Victoria, BC: Department of Economics, University of Victoria.

Ghosh, A., Saidi, R., Johnson, K. (1999). Who Moves the Asia-Pacific stock markets – US or Japan? Empirical Evidence Based on Theory of Cointegration, *The Financial Review*, Vol. 34 Issue 1, p. 159.

Gupta, S. Kangur, A, Papageorgiou, C and Wane, A. (2011). Efficiency-Adjusted Public Capital and Growth. IMF Working paper 11/217. Washington DC: International Monetary fund.

GoM, (2002). Diagnostic Trade Integration Study, Transport Sector, Chapter 3, Volume 2. Lilongwe, Malawi

GoM, (2006). Malawi Growth and Development Strategy, 2006 - 2011. Lilongwe, Malawi

GoM, (2010). Road Sector Programme – Investment Programme for the Road Sector in Malawi, 2010 – 2020. Lilongwe, Malawi.

Gonzalo, J. (1994). Five Alternative Methods of Estimating long-Run Equilibrium Relationship. *Journal of Econometric.* 60(**1-2**), 203 – 233.

Gramlich, M. E. (1994). Infrastructure Investment: A Review Essay. *Journal Economic Literature.* 32(**3**), 1176 – 1196.

Greir, K. B. and Tullock, G. (1989). An Empirical Analysis of Cross-National Economic Growth: 1951 – 80. Journal of Monetary Economics, 24(2): 259 – 276.

Grossman, G. and Helpman, E. (1991). Innovation and Growth in the Global Economy. Cambridge MIT Press.

Guild, R. L., (2000). Infrastructure investment and interregional development: Theory, evidence, and implications for planning. *Public Works Management and Policy*. 4, 274-285.

Gujarati, D. N., (1995). Basic econometrics. (3rd edition). McGraw-Hill, Singapore.

Gujarati, D. N., (2003). Basic economics. 4th ed. New York: McGraw-Hill.

Gujarati, D. N., (2004). Basic Econometrics, Fourth Edition." McGraw-Hill Companies 810-820.

Granger, C. W., (1969). Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37, 423-438.

Granger, C.W.J. (1983). Co-Integrated Variables and Error-Correcting Models. UCSD Discussion Paper, No. 83-13.

Greene, W. (2003). Econometric Analysis. Fifth Edition. Prentice Hall, USA, 640 – 647

Gregory, A. W. and Hasen, J. M., (1996). Testing for structural breaks in cointegrated relationships. *Econometrics,* 71, 321 – 341.

Grier, K. B. and Tullock, G., (1989). An Empirical Analysis of Cross National Economic Growth, 1951 – 1980. *Journal of Monetary Economics*. 24, 259 – 276.

Hall, S. G. and Henry, S. S. B., (1989). Macroeconomic Modelling. Amsterdam (The Netherlands): Elsevier Science Publishers.

Harris, R. Z. D., (1985). Using Cointegration Analysis in Econometric Modeling. London, University of Portsmouth Prentice Hall.

Harrod, R. F. (1948). Towards a Dynamic Economics, London, Macmillan.

Harrod, R. F. (1951). Notes on TradeCycle Theory, Economic Journal, 61: 261 – 275.

Helms, L. (1985). The Effects of State and Local Taxes on Economic Growth: A Time series – Cross Sectional Approach. Review of Economics and Statistics, 67(3):574 – 582.

Holtz-Eakin, D., (1994). Public Sector Capital and Productivity Puzzle. Review of Economics and Statistics. 76(**1**), 12 – 21.

Holtz-Eakin, D. and Schwartz, A. E., (1995). Infrastructure in a Structural Model of Economic Growth. *Regional Science and Urban Economics*. 25(**2**), 131 – 151.

Ighodaro, C. A. and Oriakhi, D. E., (2010). Does the relationship between government spending and economic growth follow Wagner's law in Nigeria? *Annals of the University of Petrosani, Economics*. 10(**2**), 185 – 198.

ILO. (2010), Local Development through Infrastructure Investments and Jobs - Advisory Support, Information Services and Training Programme (ASIST-AP), ILO Regional Offices for Asia and the Pacific. Available at: http://www.ilo.org/asia/whatwedo/projects/lang-en/WCMS_098915/index.htm. Accessed on March 24, 2013.

