THE RELATIONSHIP BETWEEN ROAD INFRASTRUCTURE INVESTMENT AND ECONOMIC GROWTH IN SOUTH AFRICA.

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DECLARATIONS

I, August Moeketsi, declare that this dissertation for the Degree of Masters in **economics**, submitted at the North West University, Mafikeng campus, has not been submitted by me at this or any other university. This work has been done by me and all other materials included have been acknowledged.

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ABSTRACT

The aims of this dissertation is to investigate the relationship between road infrastructure investment and economic growth and other macro-economic variables such as ICT investment and labour input. Annual time series data between 1960 and 2013 are employed in this dissertation. The gross domestic product, road infrastructure investment, ICT investment and labour input are from the South African Reserve Bank.

The quality of road infrastructure and ICT investment results in different decisions that influence business establishments and employment. The enhancement of economic growth requires upgrading, routine, preventative and emergency infrastructure maintenance.

The Vector Auto regression (VAR) model was used for the implementation and forecasting of time series data. It was also used to examine the dynamic shock in one variable to another. The Cobb-Douglas production function was also used to test the relationship between infrastructure capital, labour input and ICT investment, whereas gross domestic product is considered as an output.

The findings of the study shows the impact of road infrastructure investment, ICT stock and labour input that continues to have positive relation to economic growth.

KEYWORDS: Road Infrastructure investment, ICT investment, labour input, economic growth and VAR

LIST OF ABBREVIATIONS

1. BRT	: Bus Rapid Transport
2. CBO	: Community Based Organisation
3. EPWP	: Expanded Public Works Programme
4. FAO	: Food and Agriculture Organisation of United Nation
5. GDP	: Gross Domestic Product
6. GNI	: Gross National Income
7. ICT	: Information Communication Technology
8. ILO	: International Labour Organisations
9. MDG	: Millenium Development Goal
10. NEDLAC	: National Economic Development and Labour Council
11. NEPAD	: New Partnership for Africa's Development
12. PRMG	: Provincial Road Maintenance Grant
13. SAICE	: South African Institute of Civil Engineering
14. SANRAL	: South Africa National Road Agency Limited
15. UN	: United Nations
16. UNCTAD	: United Nations Conference on Trade and Development
17. UIF	: Unemployment Insurance Funds
18. WB	: World Bank
19. N	: National road or street or paved network

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CHAPTER 1

1.1 INTRODUCTION

South Africa's national and provincial roads are classified into various operational frameworks, practical classes and geometric sorts. These orders are essential for connecting people and goods to various places. The aggregate South African road system comprises of around 754 600 kilometres, which are proclaimed as national, provincial and district roads, with a 16,7 per cent been tar and remainder been not tarred (South Africa: State of Economic Infrastructure, 2012).

The National Department of Transport through the South African National Road Agency Limited (SANRAL) is responsible of all national road system, which comprises of 11 per cent of the aggregate national tarred road system. Provincial government departments which control and regulate provincial roads networks are responsible for 31 per cent of the total network. The fundamental function of these networks, is to give access and safer movement within the country, provinces and districts.

The conditions of the provincial and municipal roads are waning due to poor routine and preventative road network maintenance and repairs and it vastly compromises economic growth and development. The study related to NEPAD and reflected that African countries excluding, North of Africa, have road networks which are generally in apoor state, with the lowest rate of tarred road compared to any country in the rest of the world (United Nation, 2002).

One of the main obstacles holding back the capital upgrading and replacement of road networks is the decreased or non infrastructure budget. This results to declining or stagnation in economic growth and development. The Food and Agriculture Organization (FAO) of the United Nations (2002) mention that foreign direct investment in economic improvement and growth from 1990-1996 for Sub-Saharan Africa was in the range of US$ 26.7 billion in comparison with US$ 41.4 billion for Latin America and the Caribbean and US$ 101.9 billion for Asia.

Taking into cognisance the above analysis, the financing needs for network development and improvement is very crucial. The problem lies in the determination of South Arica's roads financing requirements, through the execution and analysis of the accurate evaluation of the nature and degree of the nation's network system, which are network asset value and its condition.

The deficient investment results in the road infrastructure network not being upgraded, rehabilitated or replaced timeously. The waning of the infrastructure road network is not only limiting accessibility, movements of goods and commuting to different destinations, but also results in the increased prices of transport cost, spares and fuel costs which adversely affect the economy.

1.2 BACKGROUND OF THE STUDY

The report on SANRAL indicates that South Africa has the aggregate length of the infrastructure road network of 754 600 kilometers which makes it the widest network in Africa. The drive from Beitbrige in Limpopo which is the Zimbabwean border post to Cape Town in the south covers a 2 000 kilometers journey alone on a well tarred road (SANRAL). The National Department of Transport is in charge of overall policy documentation and interpretation as well as funding of national and provincial road networks in the form of grants. Provincial preventative and routine road maintenance is within the provincial spheres of government.

SANRAL was formed to be a statutory organ, working as a government parastatal along the commercial lines, regulated through the Act of Parliament in April 1998. The motive wasto maintain and grow South Africa's national road network infrastructure system and to oversee resources with a depreciable replacement value estimated to 238 billion rand, barring land, working within the terms of its established Act, the South African National Roads Agency Limited and National Roads Act (Act No. 7, 1998). SANRAL is represented by a leading group of eight individuals, with a clear mandate of ensuring the road network system is in good and

driveable condition covering 16 200km radius. According to SAICE (2010), there are around 185 000km of provincial road and 66 000km of municipal road networks in South Africa.

National networks in South Africa are a class of highways, national roads and freeways which joins main cities and metropolitans. They are categorised in South Africa route numbering scheme and noted with numbers beginning with 'N', which is from N1 to N18. Around 19 per cent of the national road network system istolls, a large portion of which is kept up by SANRAL, while the rest has been offered admission to privately owned businesses to create, work and keep up. A multi-billion rand expressway change plan has altogether facilitated clog on the streets in Gauteng province, the nation's busiest region (South Africa.Info).

Transportation through road networks as a major aspect of development is fundamental for all conveyances from field to grain storages at silos. The grains are conveyed through paved and unpaved network systems, delivering using different types of deliveries such as tractors, trailers combinations, trucks and sophisticated vehicles combinations determined by the scale and size of farming. It is however basic and economic to keep up the paved network system is in good condition to ensure the economic spin offs. Verifiably the business has been substantial scale client of rail transport and actually all storehouses are arranged along the rail lines and the offices at the silos are intended for paved network conveyances from farms and rail for longer and more destinations.

In the course of recent years, the volume of grain transported by rail has lessened continuously because of diminishing administration level and increasing expenses that have made the rail mode not competitive in connection to road network transport. The present utilization of road infrastructure network transport for grains is 80 per cent moving from storehouses to processes, both for the creation of maize meal and for use in animal feed (Freight Transport Databank, 2004).

The mining business is another primary monetary area in South Africa representing roughly 33 per cent of the GDP, and 50 per cent of outside trade profit. Mining is one of the key parts in South Africa, which delivers 70 per cent of the platinum in Rustenburg (Freight Transport

Databank, 2004). Road network system is an integral part to convey to platinum and different valuable metals smelter for finish product.

South Africa has gigantic gold metal stores, evaluated at 40 000 tons which speak to 40 percent of worldwide stores. The gold mines in the North West Province were created in the twentieth century in the Potchefstroom and further west along the Vaal waterway close Carletonville, Klerksdorp and Okney. There are 7 mines in the Klerksdorp - Orkney complex. A portion of the wealthiest mines are found in these ranges and in this manner, the vast majority of the related mechanical exercises and convergences of individuals happen in these parts of the region. Gold mines in the North West are more youthful than gold mines in Gauteng and they have long period of operations (Freight Transport Databank, 2004).

The mining operations make utilization of the paved and unpaved network systems, both inside of the mining operations and also transportation of minerals as well as different finished and raw commodities to neighbouring nations through road transport network and rail transport. Farm and game animal movements over long distance are part of road transport system in South Africa.

S'hamba Sonke ("walking together") was presented by the National Department of Transport with massive funding to ensure that maintenance of paved and unpaved networks and lessen backlogs over abundances on common street framework upkeep and repairs the system is a work escalated proposed for group improvement through extended open works program. South Africa's Public Transport Strategy presented in 2009/10 was expected to incorporate rail, taxi and transport administrations in conjunction with private transport operators, both operationally and through ownership. The grouping was for modernizing the vehicle operation and formalizing it professionally.

According to South Africa.Info, the success case study of the Johannesburg bus rapid transport framework (BRT) has prompted it being adjusted and actualized in other South African urban areas, which include major metropolitan cities such as Cape Town, Nelson Mandela Bay, Rustenburg, Tshwane and Ekurhuleni. The major part of the South African populace use taxis as their prime mode of transport. The legislature has presented obligatory wellbeing guidelines

and a taxi recapitalisation program, which was meant for disposing of hazardous taxi through scrapping remittances. This was to guarantee that the road framework system is protected and secure every one of the vehicles are roadworthy, keeping in mind the end goal of bringing economic spinoffs and economic growth.

South African paved networks are generally assembled and kept up by funds gathered from a devoted duty on fuel deals. The duty was, however abrogated in 1988 (State of South Africa's Economic Infrastructure, 2012). Since that point forward, the paved network development and upkeep has depended yearly grant from the central government. This grant was allotted for a longer period of time, and it diminished relentlessly. However over the following year it has become the quickest growing in the national budget. The allotment far surpasses what is collected through the fuel levy. It is assessed that at present a large portion of the sum required for street construction and development is given by government through Provincial Road Maintenance Grant (PRMG) (State of South Africa's Economic Infrastructure, 2012).

The grant for provincial road upkeep was made to support shortages of the provincial road network system. These funding were observed through the system called S'hamba Sonke which is the new programme by the Department of Transport to address the weakening on provincial streets. It includes a street development and upkeep approach that are both labour intensive and construction related, carried through the Expanded Public Works Program (EPWP) and meets the criteria of coordinated Transport Sector Code and the Construction segment code (Department of Transport, 2011).

The broad aim was to make three year Medium Term Expenditure Framework (MTEF) experimental run program with the provinces targeting to:

• Benchmark value for money in the development and upkeep spending on road;

• Oversee the presentation of uniform best practice systems; and

• Create new employments and opportunities where individuals reside.

The system is necessary to the enhancements of country rural commonplace streets system. Basically, it has the potential not just to enhance the state of rustic streets and extend the country system by upgrading work portability, additionally to make direct job in zones with abnormal amounts of destitution and unemployment. Commonplace street systems, if looked after legitimately, can possibly upgrade financial development.

1.3 PROBLEM STATEMENT

Road Infrastructure Network is a primary mode of transport in South Africa for both freight and passenger deliveries. It comprises of paved and unpaved roads. It carries over 80 percent of goods and services (Pinard, 2004).The road network is characterised by several constraints that limit economic growth and development in the South Africa. One of the major constraints confronting the development of roads is the availability of funds. Despite increased funding for roads by three spheres of government, resources allocated to roads infrastructure remain inadequate to eliminate the huge backlogs in maintenance and construction of roads. These constraints adversely affect economic growth and development.

The deterioration of the road network does not only limits accessibility, mobility and regional connectivity of the country, but it also results in the increased production and transportation costs (Lombard & Coetzer, 2007). Rural and urban households spend a large amount of time on road transport to fulfil their basic needs. They are very often severely hampered by lack of an adequate road networks. This results in a significant limitation of growth and development of rural communities that is still experienced today. Poverty is far worse in rural areas than in urban centres due to lack of adequate accessibility and mobility of road networks. Rural local roads are often impassable making it difficult for rural families to have access to the means of economy.

Poverty alleviation through the Expanded Public Works Programme introduced by the Department of Public Works, Road and Transport intended to provide rural communities with seasonal work such as pothole patching, road markings, fencing and bush cutting. It was also realised that this would help in terms of poverty alleviation and enhances economic growth,

However, inadequate technical skills such as those of civil and structural engineers in South Africa have a significant effect to the current status of the road network.

1.4 RESEARCH AIM AND OBJECTIVES

The aim of the study is to assess the relationship between road infrastructure investment and economic growth as well as ICT investment and labour input focussing in South Africa as a case study. The discussion brings a clearer picture on what should be done for road infrastructure improvements in order to stimulate economic growth. The deployment of enough resources to road infrastructure network is crucial as it is a prerequisite for the provision of accessibility and mobility for both freight and passenger road transport. The results of the study may be used by the public sector, private sector and communities to enhance economy growth and alleviate poverty.

The objectives of the study are:

- To investigate the strength and direction of the relationship between road infrastructure investment and economic growth.
- To investigate the growth impact of road infrastructure investment on economic growth.
- To investigate the impact of road infrastructure investment and economic growth with increasing returns to scale.
- To investigate the impact of road infrastructure investment and economic growth with constant returns to scale.
- To examine the contribution of road infrastructure investment in realizing the full potential of the economy.
- To investigate the long run relationship of road infrastructure investment and economic growth.
- To investigate the short run relationship of road infrastructure investment and economic growth.
- To investigate the response of road infrastructure investment to shocks in the system.

1.5 HYPOTHESES OF THE STUDY

This study is intended to survey the relationship between infrastructure frameworks and monetary development, and to evaluate the effect of very much kept up streets to financial development in South Africa.

The invalid speculation of the study is based on that:

H0: There is no noteworthy relationship between infrastructure framework and monetary development in South Africa.

The option speculation of the study is:

Ha: There is a relationship between infrastructure framework and financial development in South Africa.

1.6 IMPORTANCE OR BENEFIT OF THE STUDY

The significant part of network base in financial development has been all around acknowledged, such that the provincial rural linkages and the force impacts of urban centres focuses have for some time been perceived to be basically dependant on street development. Street infrastructure is extremely thorough and brings components, for example, data correspondence innovations and technological work information (Chaudhary 2012). Cross nation examinations of the levels of traveller and cargo with per capita pay have shown that the level of portability in a nation generally mirrored the level of a nation's riches. The interest for portability in South African streets by vehicles is expanding for both business and joy.

Base improvement, for example, the redesigning, restoration and repairs of streets base helps the groups to drive to work and go to occupations where wages are generally higher at the decreased expenses. It helps little and peripheral agriculturists and in addition financially dynamic individuals to move far from their towns where manual work is looked downward on, to places where job and costs are high.

Linkages push the wealthier segment to occupy their venture from constrained credit business sector to non-rural exercises in provincial ranges and towns. This likewise helps in giving extra vocation to rustic work. The lessening of showcasing edges has expansive results for the near point of preference enchanted by nation and for its focused quality of strength for the overall economy (Ahmed & Hossain, 1990).

The street base is for the most part used to transport cargo including the greatest size vehicles in the mining zones around the nation. The transportation of valuable assets additionally creates additional substantial transport development to upgrade monetary development.

The overview done by Freight Transport databank demonstrates that more than 500 millions huge amounts of cargo are proceeding onward the street base yearly (Freight Transport Databank, 2004).

The presentation of the manual work concentrated system for the street network infrastructure called the Expanded Public Works Program (EPWP) is significant to the changes of country streets. It also aims at decreasing unemployment and neediness rate among the young females and impaired persons. The handiness of street network base speculation is valuable to upgrade financial development and draw in equipped gifted workforce.

1.7 LIMITATIONS AND CONSTRAINTS OF THE STUDY

The impact of the roads infrastructure investment cannot be easily quantified in the economy. However, only the freight and passengers from the production site that are transported can be accounted and the impact can be easily measured in terms of real Gross Domestic Product. Although the movement as a result of traffic flow and the investment on road infrastructure can be accounted for, it is not as significant as actual goods and services.

1.8 RESEARCH METHODOLOGY

The study covers the road infrastructure investment issues such as the construction and maintenance of roads, both paved and unpaved, from 1960 to 2013. Data was obtained from the South African Reserve Bank. Employment creation through Expanded Public Works Programme and Emerging Contractors Development, focus was on the youth, females and disabled persons, with the intention to alleviate poverty. Other data was sought from the Department of Public Works and Transport. For the infrastructure budget allocation for the medium term expenditure framework (MTEF) 2009/10, 2010/11 and 2011/12 financial years, the data was obtained from the Estimates of Provincial Revenue and Expenditure (EPRE). Technical personnel employed by the Department and the vacancy rate experienced in the Road Infrastructure programme, information was obtained from the Departmental Human Resource Management, for the MTEF period. In this study, ADF [Augmented Dickey Fuller] unit-root tests, co-integration tests, Granger causality analysis, and the error correction model will be used. The methodology is appropriate because it examines road infrastructure conditions to enhance economic growth. Computer programme (EViews) was utilised for statistical data analysis.

1.9 DEPLOYMENT AND PLAN OF THE STUDY

Chapter 1 presents the background of the study and problem statement. This chapter explains the aim and objective of the study, hypothesis of the study, importance of the study, limitation of the study, and research methodology.

Chapter 2 is the literature review. This chapter provides both theoretical and practical frameworks in relation to the study. It includes all conceptual and operational definitions of all the key concepts that are relevant to the study. It also includes a critical evaluation of all previous research involving the concepts of current literature. This study uses secondary data or existing literature as part of methodology techniques.

Chapter 3 discusses the research design and analysis. This is done by using econometric and statistical tools to compute the data of independent and dependent variable.

Chapter 4 presents the research methodology which includes research design and the data collection. Under this chapter, Augmented Dickey-Fuller unit root test is employed to examine the causal relationship between road infrastructure investment, ICT investment and labour input.

Chapter 5 is the conclusion and recommendation of the study.

1.10 DEFINITION OF TERMS

Relationship: This is a causation between an event (the cause) and the second event (the effect) where the second event is understood as a consequence of the first event, though the cause and effects are typically related to changes and events.

Road: A road is a thoroughfare, route, or way on land between two places, which has been paved or otherwise improved to allow travel by some conveyance, including different mode of transport. Roads consist of one, or sometimes two, roadways each with one or more lanes and also any associated sidewalks and road verges. Roads that are available for use by the public may be referred to as public roads or highways.

Infrastructure: Infrastructure is basic physical and organizational structures needed for the operation of a society or enterprise, and or the services and facilities necessary for an economy to function. It can be generally defined as the set of interconnected structural elements that provide framework supporting an entire structure of economic development.

Investment: Investment is a capital formation acquisition or creation of resources to be used in production. It is also undertaken by government, non-profit institutions, households and it includes the acquisition of human and intangible capital as well as physical capital (Coen & Eisher, 1992). According to the United Nations (UN, 2005), investment can be explained as access to basic physical infrastructure such as electricity, telephones, water and roads, access to information and advisory services, higher labour productivity.

Economy: Economy consists of the economic system of a certain country or region, which comprises the production, distribution or trade, and consumption of goods and services in that country or area.

Paved: Pave is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway. Such surfaces are frequently marked to guide traffic.

Unpaved: A road other than paved.

South Africa: Republic of South Africa which has nine provinces.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter firstly discusses the theoretical and conceptual background of the relationship between road infrastructure investment and economic growth. Road infrastructure plays a strategic and indirect role in the economic development process of a country. It does not directly increase output, but it makes a significant contribution towards growth by increasing the factor productivities such as land and capital in the production process. The profitable economic activities require efficient and functioning systems of transport infrastructural systems.

Road infrastructure in South Africa is a specific area of concern as the development of such infrastructure in the country has been neglected to a large extent in some provinces, thereby imposing significant limitations on growth and development in rural communities. An increased interest in road investment potential has developed recently mainly due to the economic development as well as the positive impact that the road investment could generate on rural communities, should they have an adequate support roads infrastructure network that is sustained over the long term. It is however a huge task to establish the impact of road investment on economic growth, particularly when the benefit received through this infrastructure is extremely difficult to be quantified (Lombaard & Coetzer, 2007).

In general, for the infrastructure to be efficiently and cost effectively managed, there should be proper and effective systems in place. The budget allocation of construction and maintenance is with very exceptions simply not sufficient, especially where the allocation had to deal with the backlog as a result of neglect (State of South Africa's Economic Infrastructure, 2012). All too frequently the inadequacy of the allocation is compounded by poor management which results to this meagre budget allocation going unspent.

The construction and maintenance of road infrastructure generate more jobs per rand spent than most other sector of the economy. This investment appears to satisfy national development needs as well as driving the priority of our developing country, the creation of much needed jobs (Department of Transport, 2011). This provision has too often been made in a flawed, through an isolated focus on capital expenditure than through life cycle costing model. Innovation and creative procurement is a specialised process essential to sustain infrastructure especially in the province beset with skills and financial constraints (SAICE Infrastructure Report Card, 2011).

