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THE EFFECTS OF GOVERNMENT TRANSPORT INFRASTRUCTURE EXPENDITURE ON ECONOMIC GROWTH IN ETHIOPIA

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The Effects of Government Transport Infrastructure Expenditure on Economic Growth in Ethiopia

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This is to certify that the thesis prepared by Tewodros Ayalew, entitled : “The effects of government transport infrastructure expenditure on economic growth in Ethiopia” and submitted in partial fulfillment of the requirement for the Degree of Master of Science (Economic Policy Analysis) complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Abstract

The effects of government transport infrastructure expenditure on economic growth in Ethiopia.

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The study investigates the effects of government transport infrastructure expenditure on economic growth in Ethiopia between 1975 and 2015 using annual time series data on Gross Domestic Product (GDP), transport infrastructure, human capital, defense, agriculture and culture and sport. The time series property of the data is checked for the presence of unit root using Augmented Dickey Fuller (ADF) unit root test technique .All variables are integrated, which implies that the variables has long run relationship .For the analysis co integration and Error Correction Model together with descriptive statistics (table, graph and chart) are used .The result reveals that government expenditure on transport infrastructure has positive and significant effects on economic growth .Additionally, from the expenditures incorporated for the analysis, expenditures on human capital, agriculture and defense have also positive and significant long run effect. However, expenditure on culture and sport has negative and significant impacts on the economic growth. On the other hand, results from the Vector Error Correction Model (VECM) shows that agriculture and transport infrastructure are significant in affecting economic growth in the short run but expenditure on human capital, defense and culture and sport are all insignificant. Based on the finding, the writer would like to recommend that government should allocate more budgets for the transport infrastructure investment together with agriculture, defense and human capital and reduce its expenditure on culture and sport.

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List of Acronyms

ADB-Asian Development Bank

ADF- Augmented Dickey Fuller

AICD-Africa Infrastructure Country Diagnostics

CPI-Consumer Price Index

EDRI-Ethiopia Development research Institute

EEA-Ethiopia Economic Association

ERA-Ethiopian Road Authority

GDP-Gross Domestic Product

GNP-Gross National Product

MOFED-Ministry of Finance and Economic Development

NBE -National Bank of Ethiopia

OLS-Ordinary Least Square

RSDP- Road Sector Development Program

UN-United Nation

URRAP -Universal Rural Road Access Program

VECM-Vector Error Correction Model

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Attaining a sustained economic growth is the prime objective of every nation over the entire world. It is an increase in national income per capita that involves the increase in Gross Domestic Product(GDP), therefore of the national wealth ,including the production capacity. It is an increase in the production and composition of goods and services thereby increasing national income (Arthur ,1994 and Haller,2012).In modern social science the process of economic growth and the sources of differences in economic performance across nations are some of the most interesting, important and challenging areas (Acemoglu,2007).

Growth in individual countries often differs considerably from average worldwide growth .The most striking example of large change in relative incomes are growth miracles (episodes where growth in a country far exceeds the world average like Japan from second world war to 1990 and Hon-Kong starting around 1960) and growth disasters (episodes where a country's growth falls far short of the world average like Argentina and many of the countries in sub Saharan Africa) (Romer ,2006,pp. 6-7).

According to the global competitiveness report (2015/2016) , seven years after the global financial crisis ,the world economy is evolving against the background of new normal of lower economic growth, lower productivity growth and high unemployment .The geographical pattern of growth shifts with advanced economies gaining ground on emerging markets .United State is recovering despite moves towards the normalization of monetary policy and strengthening of dollar (Sala ,et al., 2015/16) .In Europe ,growth is more sluggish and which are somewhat balanced by lower energy price and weakened Euro. In Japan, the monetary policy and a weaker Yen are supporting its growth whereas China is moving towards a more sustainable economic growth. Surpassed by emerging and developing Asia, many sub-Saharan economies continue to register a 5 percent economic growth on average.

Although attaining sustainable economic growth is the ultimate objective of every nation, there is huge disparity among them that is attributed to different factors .This includes, but not limited to, geographical, institutional and cultural factors.

The geographic factors ,that is ,the physical ,ecological and geographic environment of nations plays a decisive role by determining both the preference and opportunity set of economic agents in different societies .The other factor of differences in economic growth and income per capita is institutions i.e. the rule of the game in the society .It is about the effects of the society's own choices on their own economic fate .The rules, regulations, laws and policies that affect the economic incentives to invest in technology ,physical capital and human capital. Whereas, cultural factors include the beliefs, values and preferences that influence the economic behavior. (Acemoglu, 2007, pp. 157- 160).