IMF. (2010). Unproductive Public Expenditures. A Pragmatic Approach to Policy Analysis. www.imf.org/external/pubs/ft/pam/pam48/pam4803.htm

Irmen, A. and Kuehnel, J., (2008). Productive Government Expenditure and Economic Growth. Discussion Paper Series no. 464. University of Heidelberg. http://www.uni-heidelberg.de/md/awi/forschung/dp464.pdf

Isaksson, A. (2009). Energy Infrastructure and Industrial Development. Research and Statistical Branch Working Paper.

Jan, S. A., Chani, M. I., Pervaiz, Z. and Chaudhary, A. R., (2012). Physical infrastructure and economic development in Pakistan. *MPRA Paper*, No. 37785.

Jarque, C. M. and Bera A. K., (1980). Efficient tests for normality, homoskedasticity and serial independence of regression residuals. *Economics letters*, 6: 255 - 259.

Jiwattanakulpaisan, P. (2008). The Impact of Transport Infrastructure Investment on Regional Emplyment: An Empirical Investigation. Imperical College, London, UK.

Johansen, S., (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12, 231-54.

Johansen, R. and Juselius, K., (1990). Some Structural Hypotheses in a Multivariate Cointegration Analysis of the Purchasing Power Parity and the Uncovered Interest Parity for UK, Discussion Papers 90-05, Department of Economics, University of Copenhagen.

Johansen, R. and Juselius, K., (1998). Testing structural hypothesis in multivariate cointegration of the PPP and the UIP for UK. *Econometrics*, 53:211 - 244.

Joseph, T. (2012). Effects of Public Expenditure on Industrial Sector Productivity in Nigeria. Canadian Social Science. www.csccanada.org

Karragianni, S., Pempetzoglou, M. and S. Strikou, (2002). Testing Wagner's law for the European Union Economies. Journal *of Applied Business Research*, 18(**4**): 107–114.

Khan, M. S. (1996). Government Investment and Economic Growth in the Developing World. The Pakistan Development Review, 35:419 – 439.

Keho, Y. and Echui, A. D., (2011). Transport Infrastructure Investment and Sustainable Economic Growth in Cote d'Ivoire: A Cointegration and Causality Analysis. *Journal of Sustainable Development*, Vol. 4, No. 6. Accessed on 19th April, 2013 from: www.ccsenet.org/jsd

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, pp.213 – 230.

Kirchgassner, G. and Wolters, J., (2007). Introduction to Modern Time Series Analysis. Springer- Verlag, Berlin, Heidelberg,160 – 175.

Kneller, R., Bleaney, M. and Gemmell, N., (1999). Fiscal Policy and Growth: Evidence from OECD Countries. *Journal of Public Economics.* 74(**2**), 171 – 190.

Kogid, M., Mulok, D., Mansur, K., and Lim, F. Y. B., (2010). Determinant Factors of Economic Growth in Malaysia: Multivariate Cointegration and Causality Analysis. *EuroJournal, Inc. 2010*. Accessed on 15th April, 2013 from: http://www.eurojournals.com

Kulshreshtha M. and Parikh J. K., (1999). Modeling demand coal India: vector autoregressive models with cointegration variables. *Energy Economics*, 26,149-168.

Kuzozumi, E. and Yamamoto, Y. (2000). Modified lag augmented autoregressions. *Econometric Review,* 19, 207 – 231

Kweka, P. J. and Morrissey, O. (2000). Government Spending and Economic Growth in Tanzania, 1965 – 1996. *CREDIT Research Paper No. 00/6.*

Kwiatkowski, D., Philips, P. C. B., Schmidt, P. and Shin Y., (1992). Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?, *Journal of Econometrics,* 54, 159-78.

Lau, S. H. P. and Sin, C. Y. (1997). Public Infrastructure and Economic Growth: Time Series Properties and Evidence. *Economic Records.* 73(**221**), 125 – 135.