Road infrastructure is at the heart of the society. Individual mobility is essential for most working and leisure activities. Modern mobility is an expression of lifestyle and social form and is essential for the economy. Road infrastructure is synonymous with the essential to develop and has a significant impact in term of poverty alleviation as they provide the poor with the better physical access to employment (Papi & Attane, 2001).

The Expanded Public Works Programme (EPWP) is one of the arrays of government strategies aimed and addressing unemployment and infrastructure improvements through labour intensive methods. It was first introduced in April 2004 with a goal of creating 1 million jobs (EPWP Infrastructure Sector, 2009). Although the impact of EPWP in terms of sustainable employment cannot be quantified, temporary jobs were created for a period not exceeding two years. Youth, women and disabled persons were part of the beneficiaries, they were also skilled in the different field including road infrastructure construction field.

South Africa skilled labour by proportion of population has up to twenty times fewer engineers than Australia, America, Western Europe and even India and China. Furthermore, the racial and gender balances are still overwhelmed by whites and males who are ageing. Increasing the number of engineers is a recognised government priority, which will need a multifaceted approach starting with mathematics and physical science at lower school (SAICE Infrastructure Report Card, 2011). Training and mentorship of artisan and young engineering professionals is also essential at all levels including public sector. Although indications are that the remunerations at the public sector have improved noticeable through occupational specific dispensation process, this has not addressed the skills constraints in civil, structural and

electrical engineering. The problem is further exacerbated by the deployment of unskilled, unqualified and in-experienced personnel in positions that require technical abilities (SAICE Infrastructure Report Card, 2011).

The above discussion theory applies to road infrastructure investment and the impact it creates to economy. Road infrastructure investment and labour inputs are often mentioned as a key to promoting growth and development. The aim of the chapter is to review the available literature and highlight the findings from different studies, especially past and current data. It further reviews the impact of infrastructure investment or budget, the employment created on road infrastructure to alleviate poverty as well as communication technology enhancing economic growth.

2.2 THE IMPORTANCE OF ROAD INFRASTRUCTURE INVESTMENT: THEORETICAL DISCUSSIONS

2.2.1 Theoretical role of Road Infrastructure Investment

Roads infrastructure is a long term investment which may take several years to be completed and is regarded as a multi-years project. As a result, the instant and longer-term implications of road infrastructure improvements may differ significantly. Time may be required for markets to develop around new roads, and the benefits to in terms of employment and usage may not appear until several years after the project has been fully completed, as such some studies find that the causality direction is from GDP to infrastructure rather than the other way around (Gramlich, 1994; Munell, 1992).

Initial spikes in investment and consumption opportunities may occur in areas with better access to market and other public facilities, but may fall back over time as increased migration and labour supply catch up with demand (Almirall, Bergada &Ros, 2008). Price fluctuations and changes in transport costs that emerge in the short run may also revert after a few years. Many studies, however, have examined how impacts of these types of public infrastructure

programs evolve over several years, this debate has cause major controversies as such many studies have found very high returns to investment including the one by (Auscher, 1989).

The significance of interest in the framework to the financial progression of a country cannot be over clarified. Lacking or poor base breaking points open an entrance to possibilities, and additionally better life opportunities and administrations, for example, clean water, training, wellbeing, solid transport and correspondence. The ILO report (2010) indicates that in spite of the fact that framework advancement is not distinguished as an immediate Millennium Development Goal (MDG) target or pointer, without it large portions of the objectives won't be met and that maintainable foundation is not just a fundamental part in enhancing the occupations of poor people, it additionally gives chances to making employments amid development, operation and upkeep.

Framework advancement is an essential for neediness easing and business creation in immature nations. Be that as it may, vigorous and quick modernization of transport foundation and others are keys for supportable improvement and a propelled economy. Nations with all around created framework guarantees better living conditions for the general resident and the progression of intensity private organizations (ILO, 2010).

Euractiv (2010) contended that without the making of good fundamental foundation, for example, information transfers, postal administrations, transport framework and waste transfer, the vision of the current Europe with great living conditions in all areas will just remain a fantasy. Numerous analysts view framework speculation as the embodiment of monetary development and improvement. Aschauer (1989) began the examination on the effect of the foundation venture and efficiency development in the United States. He advances that generally slower development in the open foundation capital that was expereinced in the United States amid the 1970s and 1980s was to a great extent because of private area profitability log jam. One of his discoveries is that the private yield flexibility concerning open framework capital was around 0.42 for every penny, thus demonstrating a level of affectability. In connection to Africa, the framework improvement all around has been disregarded for quite a while. This is related to moderate financial development which results to high work, neediness and in the long run common wars.

Aschauer (1989), Lynde and Richmond (1993) likewise concentrated on the foundations for the decrease in the US yield and profitability development since the mid-1970s. They found that the administrations of people and in general capital are a huge part of the creation process and that around 40 for every penny of the efficiency decrease in the United States was clarified by the fall in broad daylight capital-work proportion. Moreover, Ford and Poret (1991) recommend that cross-country contrasts in monetary development may likewise be clarified halfway by contrasts in levels of framework capital consumption.

Aschauer (1993) contends that the general population base, for example, streets and parkways, information transfers, water and sewer frameworks ought to be considered as an element of creation alongside work inputs. With a specific end goal to build efficiency development, nations must help the rate of capital aggregation on the substantial capital, for example, base, plant and hardware, or elusive capital, for example, abnormal state of talented staff.

2.2.2 Neo Classical growth model

Economic theory proposed by Adam Smith[1] identifies channels through which infrastructure can positively impact on economic growth using neo classical growth theory, which sometimes called a Solow growth model. This is an expansion of Harrod - Domar growth (1946). Neo classical model assumes infrastructure capital as subjected to diminishing returns to scale in the long run economic growth.

According to Kim (2012), many countries have common elements to grow and develop their infrastructure economy, which they have stable governments that pursue prudent economic policies, provide essential infrastructure and services and take a long-term economic perspective. They use the opportunities provided by global markets and have a dynamic and competitive private sector economy. Neo classical growth model stated in this chapter influenced infrastructure accumulation by saving and depreciation rates in the short run economic growth. However, in the long run it is determined by the population growth.

[1] A Scottish moral philosopher pioneer political economy : According to Smith, output is correlated with labour, capital and land inputs. He argue further that, growth (g_Y) was determined by population growth (g_L), investment (g_K) and land growth (g_T) and results in a overall productivity (g_F). He depicted the production function : $Y = f(L,K,T)$

The notion that long run growth in the model is also influenced by the technological progress and labour force growth due to population changes, shocks in infrastructure investments can only have temporary effects on income. According to Sahoo et al. (2010), infrastructure influence output in the long run. Endogenous growth theory allows increasing or decreasing returns to scale raising a steady income per capita.

Solow model[2] believes that a sustained rise in Infrastructure investment increases the growth rate only temporarily because the ratio of capital to labour inputs goes up. However, the marginal products of additional units of infrastructure capital may decline in the long-term economic growth with real GDP growing at the same rate as the growth of the workforce plus a factor to reflect improving productivity.

Neo-classical economists believe that the increase in economic growth requires an increase in the labour input supply and increased level of labour input and infrastructure.

2.2.3 Road infrastructure financing in South Africa

Economic theory as put forward by the 20th century revolutionary economist John Maynard Keynes[3] advocated strong support for government spending to create jobs and allow utilization of infrastructure capital at a time of economic downturn when the employment of capital and labour is high. Keynes also believes that there is a need for government intervention on public infrastructure to activate and regulate the economy.

Foundation financing is one of the fundamental preconditions for empowering creating nations to quicken or maintain the pace of their development and accomplish the Millennium Development Goals (MDGs) set by the United Nations in 2000. Besides, the future venture needs of creating nations in base far surpasses the sum being spent by the administrations, the private division and different partners, bringing about an imperative financing crevice.
South Africa's monetary foundation venture has expanded somewhat to GDP in 2008 and 2009.

[2] An American economist . His works shows capital accumulation and output for an economy over time.
[3] John Maynard Keynes famous 20th century British economics, develop the idea of total output and income are determined by spending.

Hypothetical and experimental writing proposes the presence of causal connections between street foundation speculation, destitution diminishment, livelihood creation and supportable development and monetary advancement. Work on serious foundation and formative projects, especially in country ranges regularly prompt short and medium term occupation opportunities by diminishing rustic destitution (UNCTAD, 2008).

The International Labour Organization (2010) states that around the globe more than 1 billion individuals need access to streets foundation with about 1 billion without access to an all-climate street, while 884 million don't have safe drinking water, 1.6 billion have no dependable wellsprings of vitality, 2.4 billion need sanitation offices and 4 billion are without current correspondence administrations. In many examples nations with poor framework advancement are unrealistic to develop the economy and individuals are subjective to neediness and hardship.

Contemplates have demonstrated that making more prominent utilization of nearby work inputs and assets is typically 20 for each penny less exorbitant and recovery as much as 50 for each penny of remote cash necessities, notwithstanding making three to five times more employments with a multiplier impact of backhanded advantages of 1.6 to 2.0 more occupations. Be that as it may, few studies researched the causal relationship between these variables and the bearings of the causality utilizing both Granger-causality test and limits test approaches.

Among the constrained examination around there, Canning and Pedroni (1999) directed Granger causality test between interests in three sorts of financial framework that is, kilometers of cleared street, kilowatts of power creating limit, and number of phones in light of information from a board of 67 nations for the period 1960-1990. They discovered solid sign for causality running in both headings between each of the three framework variables and GDP among a critical number of the nations researched. The examination study put accentuation and affirms that there is a causal relationship between foundation speculation and monetary development, including different variables, for example, information transfers and work data.

Fedderke and Bogeti (2006) analyzed the immediate effect of foundation venture on work

efficiency and the roundabout effect of framework on aggregate variable profitability utilizing the board information examination strategy and Pooled Mean Group (PMG) estimator. Pesaran, Shin and Smith (1999) utilized unlimited blunder amendment ARDL 8 model. They contend that financial development and efficiency effects of framework have been portrayed by questionable results with little life. They propose various clarifications for the conflicting discoveries including conceivable swarming out of private by open division speculation, non-linearity creating the likelihood of foundation overprovision, concurrence between framework procurement and development, and the likelihood of numerous channels of impact in the middle of base and profitability upgrades.

The diagnostic effect of base venture on Spanish monetary development somewhere around 1850 and 1935, utilizing new foundation information and vector autoregression (VAR) strategies exhibits the positive development effect of neighborhood framework speculation, however comes back to interest in substantial across the nation systems were irrelevantly distinctive to zero as per Herranz-Loncan (2007). This likewise gives two adjusting clarifications to the last results. On the same breath, open base intercession and the use of non-proficiency venture criteria were exceptionally serious in vast foundation development while then again, comes back to new base speculation systems may have diminished significantly once the fundamental connections were built.

Moreover, measurable affirmation for the contextual analysis of the United States demonstrated that there is an immediate positive connection between framework venture and GDP for the period 1950-79 during in which development out in the open foundation contributed the proportion of around one is to one to financial development. Amid the specified period, base interest in key zones, for example, street transportation, correspondence, water administration and power era developed at a normal rate of 4 for every penny, while the general monetary or GDP development found the middle value of 4.1 for every penny amid the same period (Heintz *et al*., 2009). For street base speculation to impact on monetary development, it requires other variable components keeping in mind the end goal to affect absolutely.

Notwithstanding the yield and profitability impacts and framework speculation is accepted as being able to make a larger number of employments than different sorts of venture through

immediate, roundabout and prompted occupations. Be that as it may, the extent of circuitous and instigated impacts relies on upon the size of the foundation venture multiplier.

A comparative study was led in South Africa by Perkins, Fedderke and Luiz(2005). Utilizing Pesaran, Shin and Smith's, 1996, 2001, these creators perceived bearings of relationship between monetary foundation and financial development. They recognized long-run compelling connections from open division monetary framework venture and altered capital stock to total national output, from streets to GDP and from GDP to a scope of different sorts of base. They additionally found that there is an easy going relationship between monetary framework and financial development and the relationship keeps running in both bearings, which infers positive connections.

The present study varies from the past ones in three regards:

To begin with, the Fedderke and Bogeti (2006) and Perkins et al.'s (2005) examination utilized the information from pre-2005 period, of which their time arrangement did not consolidate the expanded monetary foundation speculation time of 2005-2009. In these cases, the present study overhauls results.

Secondly, their study excluded the causal relationships between economic infrastructure investment and public and private sector employment. Given the impacts of infrastructure investment on private sector employment, the investigation of the existence and the direction of causality among these variables is of importance. The present study makes an exclusive contribution by investigating these causal relationships. Moreover, the main objective of the study was to measure the elasticity of the various infrastructure investments with respect to labour productivity and total factor productivity, instead of economic growth only and as such our approaches are different (Fedderke & Bogeti, 2006).

Thirdly, the current study extends the pair wise Granger causality tests to the analysis of the short-and long-run causality between gross domestic product and economic infrastructure investment in an ARDL or bounds test framework from which the long term elasticity of economic infrastructure investment was projected. The projected outcomes elasticity are found

to be much smaller than those obtained by previous empirical studies that used data of before 2005.

2.2.4 Experience of road infrastructure funding across the world

2.2.4.1 Transport infrastructure investment in China: Case study

Before the change time of China, street ventures were subsidized prevalently by household sources in China. These sources included government appointments, benefits from state possessed ventures, and neighbourhood government demands. The focal government was in charge of the improvement of national streets, while the common and nearby governments were for the commonplace and neighbourhood street systems (Démurger 2001). Under the halfway arranged framework, commonplace and neighbourhood governments typically got stores for foundation development from the focal government.

Taking after the financial changes, the wellsprings of assets for streets have progressively extended and now incorporate assets from focal and nearby governments, as well as advances from universal associations and banks, and additionally outside capital. Another vital modification has been the issuance of long haul open bonds to back foundation ventures. Somewhere around 1998 and 2002, the government provided more than 660 billion yuan in bonds. These bonds were issued to state-claimed banks, for example, the Industrial and Commercial Bank of China and the Agricultural Bank of China, and were doled out to extends went for:

I. Infrastructure interest in horticulture, woods, water conservancy, and the earth.

II. Construction of expressways, railroads, landing strips, ports, and telecom ventures.

III. Environmental security.

IV. Upgrading rustic and urban electric and correspondence systems.

As nearby governments were given more self-rule in the post-change period, they got to be in charge of the majority of the base activities financed by bonds. Nearby governments applying for express way development undertakings are presently required to raise 35 percent of the cost themselves from their own income which incorporates tolls this was through offers of securities. The remaining 65 percent of the expense is financed through bank advances. Previously, banks were hesitant to give advances to street ventures (Démurger, 2001).

Financing in streets, particularly in thruways and turnpikes, has ended up being useful as of late, notwithstanding, banks are currently more anxious to store street ventures; be that as it may, in the eastern area and in western district the bank are as yet opposing subsidizing street ventures. The more noteworthy self-rule given to neighbourhood governments additionally added to extending provincial disparity as the ability to raise assets to fund framework ventures relied on upon nearby government income (which thus relied on upon the level of nearby monetary movement) and the capacity of nearby governments to arrange higher commitments from the focal government (Démurger, 1999). The developing uniqueness in street procurement crosswise over areas drove the focal government to dispatch significant street development improvements in the focal and western districts. Thus, the offer of expressway interest in eastern China declined from 54.8 percent in 1998 to 45.2 percent in 2001, though the relating offers in focal and western China expanded from 45.1 percent to 54.9 percent.

2.2.5 Road Infrastructure and Economic Growth

In the study directed by Kweka and Morrissey (1990), it was discovered that the administration spending and financial development in Tanzania was set up in a way that open speculation on physical framework and human capital contributed monstrously to monetary development through venture. The related investigations of Al Yousify (2000) and Abdullah (2000) which is autonomous of each other, uncovered that Saudi Arabia government use contributes emphatically to monetary development. The same positive relationship upheld by Ranjan and Sharma, (2008) on the examination of base effect of India.

This position did not get the endorsement of other people who contended that the despite what might be expected, an expansion in the administration consumption instead of advancing financial development really backs off the execution of the economy. In this gathering are Laudau (1986), Barrow (1991), Engen and Skinner (1992) and Folsters and Henrenkson (2001). This contention is based on the point that endeavor to expand the spending by government will energize increments in tax collection and obtaining, which thus would diminish pay, total request and demoralizes diligent work, advancement and inventiveness. Higher benefit duty will make higher expense of generation which could adversely influence speculation use and the procuring of the organizations.

Oyinlola (1993) in an experimental examination on the relationship between resistance use and monetary advancement reasoned that a positive relationship exists. Fajingbesi and Odusola (1999) experimentally decided the relationship between government consumption and financial development in Nigeria where the result demonstrated genuine government capital applying huge positive impact on genuine yield, while the genuine government intermittent use indicated negligible impact on development.

Utilizing a disaggregated technique on government use whose segment incorporates capital, repetitive, regulatory, financial, social, and group administrations, Akpan (2005) presumed that a condition of immaterial relationship between most parts of government consumption and monetary development. Comparable studies on the impacts of open consumption on base and financial development over the world showed that by and large positive relationship as in the investigation of the USA and Japan by Shioji (2001) which demonstrated that base capital has beneficial outcome on long-run yield in both nations and in the Netherland where Sturm (1998) had the same result as got in the USA and Japan.

Ghali's (1998) investigation of Tunisia showed a positive relationship between open speculation and development. In any case, Al-Faris (2002) in his work on Public Expenditure and Economic Growth reasoned that an unimportant relationship exists between government utilization consumption and the rate of financial development. Barro and Sala-i-Martin (1995) considered use as either gainful or ineffective, where beneficial consumption has direct effect on the rate of financial development, while inefficient use has roundabout or no impact on the

development rate of the economy. Israel (1991) in an examination did to investigate the monetary rate of return of World Bank budgetary undertaking from 1968-1984 indicated transportation speculation especially on streets to be exceptionally profitable.

Subsequently, an effective street system could decrease the time and cost of development of merchandise inside of a nation and just as empowers association among the distinctive parts of the nation which enhances communication. Anyanwu, Adebusuyi, and Kukah (2003) in their article on upkeep of Highway in Nigeria watched that the development of monetary exercises in Nigeria relied on upon the level of change on the streets. Aigbokhan (1999) in his study on base opined that, framework variables have positive relationship with private speculation and monetary development, and that empowering venture drove development requires palatable subsidizing on foundation to create new limits and similarly keeping up the current ones.

Streets framework upgrades the circulation of products and administrations through national and universal markets and great transport associations diminish transport costs, while empowering mechanical advancement. Familoni, refering to Aigbokhan (1999) in a paper "Assessing Investment on Basic Infrastructure in Nigeria" gives samples of foundation as open utilities, for example, power, information transfers, funneled water supply, sanitation and sewage, strong waste accumulation and transfer and channeled gas and in addition open works which incorporate streets, significant dams and waterways for watering system and other transport ventures like urban and entomb urban railroads. To Aigbokhan, open base does three things: It gives benefits that are a piece of the utilization heap of inhabitants.

Huge scale uses for open works escalates total request and give short-run boost to the economy and it serves as an information into private area creation, in this way enlarging yield and efficiency. The conveyance of monetary framework can grow the profitable limit of the economy by expanding the amount and nature of such base. Upgrades in support would enhance the nature of existing base offering ascend to financing overflow. Streets and transportation are exceptionally basic to individual from the general public for not too bad expectation for everyday comforts.

Transport is exceptionally key to monetary development it might be said that an immediate relationship exists between a nation's financial development and flourishing (Owen, 1964, Queiros and Gautam, 1992). Be that as it may, numerous creating nations need tasteful transport offices. An exact examination directed by the World Bank (1992) covering ninety eight (98) nations utilizing the time arrangement information from 1950 demonstrated a reliable and noteworthy relationship between financial development as far according to capita gross national item and street base, per capita as far as length of cleared street system.

2.2.5.1 Economic Development: Case Study of Estonia

There have been a few foundation information corrections to yield measurements in Estonia amid 2009. These updates were sufficiently critical to oblige rectifications to the prior comprehension of Estonia's potential financial development rate. The most recent information vintage from 2009 is utilized to gauge Estonia's potential yield development and yield hole. In any case, the creation capacity approaches have been utilized to shows that the hole changes widely. The full scale model reproductions expect the potential development rate to diminish later on. The abatement in the peripheral profitability inputs makes financial development moderate to around 4-5 for each penny in the following five years, if there are no extra stuns to the economy (Katti, 2010).