Infrastructure investment is seen as an important prerequisite for sustainable economic growth. Spending on physical infrastructure such as roads, ports and power plants affect the productivity of firms and industries and the entire economy. This common beliefs is reflected in a strong emphasis on the part of all donors ,especially those of multi-lateral aid .World Bank lending Africa to these sectors amounted to US $3.3 billion in 2009,which is a doubling of infrastructure aid since 2006 (Abdon et al.,2014 and Frosch ,2014).Transport infrastructure is one of the major determinant of economic growth ,particularly in developing nations as it creates production facilities and stimulate economic activities ,reduce transaction and trade cost, improving competitiveness and provide employment opportunities for the poor. It provides access between spatially separated locations for business and house hold sectors in the movements of commodities and persons. Therefore, having good transport impacts the economy through increasing business efficiency supporting cluster and agglomeration of economic activity. (Sahoo et al., 2010).

Thus transportation infrastructure is a requirement for every nations, regardless of its industrial capacity, population size or technological development (Jiang, 2001).This shows that for a growing economy, like Ethiopia, investment on transport infrastructure will be even more necessary requirement for its economic growth.

Having recognized the socio economic importance of transport infrastructure the government of Ethiopia has devoted in expanding the road network with high level of capital expenditure with the support of international donors .Specially from 1997 onwards the country has implemented the Road Sector Development Program (RSDP) that elapsed up to 2015.

According to the Ethiopian Road Authority (ERA, 2015) report the total amount disbursed for the program was $14.3 billion from which around 80% of the expenditure was from internal source.

1.2. Statement of the Problem

The fundamental tasks of every economic system is to determine which goods are produced ,how they are produced and who gets them .A system of competitive market can tend to perform this task both cheaply and reasonably well. But, there are some situations where the competition generates unsatisfactory outcomes, especially when the good are pure public goods (non-rival which means one person's consumption doesn't diminish that of the others and non-excludable which means that if the good are provided to one person ,they are automatically made available to everyone) like transport infrastructure. In this situation (collectively known as market failure) government intervention can lead to better outcome. The development of an economic system has a number of prerequisite without which growth or an increase in the rate of growth cannot be achieved .There is a need for technology ,skilled labor ,adequate quantities of labor , natural elements (such as raw materials ,water or climatic conditions),markets and management skills to coordinate those factors .However, there is uneven distribution of raw materials ,labor ,capital assets and markets throughout the world ,so that the needs of modern societies must usually be satisfied from worldwide locations. To meet this demand manufacturers need to transport raw materials to factories to produces the finished goods which in turn are transported to the markets (Leach, 2004, pp-156 and Cole, 2005, pp.403).

Extensive and efficient infrastructure is critical for ensuring the effective functioning of an economy, as it is an important factor determining the location of economic activities and the kind of activities or sector that can develop in a particular economy. Well-developed infrastructure reduces the effects of distance between regions, integrating the national market and connecting it at low cost to markets in other countries and regions. The quality and extensiveness of infrastructure networks significantly impacts economic growth and affect income inequalities and poverty in a variety of ways. A well-developed transport and communication infrastructure networks is a pre requisite for the access of less developed communities to core economic activities and services .As a result transport remains one of the major infrastructure facilities

critical for sustainable economic growth and development of any nation (Chukwuemeka,et al.,2013 and Schwab,2010)

Effective modes of transport, including quality roads, railroads, ports and air transport enable entrepreneurs to get their goods and services to the market in a secure and timely manner and facilitate the movements of workers to the most suitable jobs.

According to Freeman(2007) throughout the decades transport projects have played a pivotal role in the support of economic development and poverty alleviation .Transport accounts for the nearly 6 percent of global gross domestic product .It is thus no surprise that the bank has provided more than $30 billion or well over 15 percent of its total lending commitment in support of transport project during the past decades .In the past five years there has been a scaling up of transport investment as the link between poverty reduction and transport has been better understood according to the report.

Part of the cost advantage of china is not just low wage and that it has over 200 million underemployed workers in agriculture that can be brought in to industrial production, but that it has developed large scale and low cost transportation infrastructure combined with frequent shipping and air (UN, 2007)

Despite the fact that transport infrastructure has the mentioned and even more other significance on macroeconomic growth, how much exactly it contribute to the growth of an economy of a given nation is an empirical question .Moreover, results of prior research done on the relationship between transport infrastructure and economic growth are inconclusive showing the need for further research work on the area.