Laura, V., (2008). Road Infrastructure – The backbone of transport system. Directorate -General for Research Sustainable Surface Transport.

Leduc, S. and Wilson, D. J., (2012). Should Transport Spending be included in a Stimulus Program? A Review of the Literature. *Working Paper,* 2012-15. www.frbsf.org/publications/economics/papers/2012/wp12-15bk.pdf.

Leonardo, M. B., (2011). The quality of expenditure and its influence on economic growth: evidence from the State of Rio Grande do Sul (RS).

Looney, R. E., (1997). Infrastructure and Private Sector Investment in Pakistan. *Journal of Asian Economics.* 8**(3**), 393 – 420.

Loto, M. A. (2011). Impact of Government Sectoral Expenditure on Economic Growth. *Journal of Economics and International Finance*, Vol. 3(**11**), 646 – 652.

Lutkepohl, H. and Kratzig, M., (2004). Applied Time Series Econometrics. *Cambridge University Press*. Cambridge.

Lynde, C. and Richmond, J. (1993a). Public Capital and Total Factor Productivity. International Economic Review, 34:401 – 414.

Lynde, C. and Richmond, J. (1993b). Public Capital and Long-Run Costs in UK Manufacturing. The Economic Journal, 103:880 – 893.

Maddala, G. S., (2001). Introduction to Econometrics, 3rd Edition, Wiley and Sons, Inc

MacKinnon, J. G., Haug, A. A. and Michelis, L., (1999). Numeriacal distribution functions of likelihood ratio tests for cointegration. *Journal of Applied Econometrics.* 14**(5**), 563 – 577.

Maggazino, C., (2010). Wagner's law and augmented Wagner's law in EU-27. A time series analysis on stationarity, cointegration and causality. *MPRA Working Paper, No. 26668.*

Magidu, N., Alumai, J. G. and Nabiddo, N., (2010). Public Expenditure tracking on road Infrastructure in Uganda: The case study of Pallisa and Soroti Districts. *Research Report 2.*

Mamatzikis, E. C., (2002). Public Infrastructure and Private Output: An Application to Greece. *Journal of Economic Development.* 27(**2**), 143 – 160.

Manning, L. M. and Adriacanos, D., (1993). Dollar movements and inflation: a Cointegration analysis. *Applied Economics*, 25, pp. 1483-1488.

Mankiw, G. N., Romer, D. and Well, D. (1992). A Contribution to the Empirics of Economic Growth. Quarterly Journal of Economics. 107(2):407 – 437.

Mendoza, E., Milesi-Ferretti, G. & Asea, P. (1997). On the Effectiveness of Tax Policy in altering Long-run Growth: Harberger's Superneutrality Conjecture. Journal of Public Economics. 66 (1), 99-126.

Milbourne, R. G. O. and Voss, G. (2003). Public Investment and Economic Growth. Applied Economics, 35:527 – 540.

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

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

Moreno-Dodson, B. (ed.) (2005). Reducing Poverty on a Global Scale, Washington (D.C.), World Bank Publications.

Mulamba, K. C., (2009). Long run relationship between government expenditure and economic growth: Evidence from SADC countries. Unpublished master's thesis, University of Johannesburg, RSA.

Mulhearn, C. and Vane, H. R., (1999). p. 350: – Economics, MACMILLAN Foundations.

Munnell, A. H., (1992). Policy Watch. Infrastructure Investment and Economic Growth. Journal of Business and Social Sciences, 2(1):285 – 299.

Munnell, A. H., (1999). Why has productivity growth declined? Productivity and Public Investment. *New England Economic Review*, Federal Reserve Bank of Boston, 3 - 22.

Musaba, E. C., Chilonda, P. and Matchaya, G., (2013). Impact of Government Sectoral Expenditure on Economic Growth in Malawi, 1980 – 2007. Journal of Economics and Sustainable Development, 4(2), 71 - 79

Mustajab, M., (2009). Infrastructure investment in Indonesia: process and impact. Thesis (PhD). Rijksuniversiteit, Netherlands

Nandwa, B. and Mohan, R., (2007). A Monetary Approach to Exchange Rate Dynamics in low- Income Countries: Evidence from Kenya. MPRA.