Estonia's potential development rate has changed after 2009 because of the intermittent updates of yield framework and development insights. The anticipated imperceptibly potential GDP is more troublesome because of the restricted time arrangement, covering just the most recent 12–13 years, perceiving just the chose variables. Albeit moderately restricted, this time arrangement range is rich in stun scenes. From the onset the local yield was intensely affected by the Asian and Russian emergencies. The opening of new development channels by EU supported monetary development and later strengthened by the credit blast, which got to be unfavourable stuns from the worldwide emergency. These procedures structure one full cycle, inside of which potential GDP must be identified (Katti, 2010).

Utilisng the most recent information vintage accessible in Estonia, Katti (2000) shows that the creation capacity approach returns 6 for each penny normal potential development for the

period 1997–2009, in spite of the fact that there are very sizeable tops, which are produced by the unfavourable stuns recorded before and by basic changes, for example, shifts in the work supply as an illustration. These variables have additionally created instability entirely from 8 for every penny in 1999 to above 8 for every penny in 2007. The characteristic model-based wellsprings of high development have blur away unless an unanticipated mechanical leap forward creates, potential development will settle on a more steady however altogether lower way. These discoveries are obviously a contingent on the technique chose.

For this situation of creation, capacities approach figures diminish peripheral profits for generation inputs and consequently relentlessly abating potential development. This happens until the economy develops and achieves its strong development and advancement state.

The anticipated potential development rate lies somewhere around 4 and 5 for every penny in the following five years and somewhere around 3 and 4 for each penny in the years there-after. These rates are precise if there are no real stuns, negative or positive, which could twist potential development downwards or upwards. Regardless, the present paper does not intend to give the most exact expectation of potential yield development yet utilizes numerical model re-enactments to consider that the wellsprings of fast development have as of now been utilized something like a substantial degree through the span of monetary advancement, and normal development later on will stay lower than the authentic normal (Katti, 2010).

The yield of one expanded unit of a generation data, similar to an interest in framework capital or correspondence innovation is lower than one expanded information, suggesting the financial development example or pattern additionally backs off. The genuine measured development rate might withdraw from pattern development relying upon the repetitive developments. New information demonstrates that the progressing downturn is more extreme than that of 1999. Model re-enactments, in any case, anticipate a significant fast recuperation from the most minimal point, at which the yield hole achieves 17 or 10 for each penny relying upon regardless of whether the capital made in the blast times coordinates the new request structure (Katti, 2010).

In the main, case the negative yield crevice is more checked however the economy conforms back to its past GDP level, yet this does not happen in the second situation when the collected creation limits can't be completely used to take care of the new demand structure. In this second case the negative hole is little however at the expense of a fall in the level of potential and real GDP. It must be affirmed ex post whether the previous or last holds, once there is sufficient information on the change of the economy (Katti, 2010).

2.2.5.2 Economic Development: Case study of China

Qian (2012) shows that since 1978 China moved to a business sector based economy from arranged economy, it has been encountering a time of organized and quick advancement. In any case, because of arrangement reasons, there has been imbalanced development among areas, which has gradually turned into a difficult issue. One approach to manage this circumstance is to help inland ranges through suitable foundation improvement, particularly the vehicle base. A key to this issue lies on the relationship between the vehicle foundation and monetary improvement.

In China, fast and substantial scale transport base is under development, of which numerous are parkways, rapid railroads and transport terminals. A customary idea is "Need to be rich, form street first"; in any case, to what degree the vehicle framework could support the monetary development may absence of thought. Actually, in spite of the base itself as a stock, how it ignites the economy other than the travel cost reserve funds is on talk around the world. The present study joins the dialog on the connection between transport foundation and financial advancement through some observational examination on China (Qian, 2012).

There has been a basic idea that vehicle base has the impact of improving monetary development, particularly among the government officials. Be that as it may, as per Vickerman (2001), the association between transport framework and financial development is not all that stable. It is hard to acknowledge a solitary causal heading of these two elements, concerning the high probability of common connection. By and Berechman (2001) mention that it is broadly concurred that the monetary development happens mostly because of capital, work development and just incompletely relying upon the framework change. Transport foundation

goes about as a key condition for the development to occur. Despite the fact that there is undoubtedly about the immediate impact that the vehicle framework updating adds to cost reserve funds of profitable segments, for example, efficient, whether there is overflow impact, accordingly extra advantage produced from the base is discussable.

The colossal pattern of measured investigation of this issue could go back to the work done by Aschauer (1989), who evaluated the full scale impact of foundation venture on American economy. His work was trailed by numerous analysts, for example, Munnell (1990), Ford and Poret (1991). In these first trials huge appraisal results were determined. This was investigated by different specialists that the high versatility implies improbable rate of return of foundation (Gramlich, 1994). Yet some elucidation was made that a first stun in base could bring about awesome impact, in any case, after the essential base was set up, new venture would not bring about much impact (Hulten, 1996). Seeing the larger than usual consequences of past work, Holtz-Eakin (1994) contended that outcomes were extensively adjusted when econometrically considering state or district level imperceptibly impacts. Suppositions were made that the imperceptibly impacts are time invariant. Altered impacts and first distinction relapse were utilized to re-examine the information. Positive approximations found were altogether littler than those of Aschauer (Romp & Haan, 2005). In any case, there was a contention that the main distinction will devastate the long haul relationship (Duggal *et al*., 1999).

Because of the information openness, winning studies on China are chiefly on full scale level. An earlier study by Sylvie (2001) analyzed China information to find that the framework may clarify the territorial abberations of monetary improvement. As of late some associated think about have additionally approached in China. Xu *et al*. (2007) defined a two-stage connection between's expressway transport and financial advancement. There are additionally numerous different studies on this issue (Liu *et al*.; 2005, Zhang *et al*., 2007).

2.2.5.3 Economic Growth: Case study in Turkey.

The fleeting and long haul relationship between the transportation–communication capital arrangement and genuine yield for Turkish economy were researched by An Eruygyr et al.

(2012). The examination utilized a Cobb–Douglas generation capacity for the Turkish economy under the supposition of consistent comes back to scale over the three inputs of aggregate non-private capital arrangement (K1), transportation–communication capital stock (K2), and work (L). For effortlessness and because of degrees of flexibility concerns, the variables were communicated as far as the powerful work all through the investigation.

The study used unit root tests and co-combination investigation by anticipating a VECM. As a consequence of the vector mistake remedy model (VECM) estimation, one co-incorporating relationship is seen for the Turkish economy for the period 1963–2006. By co-coordinating vector projections, it gives the idea that a ceteris paribus 10 for every penny increment in use in transportation–communication base would have been anticipated to build the yield in Turkey by around 3 for each penny which is an amazing impact. Then again, from the VECM gauges, the velocity of the conformity coefficient of the mathematical statement has observed to be -0.3. It suggests that the Turkish genuine yield encounters sharp increments with expansions in the aggregate capital and transport (An Eruygyr *et al*., 2012).

Transportation capital is ordinarily and at all times seen as a part of the aggregate open base capital and in this manner the effects of transportation capital stock on the level of yield and efficiency is for the most part watched together with the other open foundation capital. In the writing, just a little number of connected studies have included transportation capital as a different class, and just not very many studies have straightforwardly inspected the effects of transportation capital stock on monetary development (Banister & Berechman, 2003: 145).

The generation capacity methodology is one of the two primary methodologies that have been utilized in the observational writing to inspect the financial impacts of open capital and/or transportation capital. The second approach is the vector autoregressive (VAR/VECM) approach. The creation approach expected from the earlier causal linkage running from inputs to the yield, be that as it may, the VAR/VECM methodology can be delegated an information situated philosophy.

Some principle investigations of the creation capacity methodology can be said as Ratner (1983), Aschauer (1989), Ram and Ramsey (1989) and Holtz-Eakin (1994). Ratner's (1983)

original article assesses the impact of open foundation speculation on private yield, utilizing the US yearly information for the period 1949–1973 and finds that the flexibility of private yield regarding open capital is 0.06. Another fundamental examination is Aschauer's (1989) which investigated the relationship between open framework capital and total yield of private division, utilizing the US information for the period 1949–1985. His estimation result shows that private yield flexibility for open capital is 0.39. He then infers that a 1% point increment in general society capital stock would advance total yield by around 0.4% focuses.

The article of Ram and Ramsey (1989), utilizing yearly information for the period 1948–1985, records that open capital has an imperative constructive outcome on the US private business yield. Then again, Holtz-Eakin (1994) inspecting the relationship between open division capital amassing and private part profitability for the US economy for the period 1969–1986 found that there is no part of open capital on private segment efficiency.

The VAR/VECM methodology is the other procedure that has been utilized in the observational writing to consider the monetary effects of open capital and/or transportation.

Kamps (2005) emphasize that there are three points of interest of the VAR/VECM approach:

1. It permits breaking down the conceivable criticism impacts from the yield to the inputs, since it doesn't expect a from the earlier causal linkage just running from the inputs to the yield,

2. It allows breaking down the conceivable aberrant impacts of general society capital; i.e. the impacts that affect yield by implication through the effects on the private inputs, and

3. It does not as a matter of course concur on that there ought to be at most one co-mix relationship.

Numerous studies have been directed utilizing this methodology, which incorporate Looney (1997), Pereira and de Frutos (1999), Everaert and Heylen (2000) and Herranz-Lonca'n (2007). The article of Looney (1997) examins the part of framework variables, for example, vitality and transport in Pakistan's monetary development for the period 1973–1995, applying the

Granger causality tests and finds that open offices increments absolutely because of the requirements of the private division. Pereira and de Frutos (1999) look at effects of open capital on private area variables for the US economy for the period 1956–1989. Their observational result recommends that a one-dollar extra in broad daylight capital builds private yield in the long haul by 65 pennies.

The investigation of Everaert and Heylen (2000) researched the impacts of open foundation capital on multifaceted monetary development in Belgium, utilizing yearly information for the period 1953–1996. Their outcomes in light of a solitary mathematical statement co-reconciliation examination point to a solid positive association with causality running from open framework money to development. Additionally, Herranz-Lonca'n (2007) analysed the impact of foundation venture on Spanish monetary development for the period 1850–1935. The study highlighted that while the development effect of the nearby extension foundation venture is certain, profits to interest in vast nation systems are not extensively not the same as zero.

Alternate studies which find that open base capital expands yield can be classified as takes after: Ramirez (2000), Ligthart (2002), Albala-Bertrand and Mamatzakis (2001), Ramirez (2004); Mittnik and Neumann (2001), Pereira (2001), Kawakami and Doi (2004) and Kamps (2005). Then again, Ghali (1998) explores the effect of open base speculations on Tunisian monetary development over the period 1963–1993, utilizing a VECM, and infers that people in general base ventures have contributed adversely to Tunisia's financial development and improvement. As far as anyone is concerned, among the studies that have utilized the VAR/VECM approach, this is the main study in which open base speculations negatively affect development.

There are likewise those studies which inspected transportation and correspondence base speculation independently. For instance, Easterly and Rebelo (1993), utilizing pooled relapses, examined that among the other sectoral segments of open speculation, just transportation and correspondence foundation venture is absolutely connected with development with a high coefficient somewhere around.

2.2.6 The role of Information communication technology and economic growth

There is a growing evidence linking investment in ICT to economic growth, but little convincing evidence to labour input. Robert Solow triggered the idea of a paradox, saying " You can see the computer age everywhere but in the productivity statistics". Waver man *et al* (2005), Lee *et al.* (2009) and Qiang ( ) have demonstrated a clear connections between mobiles and economic growth. Their study on ICT stocks addresses the "endogeneity" problem. There is growing evidence in many parts of the world demonstrating the positive relationship between ICT investment and economic growth. ICT sector

2.2.7 Expanded Public Works Programme and Roads infrastructure

Job under the EPWP is represented by the learnerhip Determination for unemployed learners and the Code of Good Practice for Special Public Works Programs for every single other member. The Code was gazetted by the Minister of Labour after discourses at National Economic, Development Labour Council (NEDLAC). It takes into consideration exceptional states of livelihood to encourage more prominent business on Public Works Programs, specifically:

1. Employers might set rates of pay locally at self-focusing on rates to abstain from pulling in specialists far from more perpetual occupation.

2. Reduced commitments for businesses, e.g. no Unemployment Insurance Fund (UIF) protection instalments.

3. Task-based instalment for work serious works.

This code and the going with Ministerial Determination are accessible on the EPWP site. These unique states of livelihood apply on condition that labourers on EPWP's have a qualification to preparing and that specialists are utilized under these extraordinary states of work for a restricted term of time.

The job conditions on EPWP undertakings are from perceived commercial ventures. This is so as to forestall EPWPs being a vehicle for deregulation of the work market or for advancing casualization in the work market. The Code of Good Practice additionally sets governmental policy regarding minorities in society focuses for the livelihood of youth, ladies and individuals living with inabilities on EPWP ventures. It likewise requires that important group based associations (CBOs) be counselled with respect to the decision of specialists to be utilized on activities. The Department set these principles to guarantee that the arrangement of EPWP is managed legitimately and appropriate consistence and is inside of the structure of work contract.

Notwithstanding working with unemployed members in the project, the EPWP will likewise concentrate on preparing open area authorities, private division experts and other invested individuals in labour-escalated ways to deal with the conveyance of products and administrations. This, joined with the work attempted by the Business Trust to bolster development and make a groundswell of backing for the reception of work based methodologies, plans to make an empowering situation for easing unemployment.

The base arrangement is being driven by the Department of Public Works and incorporates the Departments of Transport, Housing, Provincial and Local Government, Water Affairs and Forestry, Public Enterprises, Minerals and Energy and Education. What is more, the Independent Development Trust has been drawn into the arrangement. The lead at the fore by the offices was to guarantee that the unemployment is decreased radically, of which it is based on youth, ladies and debilitate persons.

The arrangement expands on the experience of the Zibambele program in KwaZulu-Natal, Itirele program in the North West Province and the Gundo Lashu program in Limpopo. Territorial business is utilized as an appropriate measure of surveying the impacts of transport framework on neighbourhood monetary development (Bannister & Berechman, 2000). There will be a solid accentuation on proficiency, cost-viability and nature of items when presenting work escalated development strategies in common works under the EPWP. The work will be done utilizing a fitting blend of work and machines. Temporary workers will be permitted to utilize machines for development exercises where it is not actually or financially plausible to

utilize work. All the work will be completed by ordinary industry quality measures. The project includes ring-fencing a segment of the current contingent framework gifts to territories and districts. Throughout the following five years, roughly R15 billion or 33% of the aggregate spending plan will be spent on the work serious development and upkeep ventures, for the most part low-volume streets, storm water channels, trenching for pipelines and walkways.

Berechman (2000) mentions that transport framework changes are done incrementally, extend by undertaking after some time. Monetary development is a persistent procedure of yearly increments in per capita wage and business, of which vocation is utilized as most basic measure of financial development. The project all things considered has accomplished its targets as far as abilities advancement through preparing furthermore develops the economy through EPWP.

2.2.8 Infrastructure development and current situation in China: L Y U

During the last half century, the economic development in China has experienced three periods. As pointed out by Liu (2003), they are highly central planned period, transformation period and market based period. In the central planned period before the Reform and Opening up policy had been taken in the late 1970, infrastructure in China experienced slow development stages, but the industrial investment growth is relatively fast. In the early 1950, China was in the extreme poverty. After three years of recovery, the first five year plan started from then, China underwent a large-scale economic construction, of which basic industries and infrastructure were an important composition.

According to Yu (2011), between 1954 and 1977 the total aggregated basic industries and infrastructure investment in capital construction was 299.6 billion Yuan with annual growth rate of 8.7 per cent. At that period the economic growth focus of the government was on the heavy industry. Coal mining, oil and electricity industries grow fast. Also, due to the influence of the great leap forward and Cultural Revolution, the fundamental industry grew at the lowest annual average rate after 30 years of the reform and opening up policy. At the beginning of the transformation period during 1978-1989, the scale of the investment of the whole society was very small. Basic industry and infrastructure were still very weak. To change this situation, China devoted its limited funds to several key industries, such as agriculture, transportation,

source of energy, education, health care etc. During that period, the total investment of basic industries and infrastructure construction was 547.9 billion Yuan, with the average annual increase 10.7 per cent. As a reform and opening up continued, the material production became continuously abundant and product supply was prosperous.

The opening up also facilitated the inflow of foreign direct investment (FDI) to the manufacturing sector. Cheap labour and better infrastructure both nourished the export led growth strategy. However, unlike the seemingly unlimited supply of cheap labour, infrastructure failed to grow as fast as the economy, causing the bottleneck problem. After 1990, in order to realize the second step of strategic modernization target the Chinese government outlined the "People's Republic of China's ten year national economic and social development planning and eighth five-year programme which proposes future development goal of agriculture, water conservation, energy, transportation, post and telecommunications, raw materials and other industries.

During 1990-2002, the total investment in basic industries and infrastructure construction was 8.0249 trillion Yuan, with an annual growth of 26 per cent, much higher than the average annual rate of 15 per cent during 1979-1989. During that period Treasury funds played an outstanding role in the basic industry and infrastructure. Since 1998, after the Asian financial crisis, the Chinese government intended to stimulate the domestic demand by an expansionary fiscal policy.

About 660 billion Yuan of special Treasury bonds were issued during 1998-2002 for basic industry and infrastructure investment. These funds were mainly used in agriculture, water conservation, transportation, communications, urban infrastructure, urban and rural network reconstruction, the central reserve, grain depot and other infrastructure projects. The capital investments, joined by private capital, formed the basis of rapid growth of investment in industry and infrastructure projects. During 1998-2002 total investment in basic industries and infrastructure construction was 7, 3380 trillion Yuan, with the average annual growth of 13.1 per cent. This investment spurred the growth of investment of the whole society and also led the country smoothly out of difficult economic times. During the year 2003-2008, the Chinese government one hand took measures to strengthen government investment in the basic industry

and the infrastructure constrauction, on the other hand, encouraged foreign and domestic private investmentin the basic industries and the infrastructure construction projects. This bosted China's basic industries and infrastructure and vastly improvedpeople's living conditionin urban and rural areas. During 2003-2008, total investment in basic industries and infrastructure was 24.667 trillion Yuanat the average growth rate of 24.5 per cent. Chinese government has invested 4 trillion Yuan in infrastructure and public services to stimulate economy and maintain high growth rate.

2.2.9 Role of road infrastructure in poverty alleviation in South Africa

Advancement of the vehicle segment like other framework parts prompts increment in component efficiency in different segments by expanding openness and diminishing transport costs. Visser states that as a rule transport advancement concentrates on expanding proficiency and development, despite the fact that now and again like interfacing rustic connection streets to tribal or remote territories it might straightforwardly concentrate on destitution diminishment. It is, be that as it may, remarkable that even development arranged transport improvement ventures make critical commitment to neediness lessening. Transport undertakings can be isolated into:

(a) Those concentrating on neediness;

(b) Those concentrating on proficiency and development; and

(c) Proficiency cum-neediness ventures.

It is once in a while hard to quantify the effect of transport on destitution diminishment since it includes numerous connections inside of the general harmony structure. It is perceived that maintained financial development prompts lightening of neediness. Transport gives moderate administrations which encourage association between beneficial exercises. Transport improvement decreases the expense of collecting inputs, including capital and data, for creation from various areas, consequently diminishing the expense of generation. Further, it encourages the dispersion of innovation through expanded rate of spread of skill.

The yield costs likewise get lessened, along these lines prompting extra request and advancement of provincial and universal exchange. It additionally encourages horticulture to popularize, industry to practice and the economy to appreciate advantages of scale. It likewise advances broadness of the economy. Accordingly, the critical part of transport advancement in improving financial development is all things considered perceived. There is a solid understanding that great transport is a key condition yet not an adequate condition for financial development way. Then again, monetary development expands interest for transport base. Interest in the vehicle segment produces salary and creating so as to win open doors for the poor employments for untalented work in development and support of transport base. Notwithstanding occupation, interest in country transport results in transport affected lower costs of purchaser merchandise that convey alleviation to the shopper spending cost (Rust *et al*., 2008).

Further, by bringing down costs of rural inputs, it helps poor ranchers to modernize their generation design. It likewise prompts higher acknowledged cost for agriculturist's yield due to diminished transportation costs. Besides, expanded availability additionally prompts expanded prosperity through encouraging higher individual portability and enhancement in financial exercises that outcome from expanded stream of data and expanded utilization of transport administrations because of lessening in the expense of administration conveyance to the provincial poor.