According to the study on the European countries, government outlays on infrastructure (economic affair and general public services) and property right protection (defense, public order -safety) exert a positive impact on per capita growth. On the contrary government expenditure on human capital enhancing activities (education ,health ,housing community amenities ,environment protection, recreation -culture -religion) and social protection don't have a significant effect on growth (Benos,2009) .On the other hand a study by Hasnul (2015) on Malaysian economy, using OLS technique based on a time series data between 1970-2014,shows that there is negative relationship between government expenditure and economic growth.

Study on the Indian economy for the period 1970 to 2010 showed that transport infrastructure not only influences economic growth but also growth capital formation suggesting that increasing transport facilities along with capital formation will lead to more pervasive economic growth . Contrary to this, study on the Nigerian economy for the period 1977 to 2009 suggested that transportation is insignificant in determining economic growth.

Moreover, public spending on transport infrastructure and economic growth had even negative relation for the period 1981 to 2010 in Nigeria as well (Chukwuemeka ,et al., 2013, Kayode et, al., 2013 and Pradhan &Bagchi, 2012)

In Africa the development of transport infrastructure is linked with the colonial authority, which did the most .However because the system were designed to facilitate the extraction and transmission of products from the continent to the colonial master nation ,they are deemed incapable of enhancing the active participation of African countries in the globalization process (Njoh,2008) .Road dominate the transport sector in most African countries carrying 80 to 90 percent of passenger and freight traffic. Moreover they are the only means of access to most rural communities (Bofinger, 2011)

According to the 2014 united nation development program report the Ethiopian economy has experienced impressive growth performance over the last decades with average GDP growth rate of 11%, which is about double of the average GDP growth for sub-Saharan Africa.2012/13 was markedly successful in terms of maintaining macroeconomic stability and fiscal management as witnessed by inflation falling to a single digit which had been a major challenge in the past two years.

In recent years Ethiopia has made significant progress in infrastructure, and its infrastructure indicators compare relatively well with low income country peers. It has launched an ambitious investment program to upgrade its network of trunk roads and is establishing a modern funding mechanism for road maintenance (AICD, 2010).What is the contribution of such expanding transport infrastructure for the ongoing economic growth of the country?

Does transport infrastructure expenditure promote economic growth? There is no clear cut answers to this question as there is complex interaction between transport infrastructure and economic growth .Increase in public expenditure on different infrastructure including transport

sector may affect private investment negatively by decreasing available fund for investment .That means a rise in public investment needs to be financed ,which may imply more taxes or impose higher demand for funds from the government in the capital markets ,therefore causing interest rate to rise .This would reduce the amount of saving available for private investors and decrease the expected rate of return of private capital ,leading to crowding out effects of private investment, thereby decreasing economic growth that might happen have had the private sector get enough saving for investment (Afonso and Aubyn,2008).

Public investment can create additional favorable conditions for private investment, for instance, by providing or promoting relevant infrastructure such as roads, highways, sewage systems or airports. The existence of infrastructure facilities may increase the productivity of private investment which can then take advantage of better overall infrastructure and potentially improved business conditions there by contributing high for increase in national productivity . Thus, Public investment had a contractionery effect on output in some case with positive public investment impulses leading to a decline in private investment. On the other hand expansionary effect and crowding in prevailed in others case .Private investment impulse, by contrast, were always expansionary in GDP terms and effects were usually significant in statistical terms (Afonso and Aubyn, 2008).Thus what effect public expenditure (public transport infrastructure expenditure in particular) has on economic growth is an empirical question. So that we can have an appropriate policy intervention on the sector.

Based on the reviewed theoretical and empirical literature the study has identified the following main research gaps:

- studies that try to make a comparative analysis on the transport infrastructure in Ethiopia are scanty,
- To the level of my knowledge empirical studies that try to show the effects of transport infrastructure on economic growth are not sufficient compared with its given priority in the macroeconomic policy of the country?
- The role of transport infrastructure expenditure on economic growth is different for different countries (in some case significant and in some other it is insignificant and even

negative) which show that the relationship between transport infrastructure and economic growth is an empirical question. Thus the study tries to fill the above mentioned gaps.

1.3. Objective of the Study

The general objective of this study is to assess the economic growth contributions of the transport infrastructure in Ethiopia.

More specifically, the study tries to achieve the following objectives:

- To examine the trend of the transport infrastructure expenditure of Ethiopia ,
- To explore the contribution of transport infrastructure to the country's economic growth, and
- To provide some possible policy recommendations based on the finding

1.4. Research Questions

Generally the study tries to answer the following basic research questions

- What is the trend of transport infrastructure investment in Ethiopia?
- Is transport infrastructure contributing to the economic growth of the country? and
- What should be done to improve the transportation sector of the economy?