Ng, S. and Perron, P., (2001). Lag length selection and the construction of unit root tests with good size and power. *Econometrica*, 69: 1519-554.

Niloy, B., Emranul, M. H. and Denise, R. O., (2003). Public Expenditure and Economic Growth: A Disaggregated Analysis for Developing Countries, JEL, Publication.

Nketia-Ampoasah, E. (2009). Public Spending and Economic Growth. Evidence from Ghana (1970 – 2004). Development Southern Africa, 26(**3**):477 – 497.

Nursk, R. (1953). Problems of capital Formation on Undeveloped Countries. Oxford: Basil Blackwell.

Nurudeen, A. and Usman, A., (2010). Government Expenditure and Economic Growth in Nigeria, 1970-2008: A Disaggregated Analysis. *Business and Economics Journal*. 2010(**4**), 1 – 11.

Nworji I. D. and Oluwalaye O. B., (2012). Government Spending on Road Infrastructure and its Impact on the growth of Nigerian Economy. www.ijbs.com

Omoke, P., (2009). Government Expenditure and National Income: A Causality Test for Nigeria. *European Journal of Economic and Political Studies*, 2, 1-11.

Osterwald-Lenum, M. (1992). A Note with Quintiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistic. *Oxford Bulletin of Economics and Statistics*. 54(**3**), 461 – 472.

Peacock, A. and Scott, A., (2000). The curious attraction of Wagner’s law. *Public Choice*, 102(**1**), 1–17.

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

Perron, P. and Ng, S., (1996). Useful modifications to some unit root tests with dependent errors and their local asymptotic properties. *Review of Economic Studies*, 63, 435-63.

Pfaff, B., (2006). Analysis of Integrated and Cointegrated Time Series with R. London: Springer + Business Media.

Phillips, P. C. B. and Perron, P., (1988). Testing for a unit root in times series regression, *Biometrica*, 75, 335-446.

Pradhan, R. P. (2009). The FDI-led growth hypothesis I ASEAN – 5 countries: Evidence from co-integrated panel analysis. International Journal of Business and Management, 4(12):153 – 164.

Prud'homme, R., (2004). Infrastructure and development, Paper prepared for the Annual Bank Conference on Development Economics, Washington, DC.

Punch, K. F., (2005). Introduction to Social Research. Quantitative and Qualitative Approaches. Second Edition. Sage Publications

Queiroz, C. and Gautam, S., (1992). Road Infrastructure and Economic Development – Some Diagnostic Indicators. *The World Bank Policy Research Working Paper 921*. http://www-wds.worldbank.org/

Rambaldi, A. N. and Doran, H. E., (1996). Testing for Granger Non-Causality in Cointegrated Systems Made Easy. *In Working Papers in Econometrics and Statistics, 88, 1 – 22.* Armidale, NSW: Department of Econometrics, University of New England.

Reungsri, T., (2010). The Impact of Public Infrastructure Investment on Economic Growth in Thailand. An inaugural Doctoral Thesis, Victoria University, Australia.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94, 1002–1037.

Romp, W. and De-Haan, J., (2005). Public capital and economic growth: A critical survey. *EIB Papers*, 10(1), 40-93.

Sahoo, P. and Dash, R. K., (2008). Economic Growth in South Asia: Role of infrastructure with. *Institute of Economic Growth*. Working Paper No. 288.

Sahoo, P. and Dash, R. K., (2009). Infrastructure Development and Economic Growth in India. Journal of the Asia Pacific Economy. *Rutledge.* 14(**4**), 351 - 365.

Salvador, N., (2003). The Theory of Economic Growth. A Classical Perspective.

Sanchez-Robles, B., (1998). Infrastructure Investment and Growth: Some Empirical Evidence. *Contemporary Economic Policy.* XVI, 98 – 108.

Samimi, R., (1995). Road transport energy demand in Austaralia: A Cointegration Approach. *Energy Economics.* 17, 349 - 339.

Sheshinski, E. (1967). "Optimal Accumulation with Learning by Doing." In Karl Shell (ed.), Essays on the Theory of Optimal Economic Growth, pp. 31-52. Massachusetts Institute of Technology, MIT Press, Cambridge.