Interest in transport, in any case, might have contrarily effect on the poor groups through the natural debasement that should be dealt with in transport speculation arranging stage. Toward the end, it will bring out how the absence of access to transport offices and administrations builds the endless loop of destitution and low salary in country ranges. Absence of transport offices result in low farming profitability, high transport costs, low net revenues, higher waste and loss of merchandise amid transportation and, henceforth, bring down levels of wage and expanded destitution (Department of Transport, 2011).

2.2.10 Measurement of Economic Growth and Development.

Financial development is customarily characterized as the yearly rate of expansion altogether creation or pay in the economy. Definition is qualified in two vital viewpoints being that:

• Production ought to be measured in genuine terms, suggesting that the impacts of swelling ought to be killed.

• The figure ought to be conformed to populace development, which suggests that the expression ought to be per capita premise.

Positive monetary development or improvement really happens just when add up to genuine generation or pay is developing at a speedier rate than the populace. For all intents and purposes, monetary development is measured essentially by deciding the yearly development in genuine creation or salary.

Add up to genuine generation is typically spoken to by genuine Gross Domestic Product (genuine GDP) or genuine gross national salary (genuine GNI). Gross domestic product incorporate fares yet reject imports, when genuine GDP is assessed, changes in fares are thusly considered yet changes in import costs are overlooked. Consider, when the cost of platinum expands, it influence the GDP deflator and genuine

The relationship between aggregate demand and production output is defined perfectly by John Maynard Keynes in his Keynesian model. He developed the idea that total output (GDP) and income are essentially determined by total spending in the economy.

Investment spending, which is called capital formation in the national accounts is volatile in all the components of aggregate spending, because of that it makes the economy to fluctuate. The level of investment is regarded as independent to the level of output. It clearly indicates that there is no systematic positive or inverse relationship between total investment and total output. If the investment does not respond in a systematic way to the change in output, the relationship between the investment and output can be approximated by a horizontal line.

Infrastructure investment is inherently a risky affair. The level of infrastructure spending depend on the willingness to take chances, which in turn depends on the expectations about

future economic conditions of which is the economic growth (Economics for South African Student).

2. 3 CONCLUSION

Street framework is key to financial improvement. As the economy grows, more merchandise should be transported, more individuals will go to different destinations, more items created. This can be conceivable if street framework systems are outlined and always kept up to can deal with substantial volume of merchandise.

By writing study directed in this section, two presumption identified with conceded street base upkeep that are liable to be made are that:

• The expense of working vehicle in the short run will probably increase.

• While over the long haul the restoration of cleared street each 10-20 years will be more than three times costly for the legislature.

The position is supported by World Bank (2000) that in the occasion where the street is not kept up, each rand saved money on street upkeep builds vehicle working expense. The suggestion is that, by curtailing support, the expense of street framework and the net expense to the economy is coincidentally expanded. The long haul disregard and support of street foundation system in South Africa, general has brought about the breakdown of the incorporated transport framework and further weakening of street system. Street framework venture is the way to financial development and assumes a key part in the diminishment of occupation and neediness lighten

CHAPTER 3

3. RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

This chapter reviews research methodology used to collect and analyse data in the relationship between road infrastructure investment (LG), information communication technology investment (LK), labour input (LL) and economic growth (LP) in the context of Cobb-Douglas

production function. Analytical frameworks outlining descriptive statistical model for data processing with reasons were also provided and explained.

3.2 DEFINITIONS

3.2.1 Gross Domestic Product (GDP)

The term Gross Domestic Products is applied in this paper as economic growth and an dependant variable. The data of real GDP is obtained from the South African Reserve Bank which is annually from 1960 to 2013.

3.2.2 Road Infrastructure Investments

Road infrastructure investment in this paper is called transport equipment obtained from the South African Reserve Bank (SARB) as an annual data from 1960 to 2013. The amount of investment put on road infrastructure.

3.2.3 ICT Investments

Data and correspondence innovation (ICT) ventures allude to both distinctive sorts of interchanges systems and the advancements utilized as a part of South Africa. The ICT part consolidates assembling and administrations businesses whose items fundamentally satisfy or empower the capacity of data handling and correspondence by electronic means. This is a yearly information from 1960 to 2013.

3.2.4 Labour input

Labour input is the relative merits of employment, which involves hours worked by persons in order to measure productivity. The data is obtained from the South African Revenue Services from 1960 to 2013.

3.3 DATA EXPLORATORY ANALYSIS

Time series data are used to analyse the above mentioned relationship for the period 1960 - 2013. Descriptive statistics used provide a historical background for the behaviour of the data included in the study. P -value associated with Jarque - Bera statistics suggest the departures of all variables except employment (L). Given the kurtosis of the variables, which are all less than three, the distribution of the variables exhibit non-normality (Stock and Watson, 2006).

3.3 1 Vector Auto regression Model (VAR)

In order to investigate the effect of road infrastructure investment and other macroeconomic variables to enhance economic growth in South Africa, VAR model as an ideal model was used in the implementation and forecasting of time series data set and was also used to examine the dynamic shock in one variable to another variables. It is common that the time series model is a structural model based on economic theory (Wadarjono, 2007). Sims (1980) built the Vector Autoregression to solve the problem of the traditional structural simultaneous models and the single equation models and to minimize the theory approach on the time series model. The VAR treated set of variables in equality, no differentiation between endogenous and exogenous variables. All variables are assumed to have interrelationship in the model.

3.4 Cobb-Douglas Production Function

Cobb-Douglas creation capacity is broadly used to analyse the mechanical relationship between two or more variables, especially physical capital, work and a measure of other data that can be delivered by those variables. The Cobb-Douglas creation capacity was produced and tried against factual confirmation by Charles Cobb and Paul Douglas amid 1927-1947 Bao Hong, Tan (2008).

The dynamic relationship between financial development and street framework venture, ICT speculations and work info are analyzed as monetary indicator.

3.5 Jarque -Bera Tests

J-B test is used to ascertain whether the errors of regression are normally distributed. The normal distribution has a skewness coefficient of zero and kurtosis coefficient of three. J-B test is optimal in the sense that the Lagrange Multiplier test (LM) for the null hypothesis of normality against the maintained hypothesis is generated by Pearson family of distributions. LM test, has the maximum asymptotic power, which means that the departure of road infrastructure investment, ICT stock and output from the normal distribution except employment was suggested with the use of p-values associated with Jaque-Bera test statistics. Kurtosis variables are all less than three, the distribution of variables exhibit non stationarity (Stock and Watson, 2006). The positive signs of the skewness for all the variables are indicative of variables with long tails.

3.6 Augmented Dickey Fuller Unit Root Test

Dickey and Fuller (1979, 1981) formulated a formal system to test for non-stationarity (Asteriou and Hall, 2011).Their reason testing for non-stationarity is comparable for the testing of the unit root test. Dickey Fuller test is the test for the unit root test in the time arrangement test, which is the enlarged rendition of the Dickey Fuller test for the bigger and more muddled arrangement of time arrangement models. The Augmented Dickey Fuller (ADF) insights, utilized as a part of the test is the negative number. It is demonstrated that the more negative it is the more grounded the dismissal of the theory that there is a unit root at some level of certainty. The method of testing the ADF is the same with respect to the Dickey-Fuller test and it is perfect on the utilization of the model.

3.7 Econometric and Statistical Software

All variables used were computed by using E-views econometric software. E-views simplify and provide a clear interpretation of time series data used in this paper. It was used to produces high quality graphs and tables. It was lastly used to generate forecasting and simulation. The software is compatible to the variables used in this study.

3.8 SUMMARY

All techniques and tools applied in this empirical study were thoroughly motivated. The relevancy and usefulness in the relationship between road infrastructure investment, ICT investment, labour inputs and economic growth was perfectly tested. The next chapter analyses data using tools and techniques specified in this chapter.

CHAPTER 4

STUDY OUTCOME ANALYSIS AND RESULTS

4.1 INTRODUCTION

This section exhibits the experimental examination of the information and additionally the discourse of the outcomes. The rest of the section is organized as takes after. Area 4.2 behaviours an exploratory investigation of the information while Section 4.3 analyses the dynamic connections between monetary development and work data (LL), street base venture (LG), and ICT speculation (LK) in the setting of the Cobb-Douglas creation capacity. In

Section 4.4, the vector autoregressive (VAR) logical technique is utilized to fundamentally analyse the long-run progress among the VAR framework with specific enthusiasm for the relationship of street foundation speculation with monetary development in South Africa while Section 4.5 looks at the short-run dynamic connections among the variables in the VAR framework with specific enthusiasm for the way of causal connections in the VAR framework and the impacts of stuns on the future condition of the framework.

4.2 EXPLORATORY DATA ANALYSIS

Table 4.1 reports the summary statistics of the data. These descriptive statistics provide a historical background for the behaviour of the data included in the study. For instance, the p-values associated with the Jarque-Bera statistics suggest departures of road infrastructure investment (G), ICT stock (K) and output (P) departing from normality, except for employment (L). Given that the kurtosis of the variables are all less than three, the distributions of the variables exhibit non-normality (Stock & Watson, 2006). In addition, the positive signs of the skewness for all the variables are indicative that the variables have long tails (Stock and Watson, 2006).

Table 4.1: Descriptive Summary of Actual Data

Statistic	G	K	L	P
Mean	14828.61	127722.8	104.9880	671079.6
Maximum	71360.00	708357.0	167.5000	3534327.
Minimum	120.0000	1068.000	42.35000	5411.000
Std. Dev.	19711.88	188736.4	33.70966	960262.6
Skewness	1.443045	1.722429	0.003471	1.574518
Kurtosis	3.873070	4.747526	2.609351	4.377424
Jarque-Bera	20.45647	33.57202	0.343473	26.58088
Probability	0.000036	0.000000	0.842201	0.000002

Observations	54	54	54	54

Figure 4.1 displays the time series plots of the variables considered in the current study, all expressed in the logarithmic form – economic growth or output (LP), proxies by gross domestic product, employment or labour (LL), ICT stock (LK) and road infrastructure investment (LG). As observed, the plots suggest the existence of a linear time trend in all four variables at levels (indifference data). Visual inspection of the plots suggests none of the variables contains structural breaks. In addition, none of the variables appears to exhibit any seasonal pattern. Hence, the logarithmic data may be readily used for further analysis.

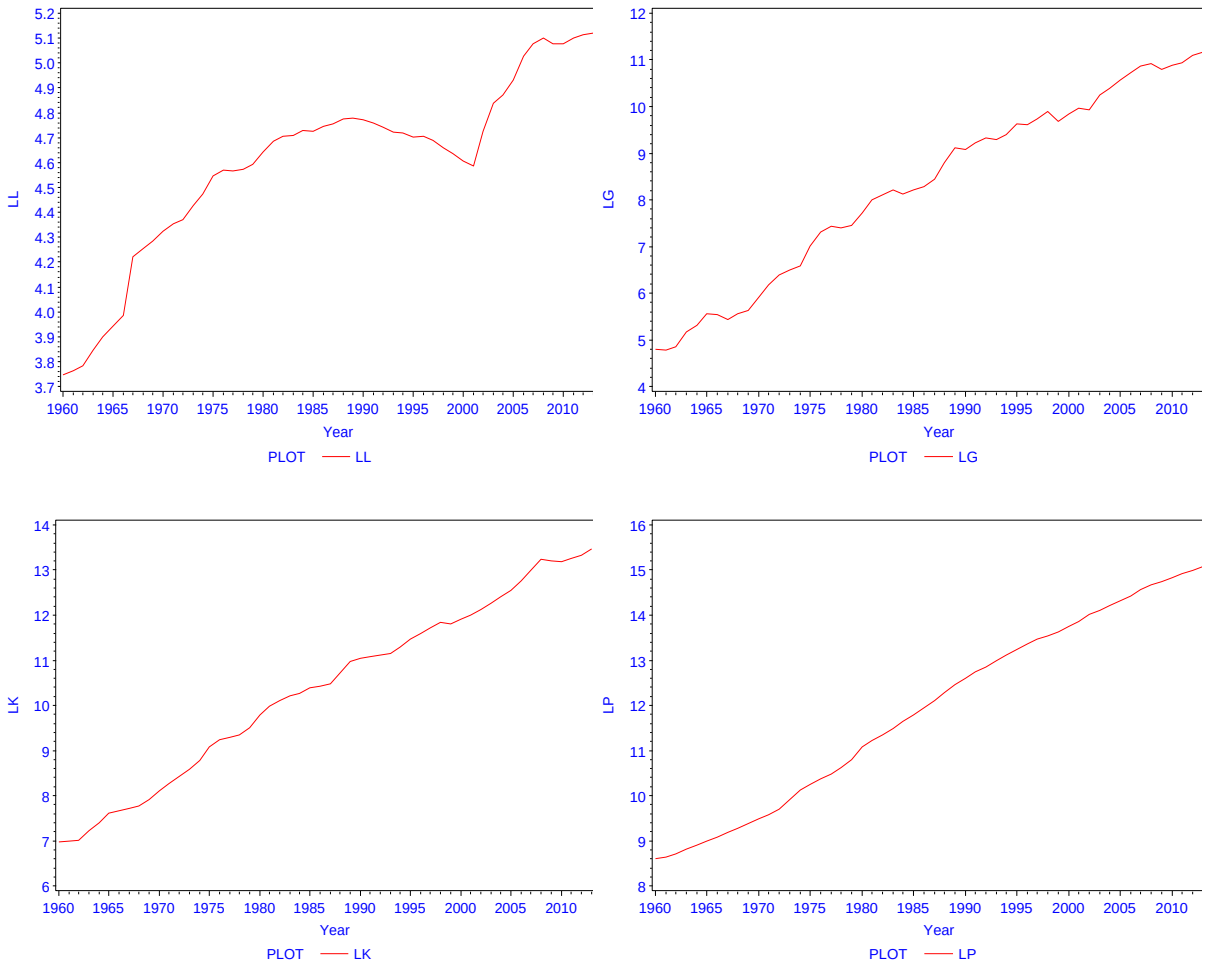


Figure 4.1: Time Series Plot of Logarithmic Data

4.3 Stationarity Tests

Determining the order of integration of variables in the VAR system is the first step to understanding the long-run dynamics in the system itself. Generally speaking, most macroeconomic time series are non-stationary, therefore, stationarity tests must be conducted prior to the conduct of cointegration tests. Consequently, this section seeks to investigate the order of integration of the variables in the VAR system using the Augmented Dickey-Fuller (ADF) unit root test. Table 4.2 and Table 4.3 reports the results of the ADF tests on the model including all three types of components – none, intercept, and intercept-trend. The results show that all four variables are non-stationary at levels (since the p-values of the test statistics selected by the AIC, SBC and HQC are greater than the 0.05 level) and stationary after taking first order difference (since the p-values of the test statistics selected by the AIC, SBC and HQC are less than the 0.05 level). It therefore means that all the variables in VAR system are integrated of order 1. Having the same order of integration allows the conduct of cointegration analysis among the variables.

Table 4.2: ADF Unit Root Tests of Log Data at Level

Variable	Exogenous	Optimal Lag	t Value	Prob >|t|	5% Critical Value	Information Criteria			Remark
						AIC	SBC	HQC	
LP	None	1	3.6133	0.9990	-1.9472	-3.7788	**-3.7038**	-3.7500	Non-stationary
	Intercept	1	-1.2801	0.6320	-2.9188	-3.7943	-3.6817	-3.7511	

	Int.+ Trend	1	-2.4046	0.3730	-3.4987	**-3.8524**	-3.7023	**-3.7948**	
LL	None	1	2.1139	0.9910	-1.9472	-3.4214	-3.3463	-3.3926	Non-stationary
	Intercept	1	-2.2688	0.1857	-2.9188	-3.4994	**-3.3868**	**-3.4563**	
	Int.+ Trend	1	-2.3883	0.3812	-3.4987	**-3.5066**	-3.3565	-3.4490	
LK	None	0	5.2768	1.0000	-1.9471	-0.4248	-0.3876	-0.4105	Non-stationary
	Intercept	0	-0.1973	0.9321	-2.9177	-0.4968	-0.4225	-0.4683	
	Int.+ Trend	0	-2.1072	0.5299	-3.4970	**-0.5435**	**-0.4320**	**-0.5006**	
LG	None	0	5.9277	1.0000	-1.9471	-1.1145	-1.0773	-1.1002	Non-stationary
	Intercept	0	-1.2619	0.6406	-2.9177	**-1.2190**	**-1.1447**	**-1.1904**	
	Int.+ Trend	0	-1.4130	0.8458	-3.4970	-1.2124	-1.1008	-1.1695	

AIC, SBC and HQC values in bold and underlined are the least

Table 4.3: ADF Unit Root Tests of Log First-Difference Data

Variable	Exogenous	Optimal Lag	t Value	Prob >|t|	5% Critical Value	Information Criteria AIC	SBC	HQC	Remark
dLP	None	0	-2.8889	0.0047	-1.9472	-3.5853	-3.5477	-3.5709	Stationary
	Intercept	0	-4.9934	0.0001	-2.9188	**-3.7998**	**-3.7248**	**-3.7711**
	Int.+ Trend	0	-5.0548	0.0007	-3.4987	-3.7771	-3.6645	-3.7340
dLL	None	0	-3.8946	0.0002	-1.9472	-3.3742	-3.3367	-3.3598	Stationary
	Intercept	0	-4.6747	0.0004	-2.9188	**-3.4388**	**-3.3630**	**-3.4092**
	Int.+ Trend	0	-4.8755	0.0012	-3.4987	-3.4328	-3.3202	-3.3896
dLK	None	3	-1.1101	0.2388	-1.9477	-0.3647	-0.2103	-0.3062	Stationary
	Intercept	0	-6.9680	0.0000	-2.9188	**-0.5983**	**-0.5232**	**-0.5695**
	Int.+ Trend	0	-6.9351	0.0000	-3.4987	-0.5655	-0.4529	-0.5224

dLG	None	0	-3.9271	0.0002	-1.9472	-0.9124	-0.8749	-0.8980	Stationary
	Intercept	0	-6.3649	0.0000	-2.9188	**-1.2033**	**-1.1283**	**-1.1745**	
	Int.+ Trend	0	-6.5192	0.0000	-3.4987	-1.1971	-1.0845	-1.1540	

AIC, SBC and HQC values in bold and underlined are the least

4.3 ECONOMIC GROWTH DYNAMICS USING THE COBB-DOUGLAS PRODUCTION FUNCTION

This section examines the dynamic relationships between economic growth and labour input (LL), road infrastructure investment (LG), and ICT investment (LK). In particular, the relationship between economic growth and the three other variables are examined as well as the relative significance of the predictors of economic growth.

4.3.1 Significance of Road Infrastructure Investment in Economic Growth

The first task involves investigating the relationships between economic growth (LP) and each of the three predictor variables – labour input (LL), road infrastructure investment (LG), and ICT investment (LK), as well as the relationships between pairs of predictor variables. Table 4.4 presents the correlation analysis of the four variables.

Table 4.4: Correlation Matrix of Variables

Pearson Correlation Coefficients, N = 54 Prob > |r| under H0: Rho=0				
	LP	LL	LK	LG
LP	1.00000	0.94950 <.0001	0.97462 <.0001	0.98225 <.0001
LL	0.94950 <.0001	1.00000	0.89808 <.0001	0.92099 <.0001
LK	0.97462 <.0001	0.89808 <.0001	1.00000	0.99289 <.0001
LG	0.98225 <.0001	0.92099 <.0001	0.99289 <.0001	1.00000

The results show significant relationships between economic growth and each of the three predictor variables. At the 0.05 level, the results show the existence of strong, positive and significant correlation between economic growth and each of the three other variables. According to the magnitudes of the correlation coefficients, road infrastructure investment LG) is most highly correlated with economic growth followed by ICT investment (LK) and labour input (LL). In addition, road infrastructure investment (LG), ICT investment (LK) and labour input (LL) are significantly and positively correlated to each other. The high significant correlations between economic growth and the three other variables point to the possibility of multicollinearity in a regression in which road infrastructure investment, ICT investment, and labour input are simultaneously included predictor variables. Instead, the significantly high correlations between economic growth and the three other variables can be used to justify that an increase in infrastructure investment will result in an increase in economic growth. Again, the positive correlations between economic growth and each of the three other variables indicate that the four variables are economically interrelated.