1.5. Significance of the Study

Besides being a partial fulfillment for a Master's Degree, this study will have an immense significance as its output will be used as an input for policy maker and development partners on the area of transport infrastructure investment .

This study will give an insight on the economic growth contributions of transport infrastructure in Ethiopia and its result will be useful for further research on the area.

1.6. Scope and Limitation of the Study

The study focus on the effects of government transport infrastructure expenditure on economic growth of Ethiopia for the period 1975 and 2015. To avoid bias expenditure on agriculture, human capital, defense and culture and sport are also included in the econometric regression for same period.

Because of limited time this study did not have a look on the relationship between all government expenditure and other factors like export, population growth, etc. that affect economic growth .Moreover due to data unavailability the study doesn't include the time period before 1975 .So that annual time series data is used only for the period between 1975 to 2015.

1.7. Organization of the Study

The study has five chapter .Chapter one, the introductions part, discuss about background, problem statement, objectives, research questions, significance and scope and limitation. In chapter two theoretical and empirical literatures and Ethiopia's economic performance is reviewed .The third chapter is about data and methodology of the study whereby the econometric model is specified and techniques used for data analysis are discussed. Then the last two chapters which are chapter four and five deals about result discussion and conclusion and policy implication respectively.

CHAPTER TWO: REVIEW of RELATED LITERATURE

2.1. Theoretical Literature

Economic growth is the process of increasing the size of national economies, the macro-economic indicators specially GDP per capita,with positive effects on the economic-social sector .It is a complex long run phenomenon, subjected to constraints like excessive rise of population, limited resources, inadequate infrastructure, inefficient utilization of resources, excessive governmental intervention, institutional and cultural models, etc that makes the increase difficult. It can be positive, zero or negative. Positive economic growth is recorded when annual average rhythms of the macro indicators are higher than the average rhythms of growth of the population .When the annual average rhythms of growth of macroeconomic indicators, particularly GDP are equal to those of the population growth we can speak of zero economic growth .Negative economic growth appears when the rhythms of population growth are higher than those of the macroeconomic indicators (Haller, 2012).

2.1.1. Transport Infrastructure and Economic Growth

Infrastructure consists of "hard" and "soft" components .The "hard" and visible infrastructure such as roads, railways, electricity and telecommunications must be accompanied and supported by its "soft" component such as policies and regulation to enable the system to perform well and generate impact. The right mix and synergy of the two is important to ensure that the infrastructure system support inclusive growth and poverty reduction (ADB, 2012) .

Investment on transport infrastructures is very important to economic development, especially at the early stage of economic growth. Such investment will open up new markets and create a more mobile network for worker and consumers which are vital to initiate growth .Transportation improvement brings not only direct injections of cash in a local economy throughout the construction process but provides multiplier effects that reverberate on a larger spatial and temporal scale.

The economic benefits from infrastructure investments includes the direct economic gain from the construction and maintenance which is related to accessibility change where transport enables larger markets and enables to save time and costs and the indirect impacts is related to the economic multiplier effects where the price of commodities drop and /or their variety increases. Moreover there is socio economic development drawn from the newly available infrastructure.

Likewise if they are deficit they will have economic costs in terms of reduced or missed opportunities.

The economic benefits of the transportation industry can also be assessed from a macroeconomic perspective that is, the importance of transportation for the whole economy and the mobility it confers are linked to a level of output ,employment and income within a national economy and micro economic perspective that is, the importance of transportation for specific parts of the economy as it is linked to producer ,consumers and production costs (Kockelman et al.,2013,pp-107 and Paul , et al. ,2006,pp.74)

2.1.2. The Rationale for Government Involvement on Infrastructure Investment

Government should provide public goods and involve in correcting market failure in addition to protecting human right and instilling fairness in the society (Manzo,2015).In order to understand the rational for government involvement for infrastructure investment, it is important to appreciate the key features of infrastructure .It is non-rival in consumption -consumption by one person does not diminish the availability for others. For example, in the case of transport on an uncrowded road, as long as there is no congestion there should be no costs to additional vehicle using the road .This would however preclude a private sector supplier from charging for road use to recover costs .It is also non excludable -if the service is offered to one person it becomes generally available to others .The classic example for non-excludability is a light home. All people in the region can see the light broadcast .This is different from normal private goods where suppliers can control consumption or use.