Siggel, E., (2005). Development economics: a policy analysis approach, Ashgate, Burlington, VT.

Sims, C., Stock, J. H. and Watson, M. W., (1990). Inference in Linear Time Series Models with Some Unit Roots. *Econometrica.* 58, 113 – 144.

Sinha, D. and Sinha, T., (2007). Toda and Yamamoto causality tests between per capita saving and per capita GDP for India. *MRPA Paper No. 2564*, 04 January. Accessed in February 2013 from: www.mpra.ub.uni-muenchen.de/2564/

Solow, R. M., (1956). A Contribution of the Theory of Economic Growth. *Quarterly Journal of Economics.* 70(1), 65 – 94.

Solow, R. M., (1957). Technical Change and the Aggregate Production. Review of Economics and Statistics, 39, 319 – 324.

Stern, N. (1991). The Determinants of Growth. Economic Journal, 101:122 – 133.

Stifel, D., and Minten, B. (2008). Isolation and Agricultural Productivity. Agricultural Economics 39 (**1**): 1–15.

Sturm, J. E. (1998). Public Capital Expenditure in OECD Countries. The Causes and Impct of the Decline in Public Capital Spending, Cheltenham: Edwards Edgar Publishing Limited.

Sturm, J. E. and de Haan, J. (1995). Is Public Expenditure Really Productive? New Evidence from the US and the Netherlands. Economic Modeling, 12:60 – 70.

Sturm, J. E. and Kupper, G. H. (1996). The Dual Approach to the Public Capital Hypothesis: The case of the Netherlands, Groningen. (CCSO Series Number 26).

Sturm, J. E., Jacobs, J. and Groote, P., (1999). Output Effects of Infrastructure Investment in the Netherlands, 1853-1913. *Journal of Macroeconomics.* 21(**2**), 355 – 380.

Straub, S. and Terada-Hagiwara, A. (2011). Infrastructure and Growth in developing Asia. Asian Development Review, 20(**1**): 119 – 156. Accessed on 15/10/2013 from: www.ideas.repec.org/

Swan, T.W. (1956). Economic growth and capital accumulation. Economic Record 32:334 – 61.

Taiwo, M. and Abayomi T., (2011). Government Expenditure and Economic Development: Empirical Evidence from Nigeria.

Tatom, J. (1991). Public Capital and Private Sector Performance, Federal Reserve Bank of St. Louis, Review, 73:3 – 15.

Tawose J., (2012). Effects of Public Expenditure on Industrial Sector Productivity in Nigeria. *Canadian Social Science*. Accessed on 19th April, 2013 from: www.csccanada.org/

Thomas, R. L., (1993). Introductory Econometrics: Theory and Applications, Longman, London.

Toda, H. Y. and Phillips, P. C. B., (1993). Vector Autoregressive and Causality. *Econometrica*, 61, 1367 – 1393.

Toda, H. Y. and Yamamoto, T., (1995). Statistical Inference in Vector Autoregressive with Possibly Integrated Processes. *Journal of Econometrics*, 66: 225 – 250.

Trochim, W. and Donnelly, J., (2006). Research methods knowledge base. (3rd Ed.). Cincinnati: Atomic Dog Publishing.

Udoh, E. (2011). An Examination of Public Expenditure, Public Investment and Agricultural Sector Growth in Nigeria: Bounds Testing Approach. Journal of Business and Social Sciences, 2(**1**):285 – 299.

Usman, A., Mobolaji, H. I., Kilishi, A. A., Yaru, M. A. and Yakubu, T. (2011). Public expenditure and Economic Growth in Nigeria. Asian Economic and Financial Review, 1(**3**):104 – 113.

Verbeek, M., (2004). A guide to modern econometrics. Rotterdam, Johan Wiley& Sons

Wagner, A., (1911). Staat (in national okonomischer Hinsicht). In "Handworterbuch der Staatswissenschaften", 727-739. Gustav Fisher Verlag.

Weisbrod, G. and Reno, A., (2009). Economic Iimpact of Public Transportation Investment, J-11(7).