Table 4.5 displays the Cobb-Douglas production function estimation results. The results reveal a significant model which accounts for nearly 98 percent of the total variation in the data (R-Square = 0.9795). The three predictor variables are all significant the 0.05 or 0.10 level and the coefficients are all positive as expected. However, the variance inflation factors (VIF) suggest

the presence of multicollinearity when road infrastructure investment, ICT investment, and labour input are simultaneously included in the model as predictor variables, confirming the earlier assertion. To assess the significance of the three predictor variables on economic growth, a Principal Component Regression (PCR) analysis was conducted to transform the predictor variables into non-correlated variables by creating eigenvectors from which the problem of autocorrelation gets addressed.

Table 4.5: Estimated Cobb-Douglas Production Function

Dependent Variable: LP						
Analysis of Variance						
Source		DF	Sum of Squares	Mean Square	F Value	Pr > F
Model		3	20.72809	6.90936	796.03	<.0001
Error		50	0.43399	0.00868		
Corrected Total		53	21.16207			
Root MSE		0.09317		R-Square		0.9795
Dependent Mean		9.24709		Adj R-Sq		0.9783
Coeff Var		1.00751		Durbin-Watson D		0.2098
Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	5.18025	0.30528	16.97	<.0001	0
LL	1	0.57608	0.09640	5.98	<.0001	7.52562
LK	1	0.08044	0.04325	1.86	0.0688	80.60826
LG	1	0.10805	0.06511	1.66	0.1032	102.74458

The results from the principal component regression of economic growth on the three predictor variables are summarized in Table 4.6. From the PCR results, the principal component regression factor accounts for nearly 96% (model effects: 95.8409) and 98% (dependent variables: 97.9492) of the predictor and response variations, respectively. The relative significance of the predictors of economic growth can be examined using the component loadings. Considering the model effect loadings together, the results show that no predictor variable appears to have less significance, although road infrastructure investment (LG: 0.585360) has the highest loading, and hence most significant predictor, among the three predictor variables, of economic growth.

Table 4.6: PC Regression Results for Cobb-Douglas Production Function

Factor Extraction Method	Principle Components Regression
Number of Response Variables	1
Number of Predictor Parameters	3

Percent Variation Accounted for by Principal Components

No. of Extracted Factors	Model Effects		Dependent Variables	
	Current	Total	Current	Total
1	95.8409	95.8409	97.9492	97.9492

Model Effect Loadings

No. of Extracted Factors	LL	LK	LG
1	0.565665	0.580841	0.585360

Parameter Estimates

	LP
Intercept	5.191260904
LL	0.572846663
LK	0.080645824
LG	0.108358439

4.3.2 Dynamics of Economic Growth

This section investigates the dynamics in economic growth with no constraints. As revealed by the results in Table 4.6, although the estimated model is significant, the existence of residual autocorrelation, heteroskedasticity, and non-normality render the results not reliable for further interpretation. From the results in Table 4.6, the Durbin-Watson statistic of 0.2098 is indicative of residual serial correlation since it is nowhere near the expected value of 2. Accordingly, the model is re-estimated and the final results summarized in Table 4.7. In the results, one autoregressive term, AR1, has been included to eliminate residual serial correlation. The model

is highly significant with explanatory power of 99.6% (R-Square: 0.9960). The Durbin-Watson statistics of 1.7183 (approximately 2) suggests no residual serial correlation. The post-model estimation results reported in Table 4.8 reveal a residual normality (Jarque-Bera: 0.5649, prob=0.7539 > 0.05) and homoscedastic residuals (p-values of Q and LM statistics at various orders are greater than 0.05). The results show that economic growth elasticity of infrastructure investment is 0.1271 (LG coefficient), suggesting that a 1% increase in the stock of infrastructure investment increases economic growth by nearly 0.13%, which is quite substantial for the South African economy.

Thus, in the absence of any constraint, the estimated economic growth model is:

$$\hat{P}_t = 285.7736 * L_t^{0.4474} K_t^{0.0753} G_t^{0.1271}.$$

The results show that economic growth elasticity of infrastructure investment is 0.1271 (LG coefficient), suggesting that a 1% increase in the stock of infrastructure investment will increase economic growth by nearly 0.13%, which is quite substantial for the South African economy.

Table 4.7: Re-Estimated Cobb-Douglas Production Function

Dependent Variable: LP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	19.55768	4.88942	2964.43	<.0001
Error	48	0.07917	0.00165		
Corrected Total	52	19.63685			

Maximum Likelihood Estimates

Log Likelihood	96.7625761	Total R-Square	0.9960
Durbin-Watson	1.7183	Observations	54

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	5.6552	0.5195	10.89	<.0001
LL	1	0.4474	0.1350	3.32	0.0017
LK	1	0.0753	0.0280	2.69	0.0098
LG	1	0.1271	0.0360	3.53	0.0009
AR1	1	-0.9176	0.0701	-13.09	<.0001

Table 4.8: Post-Model Estimation Results Economic Growth Elasticity Model

Test of Residual Normality			
Statistic	Value	Prob	Label
Jarque-Bera Test	0.5649	0.7539	Pr > ChiSq

Tests for ARCH Disturbances Based on OLS Residuals

Order	Q	Pr > Q	LM	Pr > LM
1	1.5847	0.2081	1.4363	0.2307
2	2.2880	0.3185	2.4842	0.2888
3	5.7468	0.1246	4.6155	0.2022
4	6.8236	0.1455	4.7913	0.3094
5	9.5316	0.0896	7.8738	0.1633
6	12.3383	0.0548	8.5771	0.1988
7	13.4043	0.0628	9.0280	0.2507
8	13.7749	0.0878	9.0280	0.3399
9	17.4994	0.0414	9.4596	0.3960
10	19.7253	0.0320	10.2895	0.4155
11	19.9384	0.0462	10.4058	0.4943
12	20.1544	0.0642	11.9068	0.4532

4.3.3 Dynamics of Economic Growth with Increasing Return to Scale Constraint

This section examines the dynamics in economic growth resulting from the constraint of increasing return to scale of all input variables, with particular interest in road infrastructure investment. Table 4.9 summarizes the final regression results, accompanied by a summary of the post-model estimation results in Table 4.10. The model is highly significant with explanatory power of about 98% (R-Square: 0.9793). The Durbin-Watson statistic of 1.6990 (approximately 2) suggests there is no residual serial correlation issue. The post-model estimation results shown in Table 4.15 confirm a residual normality (Jarque-Bera: 8.5693, prob=0.0751 > 0.05) and homoscedastic residuals (p-values of Q and LM statistics at various orders are greater than 0.05). With the constraint of increasing return to scale constraint, the estimated economic growth model is:

$$\hat{P}_t = 57.0427 * L_t^{0.8478} K_t^{0.0631} G_t^{0.0614}.$$

The results show that economic growth elasticity of infrastructure investment is 0.0614, implying that a 1% increase in the stock of road infrastructure investment increases economic growth by about 0.06%, which is quite substantial for the South African economy.

Table 4.9: Regression Results in the Increasing Returns to Scale Model

Dependent Variable: LP – LL					
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	4.75174	1.58391	573.51	<.0001
Error	49	0.13533	0.00276		
Corrected Total	52	4.88707			

Maximum Likelihood Estimates			
Log Likelihood	88.9256181	Total R-Square	0.9774
Durbin-Watson	1.6900	Observations	54

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	4.0438	0.2565	15.77	<.0001
LK - LL	1	0.0631	0.0317	1.99	0.0518
LG	1	0.0614	0.0366	1.68	0.1001
AR1	1	-0.8982	0.0619	-14.50	<.0001

Table 4.10: Post-Model Estimation Results

Increasing Returns to Scale Model

Test of Residual Normality			
Statistic	Value	Prob	Label
Jarque-Bera Test	8.5693	0.0751	Pr > ChiSq

Tests for ARCH Disturbances Based on OLS Residuals

Order	Q	Pr > Q	LM	Pr > LM
1	0.0371	0.8473	0.0509	0.8214
2	0.4206	0.8104	0.3529	0.8383
3	0.8330	0.8416	0.6196	0.8919
4	1.5360	0.8203	1.0979	0.8946
5	1.5365	0.9088	1.1206	0.9523
6	1.5533	0.9559	1.1256	0.9804
7	2.1432	0.9515	1.4435	0.9842
8	5.3921	0.7150	3.5126	0.8982
9	6.4488	0.6943	5.1612	0.8200
10	7.1616	0.7101	5.5779	0.8494
11	7.4239	0.7638	5.8639	0.8823
12	8.5807	0.7383	6.7078	0.8763

4.3.4 Dynamics of Economic Growth with Constant Return to Scale Constraint

This section investigates the dynamics in economic growth resulting from the constraint of constant return to scale of all input variables, with particular interest in road infrastructure investment. A summary of the final regression results is reported in Table 4.11, accompanied by a summary of the post-model estimation results in Table 4.12. The model is highly significant with explanatory power of about 98% (R-Square: 0.9793). The Durbin-Watson statistic of 1.6674 (approximately 2) is an indication of no residual serial correlation. The post-model estimation results reported in Table 4.12 shows a residual normality (Jarque-Bera: 4.0774, prob=0.1302 > 0.05) and homoscedastic residuals (p-values of Q and LM statistics at various orders are greater than 0.05). Under the constraint of constant return to scale, the estimated economic growth model is:

$$\hat{P}_t = 65.9238 * L_t^{0.8478} K_t^{0.0433} G_t^{0.1089}.$$

The results show that economic growth elasticity of infrastructure investment is 0.1089, suggesting that a 1% increase in the stock of road infrastructure investment increases economic growth by about 0.11%, which is quite substantial for the South African economy.

Table 4.11: Regression Results in the Constant Returns to Scale Model

Dependent Variable: LP – LL					
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	4.77739	1.59246	711.40	<.0001
Error	49	0.10969	0.00224		
Corrected Total	52	4.88707			

Maximum Likelihood Estimates			
Log Likelihood	91.3994496	Total R-Square	0.9793
Durbin-Watson	1.6674	Observations	54

Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	4.1885	0.1145	36.57	<.0001
LK - LL	1	0.0433	0.0283	1.53	0.1326
LG - LL	1	0.1089	0.0391	2.79	0.0075
AR1	1	-0.8963	0.0629	-14.25	<.0001

Table 4.12: Post-Model Estimation Results

Constant Returns to Scale Model

Test of Residual Normality			
Statistic	Value	Prob	Label
Jarque-Bera Test	4.0774	0.1302	Pr > ChiSq

Tests for ARCH Disturbances Based on OLS Residuals

Order	Q	Pr > Q	LM	Pr > LM
1	0.4469	0.5038	0.4886	0.4845
2	0.8489	0.6541	0.8598	0.6506
3	1.6978	0.6374	1.3311	0.7218
4	2.1933	0.7003	1.5081	0.8252
5	2.1933	0.8218	1.5482	0.9074
6	2.3041	0.8897	1.7014	0.9450
7	2.5101	0.9263	1.7970	0.9702
8	4.9392	0.7641	3.8964	0.8663
9	7.0211	0.6349	6.4826	0.6908
10	8.4832	0.5817	6.7981	0.7444
11	8.6279	0.6562	6.8148	0.8139
12	9.7391	0.6388	7.8410	0.7974

4.3.5 Total Factor Productivity

Following a standard application in the literature, the assessment of total factor productivity (TFP) of the South African economy is assumed to be characterized by the Cobb-Douglas production function with a constant to scale. In that case, $\alpha+\beta+\gamma=1$, and so the estimated production function is:

$$\ln P_t - \ln L_t = \ln A_t + \beta(\ln K_t - \ln L_t) + \gamma(\ln G_t - \ln L_t)\,.$$

and so $$A_t = TFP = \exp\{(\ln P_t - \ln L_t) - \beta(\ln K_t - \ln L_t) - \gamma(\ln G_t - \ln L_t)\,,$$

Where $\beta = 0.0433$ and $\gamma = 0.1089$. Figure 4.3 is a time series plot of TFP. Since the use of inputs is subject to cyclical factors, economic activities tend to fluctuate over the business cycle. Consequently, TFP estimates pro-cyclical behaviour and has to be adjusted for capacity

utilization. In other words, TFP estimates could be biased if capacity utilization is ignored in productivity assessment. In the literature, adjustment for capacity utilization is done using capital stock statistics such as inventory data, unemployment statistics, or power utilization (Jorgenson & Griliches, 1997). The use of these statistics is based on the assumption that, given the perpetual inventories rule, the capital stock can be regarded as indicator for the overall capacity of the economy (Dennis et al, 2000). Using the growth accounting framework, potential output (economic growth) is estimated. First, the total factor productivity (TFP) is estimated using the constant return to scale relation:

$$TFP_t = \ln A_t = (\ln P_t - \ln L_t) - 0.0433(\ln K_t - \ln L_t) - 0.1089(\ln G_t - \ln L_t).$$

Figure 4.2 displays the overlay plot of TFP and potential TFP. As observed from the plot, over the period 1960-2013, the TFP ranged between 53.9 and 76.8. Interestingly, the TFP consistently declined over the period 1960-1992, only for it recover after 1993. Again the consistent fall in the TFP can be attributed to the fact the economy was operating under the apartheid regime during that period.

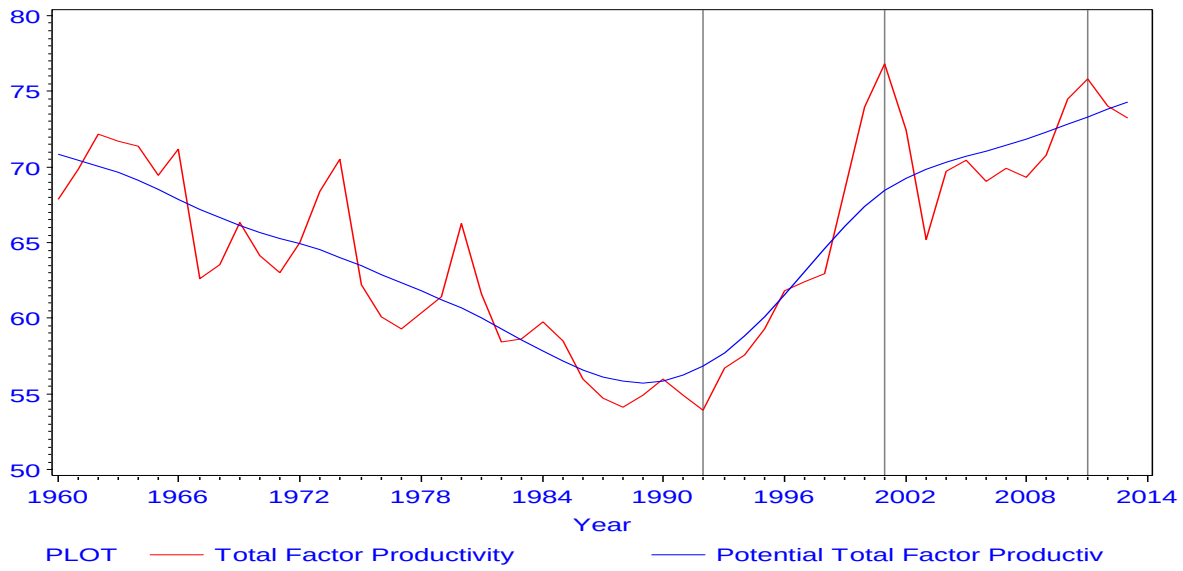


Figure 4.2: Plot of Total Factor Productivity

Over the period 1960-2013, the TFP reached its highest ever in 2001. In more recent years, the TFP estimates show that the TFP was relatively high in 2011. The potential total factor productivity (TFP) growth data is illustrated in Figure 4.3. It is obvious from Figure 4.3 that

the period 1960-1989, which falls under the apartheid years, dramatically affected the TFP outcomes of the South African technological development. The worst productivity performance occurred in 1983. However, as further observed from Figure 4.5, potential TFP values were positive, indicating progress in technological development since 1990, with the best productivity performance occurring in 1997, just some few years the first all-inclusive elections were held in South Africa.

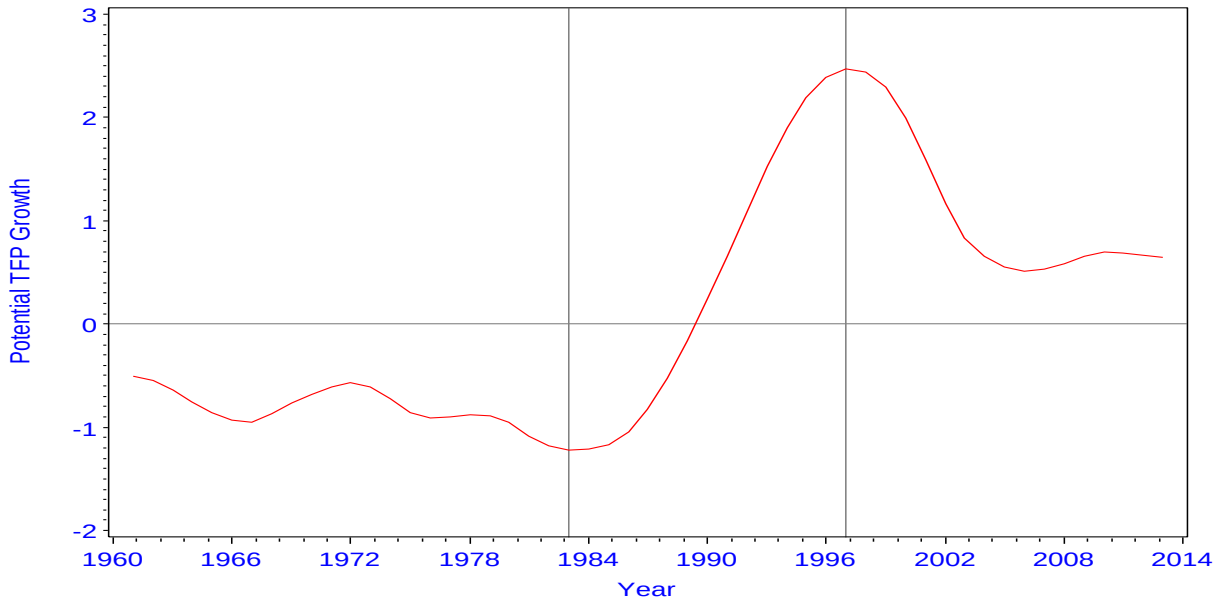


Figure 4.3: Plot of TFP Growth

4.3.6 Output, Potential Output and Output Gap

Using the Hodrick-Prescott filter, the trend component of TFP is extracted as potential technology input ($\ln A_t^{POT}$) while the trend components of labour input ($\ln L_t^{POT}$), ICT stock ($\ln K_t^{POT}$), and road infrastructure investment ($\ln G_t^{POT}$) are extracted as the potential employment, potential ICT stock, and potential road infrastructure investment, respectively Then, potential output, $\ln P_t^{POT}$, can be estimated using the relation:

$$\ln P_t^{POT} = \ln A_t^{POT} + \alpha \ln L_t^{POT} + \beta \ln K_t^{POT} + \gamma \ln G_t^{POT},$$

Using the constraint of constant return to scale, $\beta = 1-\alpha-\gamma$, where α=0.8473, β=0.0433, and γ=0.1089, the above equation becomes:

$$\ln P_t^{POT} = \ln A_t^{POT} + \alpha(\ln L_t^{POT} - \ln K_t^{POT}) + (1-\gamma)K_t^{POT} + \gamma \ln G_t^{POT}.$$

or $$\ln P_t^{POT} = \ln A_t^{POT} + 0.8478(\ln L_t^{POT} - \ln K_t^{POT}) + 0.8911K_t^{POT} + 0.1089\ln G_t^{POT}.$$

Output and Potential Output

Figure 4.4 presents the overlay plot of output, $\ln P_t$, and potential output, $\ln P_t^{POT}$. The level of potential output (P_t^{POT}) highly correlates with that from previous one (P_{t-1}^{POT}). The correlation coefficient was found to be 0.9997. The potential output in South Africa has been increasing over the study period, 1960-2013. Based on the results, the actual output was higher than potential output in 1960, 1963-1964, 1969, 1973-1975, 1980-1985, 1988-1990, 1995-1996, and 2004-2008.

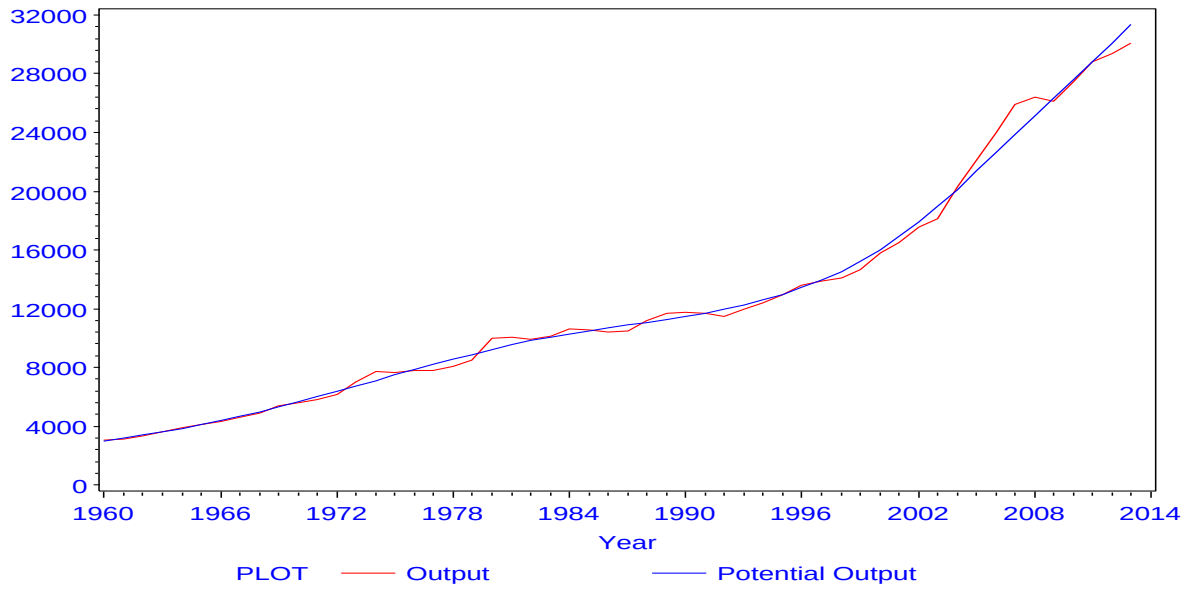


Figure 4.4: Overlay Plot of Output and Potential Output

Output Gap

Figure 4.5 displays the output gap estimates based on the production function with a constant return to scale constraint. The output gap measure displays the fact that over the period 1960-

2013, the South African economy was subject to several shocks. According to the output gap plot, economic expansion periods were generally interrupted by contractions, mimicking the excessive boom-bust cycle. In particular, over the 54-year data span, the output gap was negative for 30 years, suggesting that over the period, even with the contribution of the investment in road infrastructure, the actual output of South Africa was mostly lower than the potential output. The years of negative output gap include 1961-1962, 1965-1968, 1970-1972, 1976-1979, 1986-1987, 1991-1994, 1997-2003, and 2009-2013. Output reached its peak in 1974 after which it fell consistently to its lowest level in 1978. In 2007, output was very much close to the peak level of 1974 but declined steadily thereafter until now. A further observation of the output gaps in the more recent years shows that the economy of South Africa had been operating below its potential during 2009-2013. The consistent fall in the growth of potential output can fairly be explained by the movement in TFP which also slowed during this period.

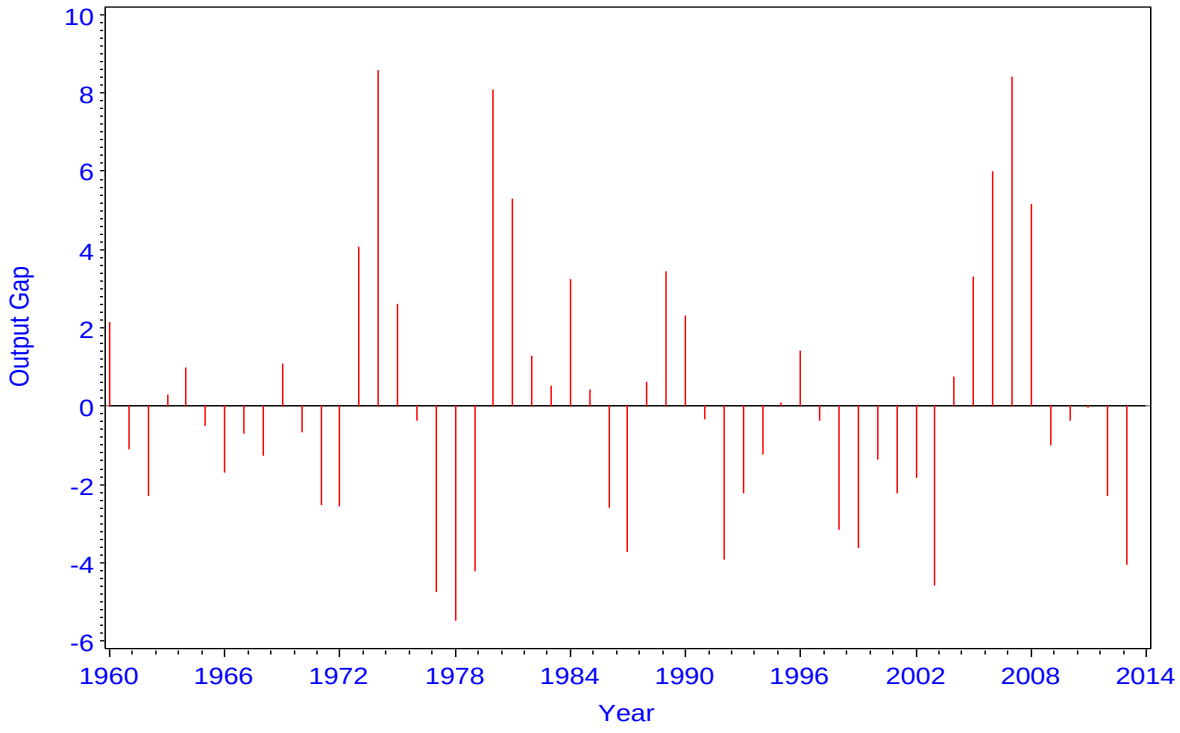


Figure 4.5: Plot of Output Gap

4.3.7 Potential Growth Accounting

In order to assess the contribution of road infrastructure investment to potential output growth in particular, and the contributions of all factors in general, the conventional potential growth

accounting analysis was conducted. A summary of the average potential output growth rates and primary factor inputs is reported in Table 4.13. According to the results in Table 4.13, TFP growth was the main source of potential output growth over the study period, 1960-2013, accounting for about 45.7 percent. Road infrastructure investment contribution to potential output growth over the study period was 9.5 percent, which is quite substantial. In recent years, the contribution of road infrastructure investment to potential output growth occurred in the sub-period 2000-2004.

Table 4.13: Average Factor Contribution to Potential Output Growth

Sub-Period	TFP^{POT}	L^{POT}	K^{POT}	G^{POT}	P^{POT}
1960-1964	3.41	2.62	0.08	0.44	6.56
1965-1969	3.29	2.73	0.10	0.48	6.60
1970-1974	2.89	2.58	0.12	0.48	6.06
1975-1979	2.09	1.96	0.11	0.40	4.55
1980-1984	1.33	1.29	0.08	0.28	2.99
1985-1989	0.80	0.80	0.06	0.19	1.84
1990-1994	0.95	0.94	0.08	0.24	2.21
1995-1999	1.69	1.62	0.15	0.43	3.89
2000-2004	2.48	2.37	0.23	0.65	5.74
2005-2009	2.35	2.32	0.23	0.64	5.55
2010-2013	1.85	1.87	0.19	0.52	4.43
1960-2013	2.08	1.91	0.13	0.43	4.55

4.4 ANALYSIS OF LONG-RUN DYNAMICS

This section employs vector autoregressive (VAR) models to examine the relationships of road infrastructure investment with economic growth in South Africa. This technique is purposely used to deal with the theoretical limitations and significant empirical controversies over the impact of road infrastructure investment on economic growth. In particular, this section employs the concepts of cointegration with the view to assess the existence or otherwise of any long-run equilibrium relationship among the variables.

4.4.1 VAR Analysis at Levels

The first step for examining the existence or otherwise of a long-run equilibrium between economic growth in South Africa and road infrastructure investment is to determine the optimal lag length for the VAR system. Table 4.14 displays the results for six different information criteria up to 7 lags. All six information criteria suggest an optimal lag length of 1, hence the VAR(1) system. Table 4.15 displays the VAR(1) estimation model using data at levels. In order to assess the stability and robustness of the estimated VAR(1) model, various post-model estimation analyses were conducted and the results reported. Figure 4.6 indicates that the VAR(1) system at levels for the data satisfies the stability condition since there are no roots lying outside the unit circle in each model. Based on the VAR residual heteroskedasticity test result reported in Table 4.16, there is no problem of residual heteroskedasticity since the p-value of the joint chi-square test is greater than 0.05. At the individual level, similar conclusions can also be derived from chi-square test results. Hence, the residuals from the estimated VAR(1) system at levels are homoscedastic.

Table 4.14: Optimal Lag Length Determination of VAR System at Levels

VAR Lag Order Selection Criteria

Endogenous Variables: LP LL LK LG

Exogenous Variables: C, t

lags	LogL	p(LR)	AIC	BIC	HQC
1	243.97288		-9.360548*	-8.415792*	-9.005030*
2	257.82373	0.03431	-9.269095	-7.694501	-8.676565
3	264.13565	0.70004	-8.856836	-6.652405	-8.027294
4	275.79519	0.10547	-8.672136	-5.837867	-7.605581
5	292.37800	0.00703	-8.696936	-5.232830	-7.393370
6	309.12457	0.00635	-8.728705	-4.634762	-7.188127
7	325.88691	0.00629	-8.761145	-4.037364	-6.983555

LogL : Log Likelihood

p(LR): P-Value of Sequential Modified LR Test Statistic

FPE : Final Prediction Error

AIC : Akaike Information Criterion

BiC : Bayesian Information Criterion

HQC : Hannan-Quinn Information Criterion

Table 4.15: VAR (1) System at Levels

Vector Autoregression Estimates

Endogenous Variables: LP LL LK LG

Exogenous Variables: C t

Standard errors in ( ) & t-statistics in [ ]

	LP	LL	LK	LG
LP(-1)	0.901713	0.322882	-0.023210	0.107052
	(0.09409)	(0.10596)	(0.48804)	(0.33091)
	[9.58373]	[3.04716]	[-0.04756]	[0.32351]
LL(-1)	0.011472	0.759107	0.123270	0.274071
	(0.06783)	(0.07639)	(0.35182)	(0.23855)
	[0.16914]	[9.93770]	[0.35038]	[1.14892]
LK(-1)	-0.026549	-0.000828	0.771799	0.127733
	(0.01919)	(0.02162)	(0.09956)	(0.06751)
	[-1.38316]	[-0.03832]	[7.75181]	[1.89213]
LG(-1)	-0.025690	-0.019048	0.140852	0.719750
	(0.02681)	(0.03019)	(0.13907)	(0.09430)
	[-0.95818]	[-0.63084]	[1.01281]	[7.63296]
C	0.982508	-1.527737	-0.397532	-0.716792
	(0.58031)	(0.65355)	(3.01010)	(2.04095)
	[1.69307]	[-2.33761]	[-0.13207]	[-0.35120]
T	0.011020	-0.005891	0.019037	0.002714
	(0.00483)	(0.00544)	(0.02504)	(0.01698)
	[2.28316]	[-1.08382]	[0.76038]	[0.15986]
R-Squared	0.997134	0.988663	0.995763	0.996486
Adj. R-squared	0.996830	0.987457	0.995312	0.996112
F-Statistic	3270.951	819.7524	2209.040	2665.748
P-Value(F-Statistic)	1.62e-58	1.74e-44	1.59e-54	1.95e-56

Durbin-Watson	1.436656	1.481335	1.672737	1.592979

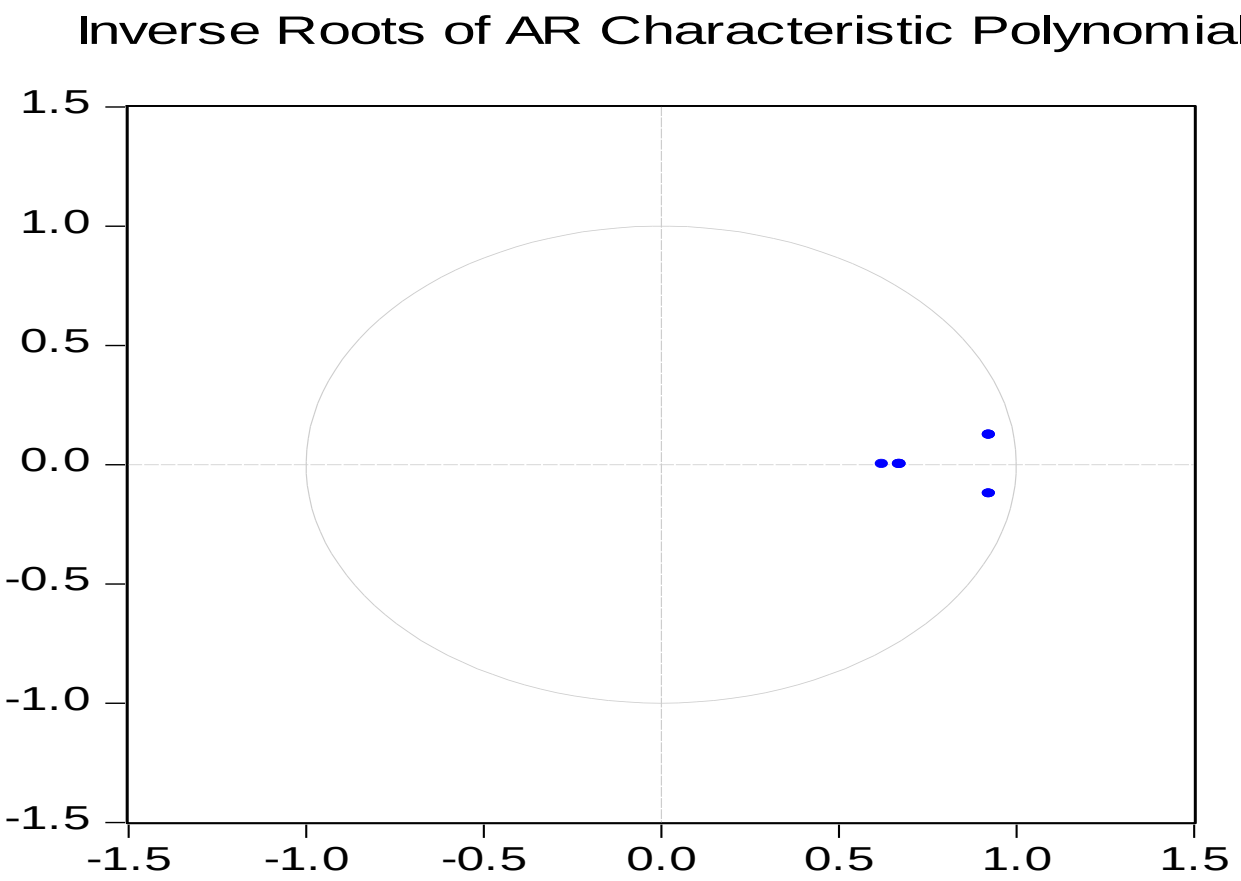


Figure 4.6: Eigenvalue Stability Condition

Table 4.16: VAR Residual Heteroskedasticity Tests of VAR (1) System at Levels

VAR Residual Heteroscedasticity Tests: No Cross Terms (only levels and squares)					
Endogenous Variables: LP LL LK LG					
Exogenous Variables: C t					
Joint Test:					
Chi-sq	df	Prob.			
119.1440	100	0.0930			
Individual Components:					
Dependent	R-squared	F(10,42)	Prob.	Chi-sq(10)	Prob.

res1*res1	0.066145	0.297487	0.9779	3.505697	0.9669
res2*res2	0.215896	1.156430	0.3462	11.44247	0.3241
res3*res3	0.226658	1.230976	0.3001	12.01289	0.2842
res4*res4	0.154146	0.765398	0.6604	8.169757	0.6123
res2*res1	0.168438	0.850734	0.5843	8.927194	0.5390
res3*res1	0.132312	0.640452	0.7708	7.012558	0.7243
res3*res2	0.166277	0.837647	0.5958	8.812704	0.5500
res4*res1	0.289652	1.712595	0.1097	15.35156	0.1198
res4*res2	0.226832	1.232193	0.2994	12.02207	0.2836
res4*res3	0.177669	0.907434	0.5351	9.416469	0.4931

The results from the VAR residual serial correlation LM tests and the VAR residual portmanteau tests for autocorrelations reported in Table 4.17 and Table 4.18 indicate no autocorrelation problem in the residuals from the estimated VAR(1) system at levels since the p-values of LM statistics, Q statistics and adjusted Q statistics are greater than the 0.05 or 0.01 levels of significance. This finding is supported by the fact that the residual plots generated from the estimated VAR(1) system at levels reported in Figure 4.7 are behaving more like a white noise process. Lastly, the VAR residual normality test results reported in Table 4.19 indicate that residuals from the estimated VAR(1) system at levels are not normally distributed either jointly or individually. As observed from the results, the problem mainly is in the skewness and kurtosis of the first and second equations, in which case, the p-values of such statistics are less than 0.05. The problem could be attributed to the relatively short sample size used, and can be resolved with longer time periods and data.

Table 4.17: VAR Residual Serial Correlation LM Tests for VAR (1) System at Levels

VAR Residual Serial Correlation LM Tests

Null Hypothesis: No serial correlation at lag order h

Endogenous Variables: LP LL LK LG

Exogenous Variables: C t

Lags	LM-Stat	Prob
1	23.19673	0.1086
2	11.69306	0.7648
3	12.97154	0.6748
4	15.23603	0.5074
5	19.23753	0.2565
6	17.71666	0.3407
7	14.07303	0.5933
8	31.04809	0.0133
9	16.22259	0.4375
10	9.159598	0.9067
11	12.91487	0.6790
12	19.08777	0.2641

Probs from chi-square with 16 df.

Table 4.18: VAR Residual Autocorrelation Portmanteau Tests for VAR (1) System at Levels

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h

Endogenous Variables: LP LL LK LG

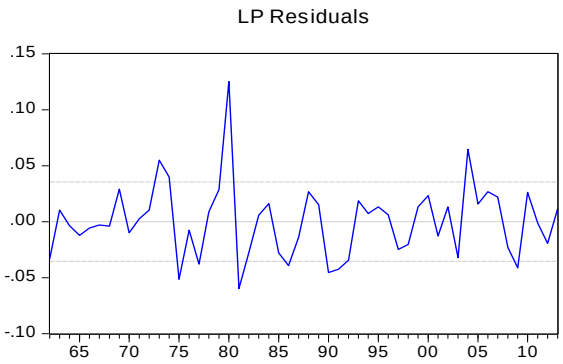
Exogenous Variables: C t

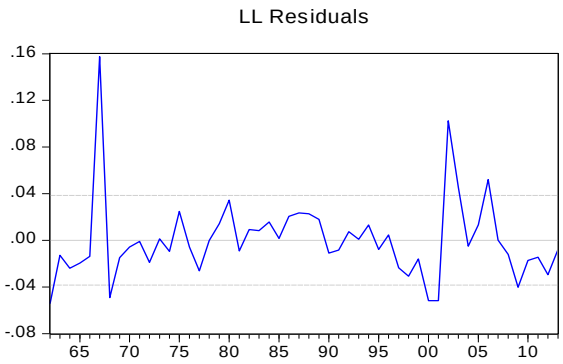
Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	16.85535	NA*	17.17949	NA*	NA*
2	25.60899	0.0598	26.27641	0.0503	16
3	37.69023	0.2250	39.08253	0.1816	32
4	52.83379	0.2928	55.46229	0.2140	48
5	70.83082	0.2604	75.33402	0.1571	64
6	86.89326	0.2801	93.44698	0.1444	80
7	100.6466	0.3527	109.2932	0.1670	96
8	126.0297	0.1723	139.1889	0.0417	112
9	140.1138	0.2189	156.1538	0.0459	128
10	148.7568	0.3758	166.8068	0.0938	144
11	158.9121	0.5094	179.6218	0.1374	160
12	174.6611	0.5143	199.9804	0.1039	176

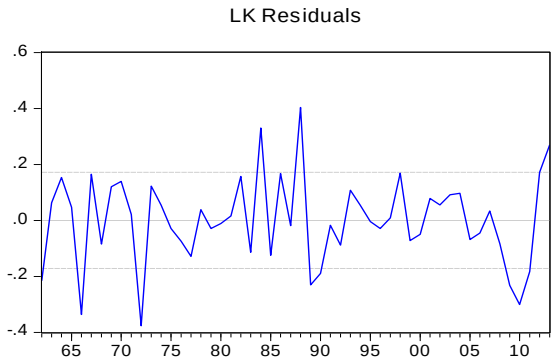
*The test is valid only for lags larger than the VAR lag order.

df is degrees of freedom for (approximate) chi-square distribution

*df and Prob. may not be valid for models with exogenous


LP Residuals
.15
.10
.05
.00
-.05
-.10
65
70
75
80
85
90
95
00
05
10


LL Residuals
.16
.12
.08
.04
.00
-.04
-.08
65
70
75
80
85
90
95
00
05
10


LK Residuals
.6
.4
.2
.0
-.2
-.4
65
70
75
80
85
90
95
00
05
10

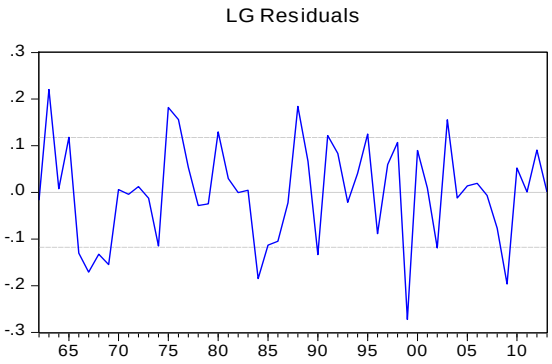

LG Residuals
.3
.2
.1
.0
-.1
-.2
-.3
65
70
75
80
85
90
95
00
05
10

Table 4.18: VAR Residual Normality Tests for VAR (1) System at Levels

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: Residuals are multivariate normal

Endogenous Variables: LP LL LK LG

Exogenous Variables: C t

Component	Skewness	Chi-sq	df	Prob.
1	1.214249	13.02388	1	0.0003
2	2.282982	46.03939	1	0.0000
3	-0.302536	0.808498	1	0.3686
4	-0.230979	0.471269	1	0.4924
Joint		60.34303	4	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	5.249355	11.17328	1	0.0008
2	12.09877	182.8227	1	0.0000
3	2.597949	0.356966	1	0.5502
4	2.632107	0.298887	1	0.5846
Joint		194.6518	4	0.0000

Component	Jarque-Bera	df	Prob.
1	24.19715	2	0.0000
2	228.8620	2	0.0000
3	1.165464	2	0.5584
4	0.770157	2	0.6804
Joint	254.9948	8	0.0000

Notwithstanding, this issue can be ignored on the basis of the appropriate models theory which argues that the lack of normality does not necessarily invalidate an estimated model, but only that there are other variables which may explain this result, a reasonable assumption being that there are many other factors that influence economic growth in general. The post-model estimation analysis results, therefore, provide ample evidence to support the stability,

robustness and adequacy of the estimated VAR (1) system at levels, allowing further analysis to be conducted on the basis of the estimated VAR (1) system at levels.