Wei W. S., (2006). Time series analysis: Univariate and Multivariate. Boston: Pearson.

Whitworth, A., (2005). Malawi's recent fiscal performance and prospects. DFID, Lilongwe, Malawi.

World Bank. (1994). World Development Report 1994. Infrastructure for Development. New York: Oxford University Press

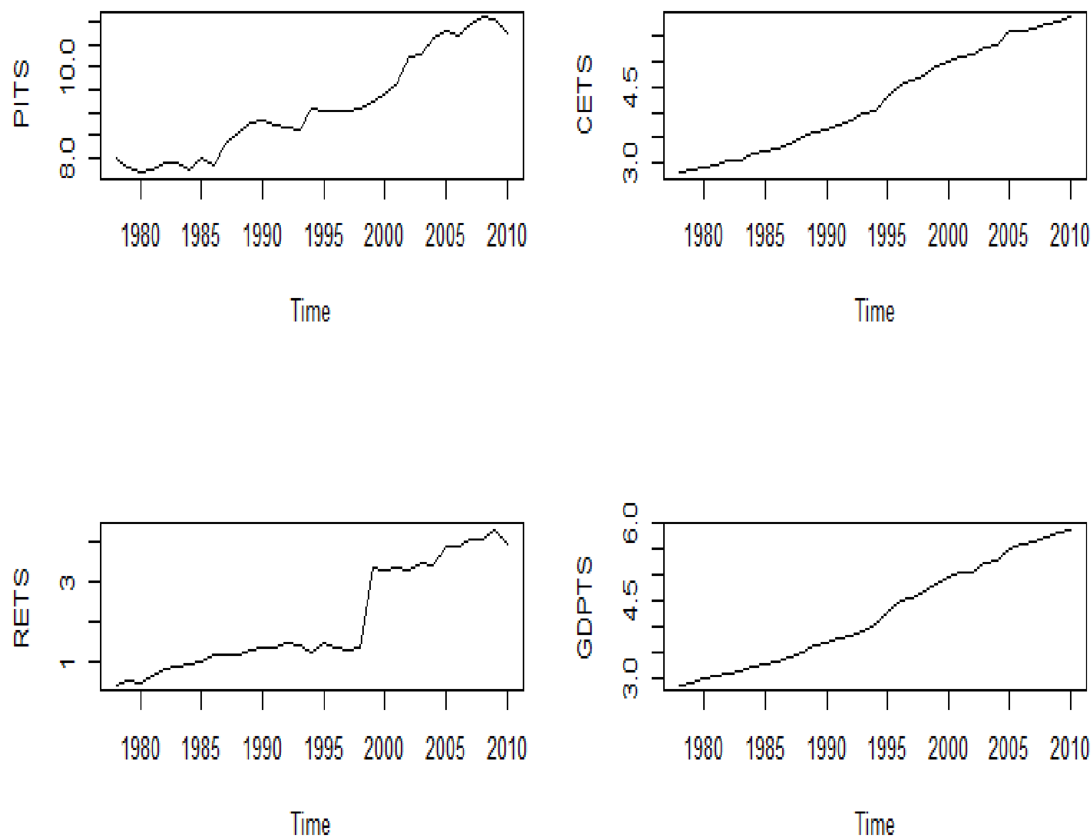
Yin, R., (1994). Case study research: Design and methods (2nd ed.). Beverly Hills, CA: Sage Publications.

Zapata, H. O. and Rambaldi, A. N., (1997). Monte Carlo Evidence on Cointegration and Causation. *Oxford Bulletin of Economics and Statistics*, 59(**2**), 285 – 298.