4.4.2 Deterministic Term Specification in the Cointegration Relationships

In Section 4.2.5, an optimal lag length of 1 for the VAR (1) system was found to be optimal for various analyses. An important question when applying the Johansen cointegration method is the deterministic term specification to be included, since results may differ from one to another.

Table 4.19: Deterministic Term Determination Test Summary

Series: LP LL LK LG

Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	0	0	0	0
Max-Eig	1	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend
Akaike Information Criteria by Rank (Rows) and Model (Columns)					
0	-8.926051	-8.926051	-9.202563	-9.202563	-9.111626
1	-9.094437	-9.056061	-9.181470	-9.208385*	-9.150998
2	-9.068251	-8.991528	-9.055176	-9.134182	-9.108072
3	-8.923905	-8.821979	-8.838512	-8.925348	-8.929896
4	-8.636679	-8.553690	-8.553690	-8.668640	-8.668640
Schwarz Criteria by Rank (Rows) and Model (Columns)					
0	-8.325668	-8.325668	-8.452084*	-8.452084*	-8.211052
1	-8.193863	-8.117963	-8.130801	-8.120191	-7.950233
2	-7.867486	-7.715714	-7.704315	-7.708273	-7.607116
3	-7.422949	-7.208450	-7.187460	-7.161724	-7.128748
4	-6.835531	-6.602446	-6.602446	-6.567301	-6.567301

Appealing to the Pantula Principle postulated by Johansen (1992), a summary of the results from all the five possible specifications of the cointegration relationships is reported in Table 4.19. Based on the AIC and SBC criteria, the model with intercept and trend (specification 4) is the best assumption for the cointegration relationships

4.4.3 Assessment of Long-Run Relationships

Table 4.20 presents a summary of the Johansen cointegration test results based on the inclusion of an intercept and trend in the VAR(1) system. At the 0.05 level of significance, both the trace statistic and maximum eigen-value test results do not support the existence of any long-run stable relationship among the four variables – output, labour, ICT stock, and road infrastructure investment. This finding is supported by the results from the Phillips-Ouliaris cointegration test results reported in Table 4.21 (p-values of tau-statistics and z-statistics are less than 0.05).

Table 4.20: Johansen Cointegration Test Results

Johansen Cointegration Test

Trend assumption: Linear deterministic trend (restricted)

Series: LP LL LK LG

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.296703	44.23603	63.87610	0.6819
At most 1	0.238108	25.93329	42.91525	0.7411
At most 2	0.128309	11.79185	25.87211	0.8262
At most 3	0.085562	4.651179	12.51798	0.6470

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.296703	18.30274	32.11832	0.7797
At most 1	0.238108	14.14144	25.82321	0.7104
At most 2	0.128309	7.140669	19.38704	0.8910
At most 3	0.085562	4.651179	12.51798	0.6470

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4.21: Phillips-Ouliaris Cointegration Test

Series: LP LL LK LG

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C @TREND

Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth)

No d.f. adjustment for variances

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
LP	-3.065460	0.5923	-16.02920	0.5978
LL	-3.212603	0.5191	-17.11500	0.5347
LK	-3.673861	0.3046	-21.25519	0.3157
LG	-3.352244	0.4503	-20.15753	0.3686

*MacKinnon (1996) p-values.

4.5 ASSESSMENT OF SHORT-RUN DYNAMICS

Having established the non-existence of any long-run equilibrium relationship among the variables, it is appropriate that the short-run dynamic relationships among the variables in the system be examined. Of particular relevance is the sort of relationship that exists between economic growth and road infrastructure investment – road infrastructure investment may promote economic growth or vice versa. Another important aspect of the short-run dynamics is effects of shocks on the future state of the system. This section particularly assesses the causal relationships in the system as well as the time profile of the effect of shocks on the future state of the system. Having established that there is no stable long-run equilibrium relationship among the variables, the short-run dynamic relationships among the variables are assessed based on a VAR model with first-differenced data (dLP, dLL, dLK and dLG), since all the variables are integrated with order 1.

4.5.1 Analysis of First-Differenced VAR System

As the starting point, an optimal VAR lag determination analysis was conducted using the first-differenced data, and the results reported in Table 4.22. On the basis of the AIC, BIC and HQC, an optimal lag length of 1 is selected. Table 4.23 presents the estimated first-differenced VAR(1) system. As revealed in Figure 4.8, residuals from the estimated first-differenced VAR(1) system satisfies the stability condition since there are no roots lying outside the unit circle in each model. The VAR residual heteroskedasticity test results presented in Table 4.24 indicate that there is no problem of residual heteroskedasticity from the estimated first-differenced VAR(1) system since the p-value of the joint chi-square test is greater than 0.05.

The individual chi-square test results also indicate that the residuals from the estimated first-differenced VAR(1) system are homoscedastic.

Table 4.22: Optimal Lag Determination in the First Difference

VAR Lag Order Selection Criteria

Endogenous variables: dLP dLL dLK dLG

Exogenous variables: C

lags	LogL	p(LR)	AIC	BIC	HQC
1	240.33961		-9.792871*	-8.989910*	-9.493536*
2	247.25955	0.61064	-9.389313	-7.943983	-8.850509
3	253.36857	0.72884	-8.949714	-6.862015	-8.171441
4	260.77679	0.53812	-8.567857	-5.837790	-7.550116
5	271.96407	0.13150	-8.353958	-4.981522	-7.096748
6	282.94620	0.14435	-8.130942	-4.116137	-6.634263
7	296.36370	0.04335	-8.016164	-3.358990	-6.280016

* indicates lag order selected by the criterion

LogL : Log Likelihood

p(LR): P-Value of Sequential Modified LR Test Statistic

FPE : Final Prediction Error

AIC : Akaike Information Criterion

BiC : Bayesian Information Criterion

HQC : Hannan-Quinn Information Criterion

Table 4.23: First-Differenced VAR(1) System

Vector Autoregression Estimates Standard errors in ( ) & t-statistics in [ ]				
	dLP	dLL	dLK	dLG
dLP(-1)	0.330698	0.382136	1.111408	0.695622
	(0.14232)	(0.16422)	(0.71664)	(0.50476)
	[2.32369]	[2.32697]	[1.55086]	[1.37814]
dLL(-1)	0.100741	0.331000	-0.645418	0.521588
	(0.11739)	(0.13545)	(0.59110)	(0.41634)
	[0.85820]	[2.44364]	[-1.09188]	[1.25280]
dLK(-1)	-0.060293	-0.065874	0.062695	0.116935
	(0.02795)	(0.03225)	(0.14073)	(0.09912)
	[-2.15732]	[-2.04265]	[0.44549]	[1.17969]
dLG(-1)	0.000189	-0.004354	-0.155128	0.069919
	(0.03757)	(0.04336)	(0.18920)	(0.13326)
	[0.00503]	[-0.10043]	[-0.81990]	[0.52467]
C	0.035257	0.011020	0.140030	0.053101
	(0.00895)	(0.01033)	(0.04507)	(0.03174)
	[3.93961]	[1.06713]	[3.10728]	[1.67293]
R-squared	0.194894	0.288288	0.068242	0.162787
Adj. R-squared	0.126374	0.227717	-0.011057	0.091534
F-Statistic	2.844351	4.759496	0.860570	2.284653
P-Value(F-Statistic)	0.034212	0.002629	0.494553	0.074164
Durbin-Watson	1.938131	2.021655	2.058211	1.910690

Figure 4.8: Eigenvalue Stability Condition

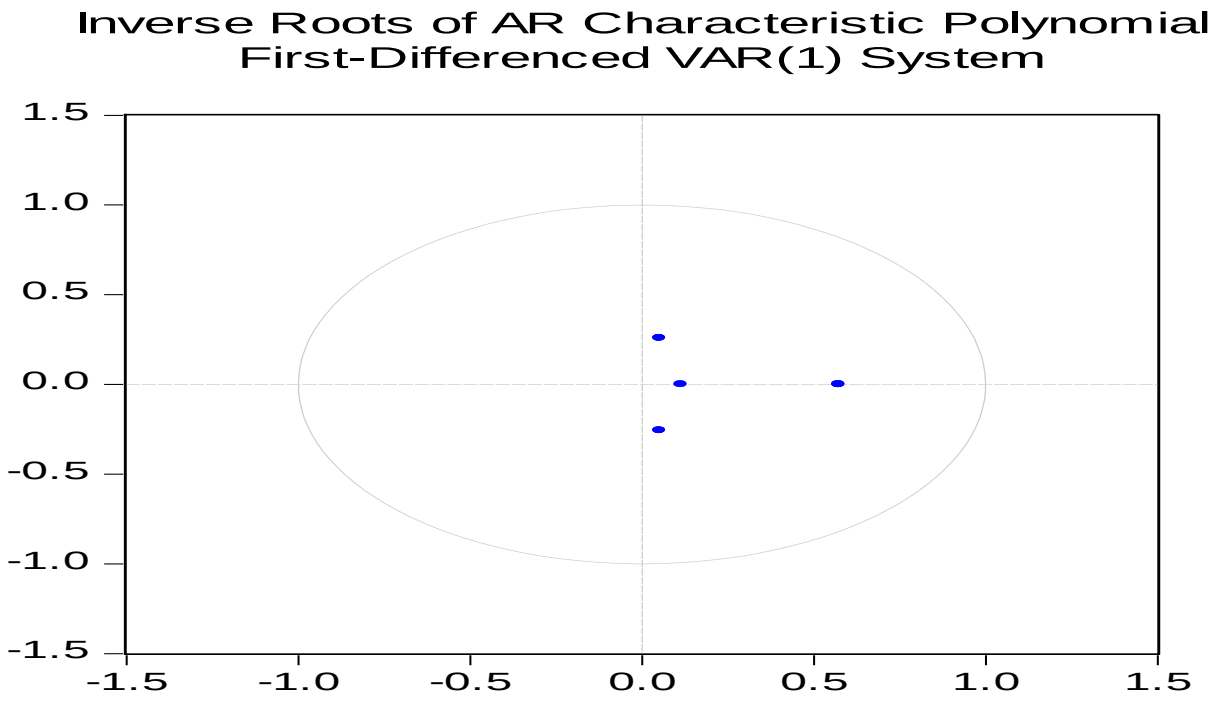


Table 4.24: VAR Residual Heteroskedasticity Tests of First-Differenced VAR (1) System

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Endogenous Variables: dLP dLL dLK dLG

Exogenous Variables: C

Joint Test:

Chi-Sq	df	Prob.
77.16801	80	0.5689

Individual Components:

Dependent	R-Squared	F(8,43)	Prob.	Chi-sq(8)	Prob.
res1*res1	0.038902	0.217563	0.9860	2.022918	0.9803
res2*res2	0.107514	0.647503	0.7335	5.590726	0.6930
res3*res3	0.121164	0.741045	0.6551	6.300535	0.6136
res4*res4	0.036742	0.205023	0.9884	1.910602	0.9836
res2*res1	0.088942	0.524733	0.8312	4.624974	0.7968
res3*res1	0.186391	1.231366	0.3045	9.692320	0.2873
res3*res2	0.247260	1.765581	0.1108	12.85753	0.1168
res4*res1	0.078667	0.458941	0.8779	4.090701	0.8488
res4*res2	0.123515	0.757446	0.6413	6.422755	0.6000
res4*res3	0.057621	0.328652	0.9504	2.996306	0.9346

The VAR residual serial correlation LM tests and the VAR residual autocorrelation portmanteau tests from the estimated first-differenced VAR(1) system displayed in Table 4.25 and Table 4.26 suggests that there is no autocorrelation problem since the p-values of LM statistics, Q statistics and adjusted Q statistics are greater than the 0.05 or 0.01 levels of significance. The residual plots generated from the estimated first-differenced VAR (1) system and reported in Figure 4.9, behaving more like a white noise process confirms the absence of autocorrelation in the residuals. Again, the VAR residual normality test results in Table 4.27 indicate that residuals from the estimated first-differenced VAR(1) system are not normally distributed either jointly or individually due to the same reasons stated earlier and therefore can be ignored on the basis of the appropriate models theory discussed earner.

Starting from the post-model estimation analysis discussions, there is, therefore, enough evidence to conclude that the estimated first-differenced VAR(1) system is stable, robust and adequate, and therefore, provide support for further analyses to be conducted on the basis of the estimated first-differenced VAR(1) system.

Table 4.25: VAR Residual Serial Correlation LM

Tests for First-Differenced VAR (1) System

VAR Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Endogenous Variables: dLP dLL dLK dLG

Exogenous Variables: C

Lags	LM-Stat	Prob
1	12.53965	0.7061
2	11.06960	0.8052
3	9.826235	0.8755
4	11.92211	0.7493
5	11.92997	0.7488
6	11.96282	0.7465
7	15.03160	0.5223
8	27.49903	0.0363
9	11.38818	0.7849
10	8.838760	0.9199
11	10.24374	0.8536
12	14.69624	0.5470

Probs from chi-square with 16 df.

Table 4.26: VAR Residual Autocorrelation Portmanteau Tests for VAR (1) System at Levels

VAR Residual Portmanteau Tests for Autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h

Endogenous Variables: dLP dLL dLK dLG

Exogenous Variables: C

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	1.496321	NA*	1.525661	NA*	NA*
2	12.66093	0.6974	13.13686	0.6627	16
3	22.64891	0.8891	23.73634	0.8538	32
4	35.20256	0.9154	37.33613	0.8669	48
5	47.54701	0.9384	50.99382	0.8806	64
6	59.29471	0.9600	64.27383	0.9001	80
7	73.50371	0.9575	80.69312	0.8688	96
8	96.21580	0.8562	107.5347	0.6017	112
9	106.4986	0.9170	119.9697	0.6811	128
10	114.7867	0.9652	130.2312	0.7879	144
11	124.0824	0.9840	142.0209	0.8432	160
12	136.5510	0.9877	158.2300	0.8277	176

*The test is valid only for lags larger than the VAR lag order.

df is degrees of freedom for (approximate) chi-square distribution

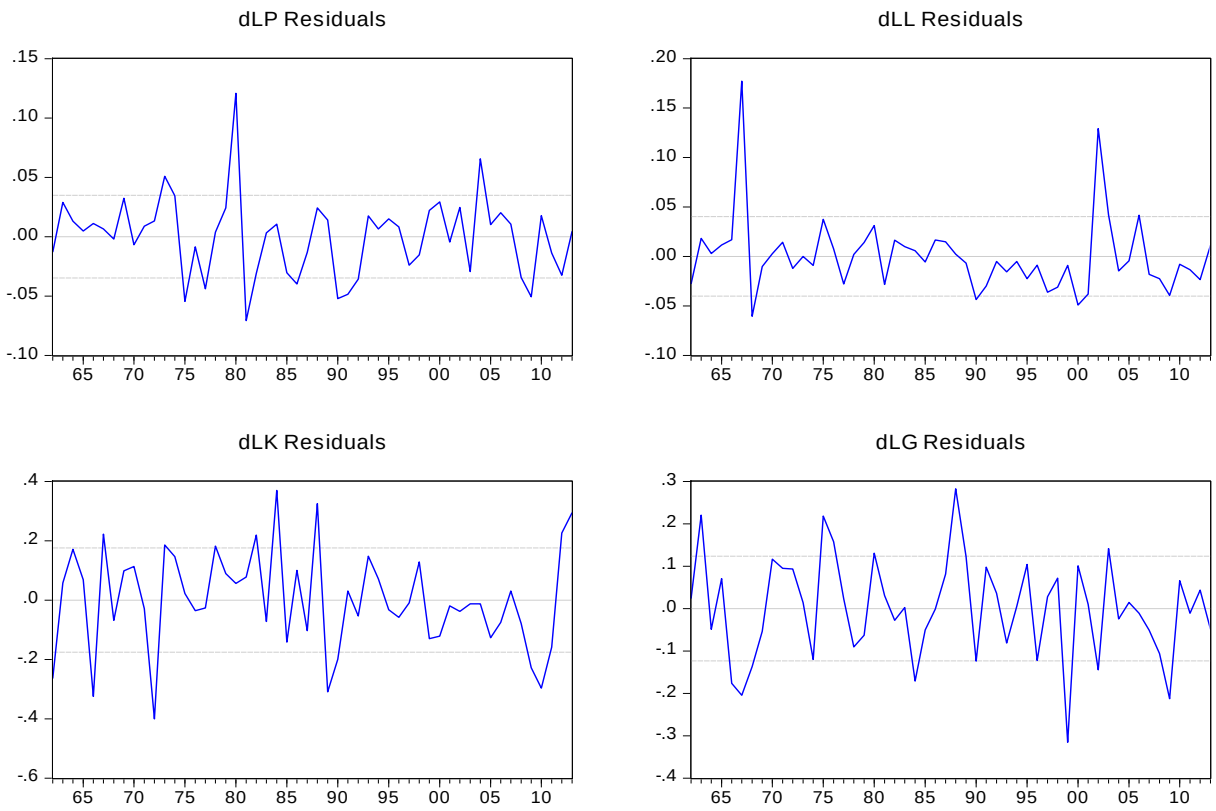


Figure 4.10: Residual Plots from the Estimated First-Differenced VAR (1) System

Table 4.27: VAR Residual Normality Tests for First-Differenced VAR (1) System

VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: Residuals are multivariate normal

Endogenous Variables: dLP dLL dLK dLG

Exogenous Variables: C

Component	Skewness	Chi-sq	df	Prob.
1	0.583955	2.955368	1	0.0856
2	2.574102	57.42533	1	0.0000
3	-0.155924	0.210707	1	0.6462
4	-0.082629	0.059172	1	0.8078
Joint		60.65058	4	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	4.948054	8.222316	1	0.0041
2	12.13550	180.8241	1	0.0000
3	2.947798	0.005904	1	0.9388
4	3.027470	0.001635	1	0.9677
Joint		189.0540	4	0.0000

Component	Jarque-Bera	df	Prob.
1	11.17768	2	0.0037
2	238.2494	2	0.0000
3	0.216611	2	0.8974
4	0.060807	2	0.9701
Joint	249.7045	8	0.0000

4.5.3 Causal Relationships in the System

Using the VAR Granger causality method, the results are summarized in Table 4.28. At the 0.05 level of significance, the results show causal relationships from ICT stock to economic growth (dLK→dLP, p-value 0.0310 < 0.05) and from ICT stock and economic growth to labour (dLK→dLL, p-value 0.0411 < 0.05; dLP→dLL, p-value 0.0200 < 0.05). To further investigate the causal relationships among the variables, pairwise Granger causality tests were also conducted and the results summarized in Table 4.29.

Table 4.28: VAR Granger Causality Test

VAR Granger Causality/Block Exogeneity Wald Tests
Endogenous Variables: dLP dLL dLK dLG
Exogenous Variables: C
Chi-Squared Test Statistics
Values in [ ] are p-values

Dependent Variable	Independent Variable			
	dLP	dLL	dLK	dLG
dLP	-	0.7365 [0.3908]	4.6540 [0.0310]	2.53E-05 [0.9960]
dLL	5.4148 [0.0200]	-	4.1724 [0.0411]	0.0101 [0.9200]
dLK	2.4052 [0.1209]	1.1922 [0.2749]	-	0.6722 [0.4123]
dLG	1.8993 [0.1682]	1.5695 [0.2103]	1.3917 [0.2381]	-

Table 4.29: Pairwise Granger Causality Tests

Pairwise Granger Causality Tests
Endogenous Variables: dLP dLL dLK dLG
Exogenous Variables: C
Lags: 1

Null Hypothesis:	F-Statistic	Prob.	Decision
dLL does not Granger Cause dLP	0.21371	0.6459	Accept
dLP does not Granger Cause dLL	4.52210	0.0385	Reject
dLK does not Granger Cause dLP	4.29701	0.0435	Reject
dLP does not Granger Cause dLK	1.42535	0.2383	Accept
dLG does not Granger Cause dLP	0.03500	0.8524	Accept
dLP does not Granger Cause dLG	4.62888	0.0364	Reject
dLK does not Granger Cause dLL	3.34696	0.0734	Reject
dLL does not Granger Cause dLK	0.35665	0.5531	Accept
dLG does not Granger Cause dLL	0.02600	0.8726	Accept
dLL does not Granger Cause dLG	4.69904	0.0351	Reject
dLG does not Granger Cause dLK	0.57067	0.4536	Accept
dLK does not Granger Cause dLG	2.79437	0.1010	Accept

* *Decision at 0.05 level.*

In particular, the pairwise Granger causality test results reveal that road infrastructure investment does not Granger-cause economic growth, but rather economic growth is a Granger cause of road infrastructure investment in South Africa. It means, therefore, that road infrastructure investment does not predict anything about the short-run properties of economic growth in South Africa. On the other hand, economic growth plays a role in the short-run properties of road infrastructure investment in South Africa.

4.5.4 Impulse Response Functions

The first-difference VAR (1) system allows the study of the impulse response of endogenous variables to one time shock of other variables in the system. Figure 4.11 and Table 4.30 display the estimated impulse response of economic growth (dLP) to shocks observed from itself, the employment variable (dLL), ICT stock (dLK), and road infrastructure investment (dLG) with Cholesky ordering of variables.

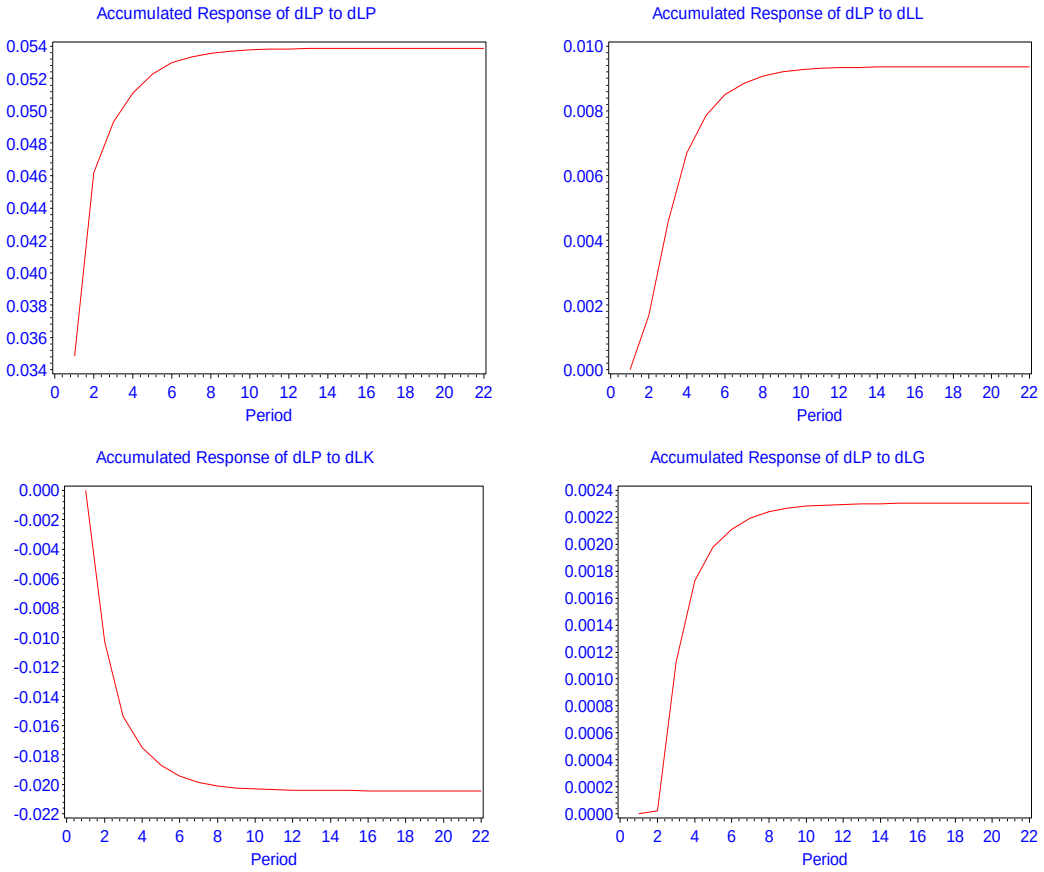


Figure 4.12: Individual Impulse Responses of dLP to Shocks in dLL, dLK and dLG

Table 4.30: Impulse Responses of dLP to to Shocks in dLL, dLK and dLG

Years	dLP	dLL	dLK	dLG
1	0.034854	0.000000	0.000000	0.000000
2	0.046156	0.001680	-0.010275	2.32E-05
3	0.049353	0.004583	-0.015381	0.001128
4	0.051095	0.006696	-0.017511	0.001729
5	0.052272	0.007862	-0.018699	0.001977
6	0.052967	0.008499	-0.019432	0.002110
7	0.053355	0.008865	-0.019860	0.002192
8	0.053575	0.009077	-0.020103	0.002240
9	0.053702	0.009199	-0.020241	0.002267
10	0.053774	0.009268	-0.020320	0.002282
11	0.053816	0.009308	-0.020366	0.002291
12	0.053840	0.009331	-0.020392	0.002296
13	0.053854	0.009344	-0.020407	0.002299
14	0.053862	0.009352	-0.020416	0.002301
15	0.053866	0.009356	-0.020420	0.002302
16	0.053869	0.009358	-0.020423	0.002302
17	0.053870	0.009360	-0.020425	0.002303
18	0.053871	0.009361	-0.020426	0.002303
19	0.053871	0.009361	-0.020426	0.002303
20	0.053872	0.009361	-0.020427	0.002303
21	0.053872	0.009362	-0.020427	0.002303
22	0.053872	0.009362	-0.020427	0.002303

Cholesky Ordering: dLP dLL dLK dLG

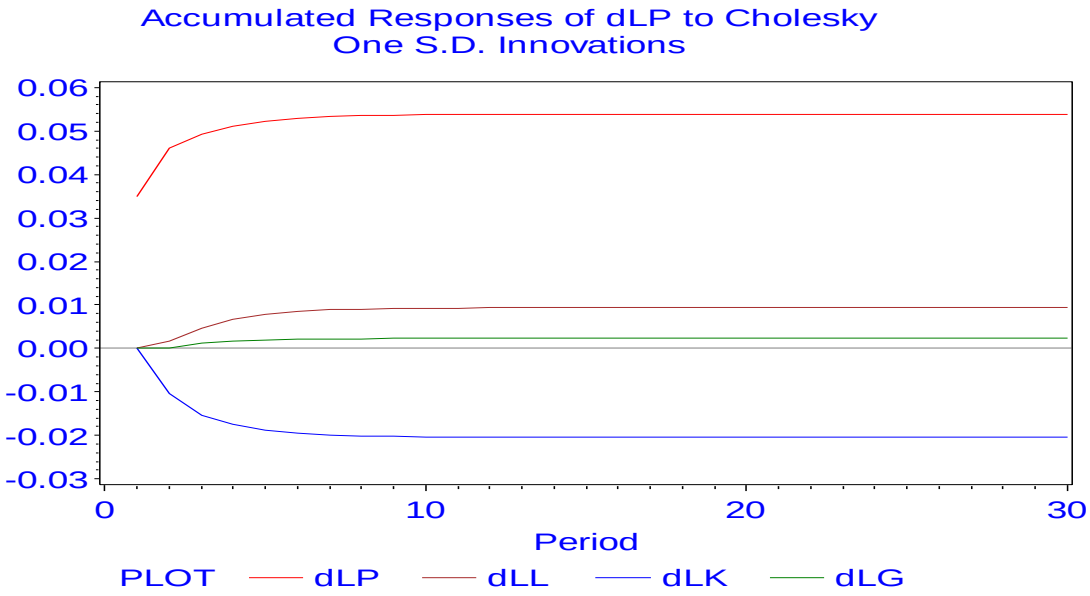


Figure 4.12: Overlay Impulse Responses of dLP to Shocks in dLL, dLK and dLG

As observed, economic growth (dLP) responded positively to its own shock behaving more like the Mitscherlich curve, stabilizing after 18 years. Economic growth responded linearly positively to the shock in the employment variable (dLL) between the first two years, but the behaviour changed thereafter, though positive, was also more like the Mitscherlich curve and stabilizing after 18 years. A shock in ICT stock (dLK) led to a negative economic growth response with a decaying pattern, but stabilized after 20 years. There was no response in economic growth to the shock in road infrastructure investment for the first two years, but the behaviour changed thereafter, though positive, also behaving more like the Mitscherlich curve, stabilizing after 17 years. From the overlay plot of the impulse response functions, the employment variable (dLL) caused the greatest shock in economic growth (dLP), ignoring the shock from itself. This could be attributed to the large number of skilled and abundant labour in South Africa.

4.5.5 Forecast Error Variance Decomposition Analysis

This section examines the relative importance of shocks from each of the variables to economic growth using the first-differenced VAR(1) system. Table 4.31 reports the forecast error variance decompositions (FEVD) for economic growth over 18 periods using the same Cholesky ordering of variables that were used in the impulse response function analysis.

Table 4.31: Variance Decomposition of dLP

Years	S.E.	dLP	dLL	dLK	dLG
1	0.034854	100.0000	0.000000	0.000000	0.000000
2	0.038091	92.52914	0.194424	7.276396	3.72E-05
3	0.038690	90.37178	0.751643	8.795023	0.081558
4	0.038850	89.83084	1.041226	9.023136	0.104801
5	0.038904	89.67191	1.128156	9.091338	0.108600
6	0.038922	89.61831	1.153897	9.118135	0.109660
7	0.038928	89.60021	1.162362	9.127366	0.110063
8	0.038930	89.59427	1.165207	9.130320	0.110204
9	0.038931	89.59233	1.166145	9.131276	0.110249
10	0.038931	89.59169	1.166452	9.131591	0.110264
11	0.038931	89.59148	1.166553	9.131695	0.110268
12	0.038931	89.59142	1.166586	9.131729	0.110270
13	0.038931	89.59139	1.166597	9.131740	0.110270
14	0.038931	89.59138	1.166601	9.131744	0.110271
15	0.038931	89.59138	1.166602	9.131745	0.110271
16	0.038931	89.59138	1.166602	9.131745	0.110271
17	0.038931	89.59138	1.166603	9.131745	0.110271
18	0.038931	89.59138	1.166603	9.131745	0.110271

Cholesky Ordering: dLP dLL dLK dLG

The results indicate that economic growth shocks were the main driver of economic growth in South Africa, stabilizing after 14 years. It means, therefore, that South Africa's economic growth, in the context of VAR system used in the study, can be predicted by its previous behaviour. Six years ahead, the strongest influence on South Africa's economic growth was ICT stock (dLK, accounting for nearly 9.12%), followed by employment (dLL, accounting for nearly 1.15%) and road infrastructure investment (dLG, accounting for a mere 0.11%). The magnitude of the contribution of road infrastructure investment in South Africa did not change significantly after 4 years (0.10% – 0.11%), implying that road infrastructure did not have significant effect on the South African economy over the study period, 1966-2013. This finding supports the finding from the IRF analysis which revealed insignificant evidence for the relationship between South Africa's economic growth and road infrastructure investment.

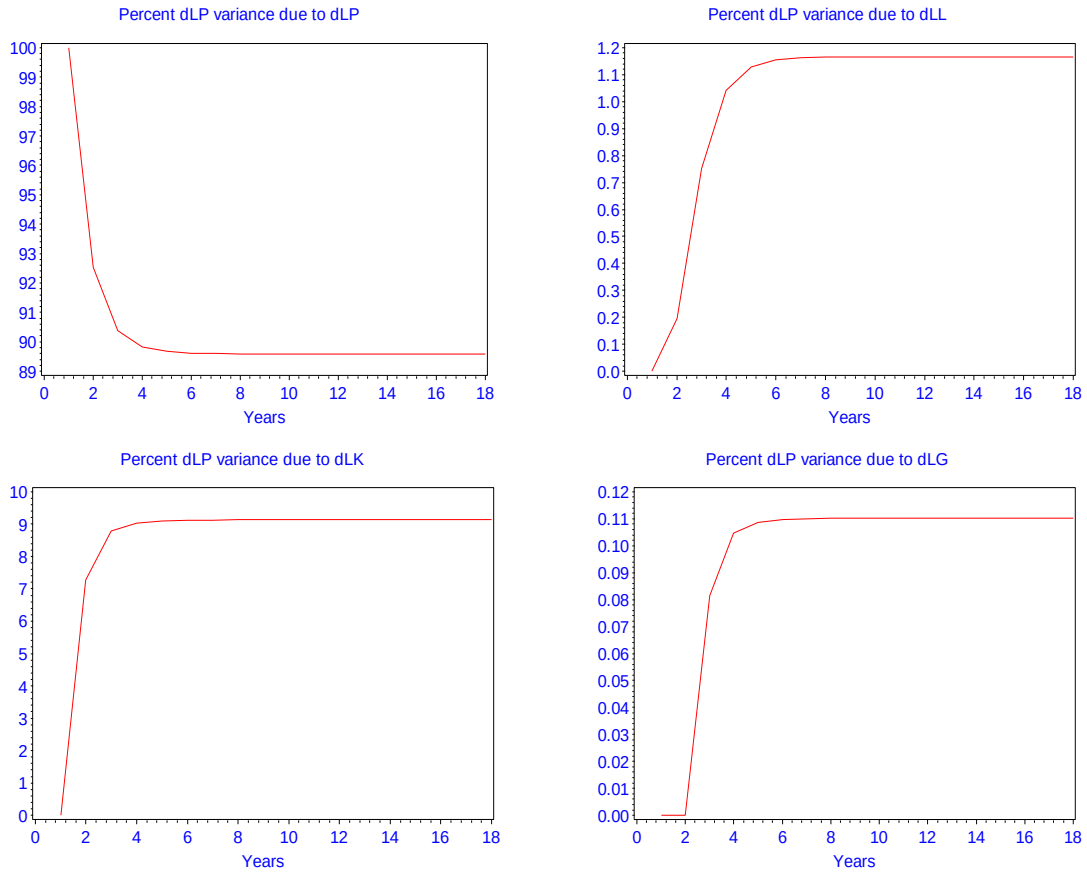


Figure 4.13: Forecast Error Variance Decompositions

4.6 CONCLUSION

This chapter has presented and conducted an empirical analysis of the data with the intent to address the research aims and objectives. Various statistical and econometric methods were applied. All results were discussed in light of the stated research aims and objectives. The next chapter presents a summary of the results and recommendations for future research.

CHAPTER 5

5. CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The role of Transport Infrastructure in the process of economic growth has received a wide attention. This study shows the relationship between transport infrastructure investment, labour input, ICT investment and economic growth from 1960 until 2013, data was sourced from South African Reserve Bank. It has been argued that while transport infrastructure investment considered as a factor input that contribute to economic growth, the way it is financed may have to be meticulously observed.

The main criticism of government intervention in transport infrastructure is not effective in allocation of financial resources, which eventually results in backlogs in maintenance and repairs. However, the rationale for private intervention is based on the public good argument that the private sector cannot provide public goods to enhance economy particularly when they are for public consumption.

5.2 CONCLUSION

The conventional wisdom is that public investment in infrastructure, particularly infrastructure on road, plays a crucial role in facilitating economic growth and international competitiveness. The development practitioners tend to emphasize the importance of reliable and affordable infrastructure for reducing poverty and its contribution in the achievement of Millennium Development Goals.

Good road linkages reduce transport costs, road congestion and promote industrial development throughout the country. This implies that the better infrastructure the positive economic development and growth. Poor infrastructure facilities, especially in transport, communications and information technologies, which is caused by the overuse and misuse even though it has received more attention from the government at all levels since early 1960, are regarded as one of the major impediments for investment and economic growth in South Africa.

Although a number of empirical studies report evidence supporting the significant contribution of infrastructure to economic development, it is a puzzling and disputing question on whether transport is the cause of growth or vice versa. Following the endogenous growth models, transport infrastructure leads economic growth while the Wagner's law regards the increase in real GDP as a main drive in transport infrastructure investment. Under some conditions, it is even possible to observe a negative or non-significant growth impact of transport investment, labour input and ICT investment. It is expected that the relationship between infrastructure investment and economic growth exhibits two-way relationship.

As the direction of relationship is theoretically unclear, the understanding and interdependency between road infrastructure, labour input, ICT investment and economic growth is relevant as it provides some guidance for policy actions. If the relationship is from GDP to road infrastructure investment then it cannot be used as a policy instrument.

Road infrastructure services are used as final consumption items for households and intermediate consumption item for firms , any wrong action taken by government that negates the growth and development of infrastructure has both micro and macro economic effect to the economy at large. The quality of road infrastructure has a direct effect on business productivity and growth, and different investments to infrastructure capital from inequality between regions and countries. The role of infrastructural development on economic is a vital issue for strategic and development country policy management for a country with weak quality of infrastructure base. Efficient infrastructure attracts centres of production and consumption, gives greater access to markets and education centres and that timely access to health care, schools and other facilities deemed essential.

5.3 RECOMMENDATIONS

The linkage between road infrastructural development and economic growth outcomes is one of the most popular topics for debates in recent scientific literature and economic research. The role is widely analysed as very vital to micro and macro-economics in the sense that the availability and quality of road infrastructure may result in different decisions for investment and may influence labour migration, business establishment location.

Although the result of infrastructural development has a positive linkage with the economy, growth research studies believe that more roads should be constructed and the existing roads adequately maintained to enhance and support economic growth. Also, the funding magnitude of the government leaves a lot to question.

Greater funding in road transport such as upgrading, maintenance, repairs and rehabilitation are important to enhance economic growth. These also enhance capacity building, improve roads conditions, enforce regulations as well as putting in place traffic management control measures in place. The support from private sector to compliment public sector investment in the improvement of transport infrastructure should also be encouraged.

Effective coordination among the national, provincial and local government on capital investment of road transport is essential should be strengthened. The benefit of road infrastructure investment is immeasurable to all.

Including the fact mentioned above, the following are the recommendations of this study:

- More roads should be constructed and the existing road should be sufficiently maintained, particularly the ones from production areas such as farms and mines as they will lead to increased in production.

- The government should enhance the competition between and the efficiency in infrastructure industries including ICT stock, which can have indirect contribution to economy.
- Demand for road transport infrastructure should expand significantly in future, due to economic growth, ICT progress, urbanization and growing congestion.

- The paper proposes that the government should as a matter of priority create more favourable institutional policy and regulatory framework to meet up these challenges.

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