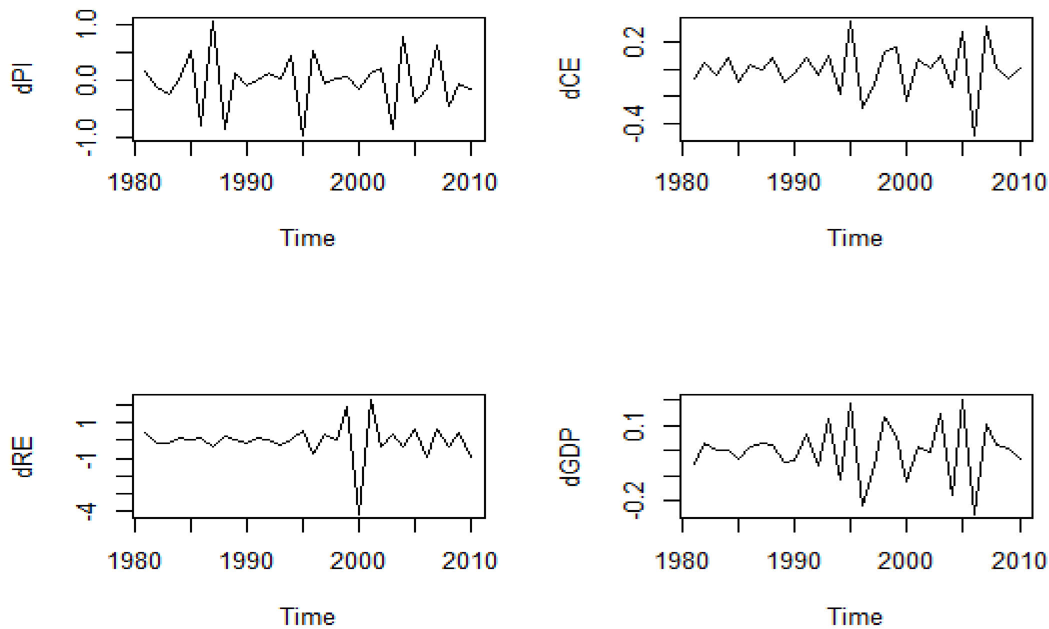
Zhai, F. (2010). The Benefits of Regional Infrastructure Investment in Asia: A Quantitative Exploration, ADBI Working Paper 223. Tokyo: Asian Development Bank Institute.

APPENDICES

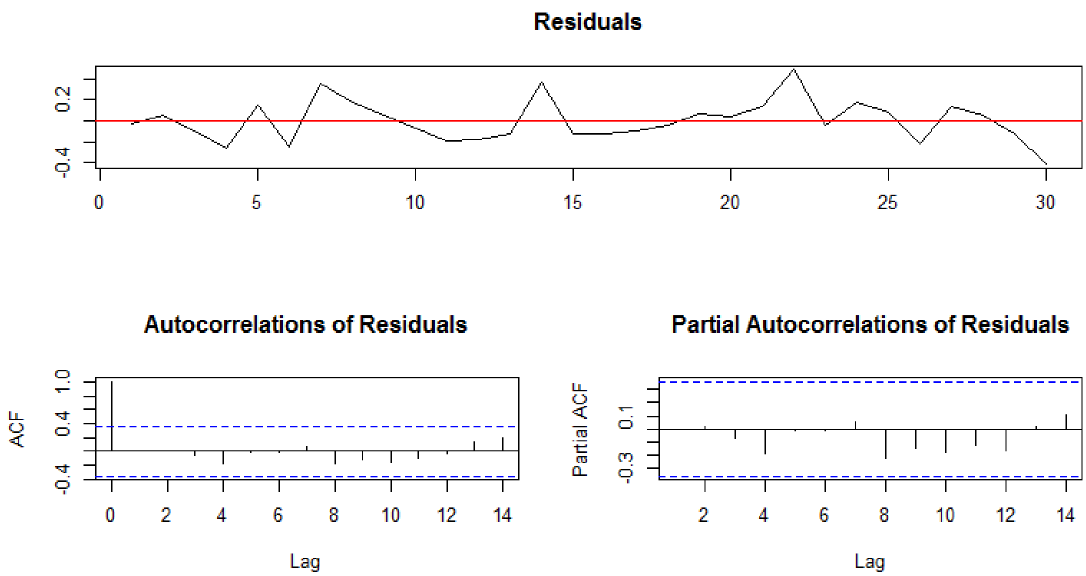
Appendix A: Plot of variables in levels



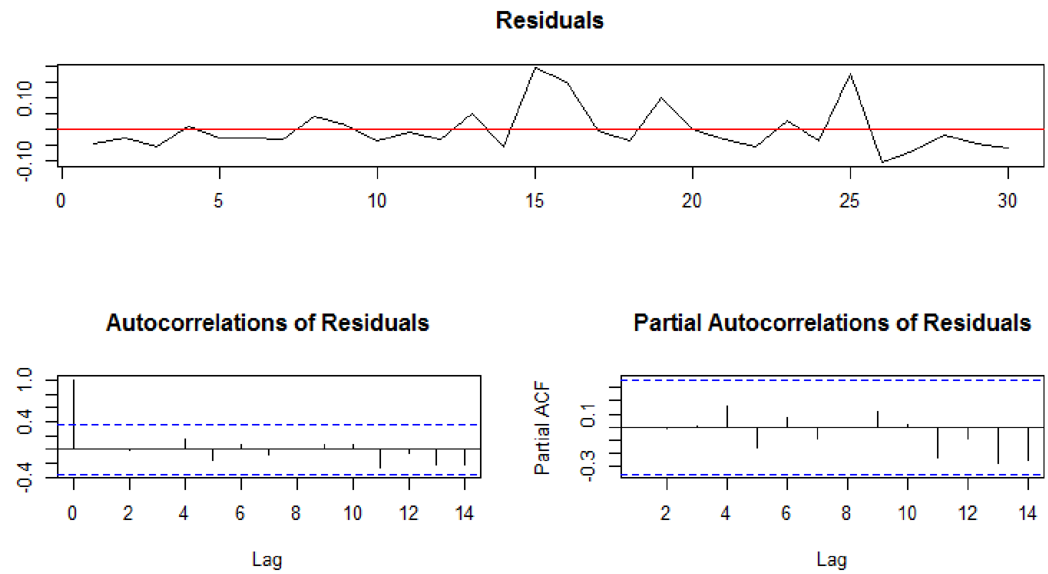
Appendix B: Plot of Differentiated variables



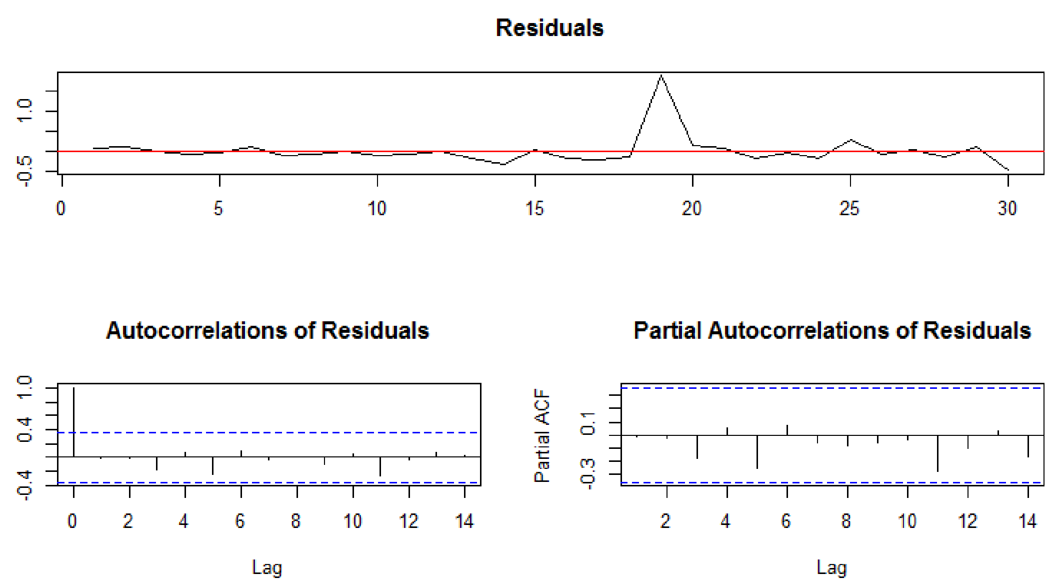
Appendix C: Residual for PI



Appendix D: Residual for CE



Appendix E: Residual for RE



Appendix F: Residual for GDP