Infrastructure investment requires a long product cycle and time horizon and long term financing and enterprise in developing countries cannot easily handle infrastructure systems because they are extremely expensive. Moreover, enterprise providing infrastructure services are often natural monopoly, supporting only single services providers in a given locality and infrastructure development may require changes in land use and use that cannot be accomplished without considerable public involvement and Infrastructure services are often important determinants of people's standard of living. Furthermore, as there is no control on consumption, there is limited scope for private firms to cover their costs by charging user fees. Because of these characteristics,

private enterprises will not supply public goods at optimal levels .This justifies government intervention in the provision of infrastructure (ADB, 2012).

2.1.3. The Nexus between Transport Infrastructure and Poverty

The allocation of budget is a key instrument for government to promote economic development and reduce absolute poverty .This is because public spending has the potential to affect growth and poverty reduction in two ways: it can raise the overall growth performance of the economy and it can increase the chance of the poor to contribute to the growth process mainly by strengthening human capabilities and reducing transaction costs (Wilhelm &Fiestas ,2005).

In developing countries public expenditure policies not only accelerates economic growths and promote employment opportunities but also plays a useful role in reducing poverty and inequalities in income distribution. By investing on transport infrastructure the government can reach for poor as many of the world's poor lives in rural areas isolated by distance ,terrain and poverty from employment and economic opportunities ,markets ,health care and education .Lack of basic infrastructure and access to transport service makes it difficult for poor people to access market and services .The main way that rural people access markets and services is through roads that connect rural communities to market towns .Therefore, transport infrastructure investment could result in an increase in agricultural productivity ,non-farm employment and productivity directly by raising the wage and employment of the poor and hence ,their economic welfare .In addition higher productivity and expanded employment leads to higher economic growth ,affecting the supply and price of goods and services and, thus ,the poor's wellbeing (Starkey and Hine ,2014).

2.1.4. Review of Ethiopia’s Economic Performance

Economic performance in Ethiopia is highly correlated with the political process .Ethiopia's history is full of conflicts ,drastic policy changes and reversals .Before 1974 ,the macroeconomic policy was largely informed by a market oriented economic system. The period 1974-1991 witnessed a centralized economic system (socialism), where the state is given a significant role in all spheres of economic activity. The post Derge back to the market oriented system of the imperial regime (Gera, 2011).

During the Imperial (Monarchy) regime, which was the Emperor Haile Selassie I reign from the period 1930 to 1974, the land aristocracy and the majority of peasants (tenants) constitute the major socio-economic agents. Land was the most important resource and source of power that served as institution to exploit the masses by the Monarchy and the Feudal land lords. The economy was predominantly subsistence agrarian (Geda and Degefe, 2005).

During the early l950s, the imperial regime called for the transformation of the subsistence agrarian economy to an agro-industrial economy. In order to fulfill this objective the country needed to develop infrastructure, expand and improve health, education, communication and other essential services that enable proper utilization of resources and improve living conditions of the population. In order to carry through this new economic policy, the regime framed centrally administered development plans. The First Five-Year Plan (1957-61) had the objective to develop a strong infrastructure, particularly transportation and communications, to connect remote regions; to produce skilled and semi-skilled personnel to facilitate the industrial process so as to reduce Ethiopia's dependence on imports, and to promote commercial agriculture in order to accelerate agricultural development. During the First Five-Year Plan, the GNP increased at a 3.2 percent annual rate as opposed to the projected figure of 3.7 percent, and growth in economic sectors such as agriculture, manufacturing, and mining failed to meet the national plan's targets. Furthermore, exports and import grew at a rate of 3.5 and 6.4 percent per annum, respectively (Balcha, 2011).

On 12 September 1974, the socialist (Derge) regime removed the emperor from power and Ethiopia was declared a socialist state on December 1974 which means the government installed a socialist economy system where market forces were deliberately repressed. During the Derge regime the overall performance of the economy was actually terrible. There was extreme vulnerability, with consumption varying dramatically from year to year as a result of drought, ill health, or terms of trade shocks.(EEA, 1999/2000 and EDRI, 2007)

After assumed power in 1991/92,the transitional government and the latter Federal Democratic Republic Of Ethiopia (FDRE) government adopted new economic policy and subsequently implemented a serious of economic reform and stabilization programs .Although the economic reform programs emphasized on building market oriented economic system and promoting

private sector engagement in the economy the role of government in directing the economic system was over sighted .Accordingly, it becomes clear that the efforts in bringing economic growth could be enhanced if the government peruses to invest in key infrastructures and social development where the private sector could not be attracted. Economic reform programs implemented between 1991/92 and 2000/01 stimulated the economy. Accordingly, GDP (at constant price) increased to 17.4 billion ETHIOPIAN BIRR (ETB) in 2000/01 (MOFED,2014)

The various appraisal forums organized to assess previous experience in promoting economic growth and development indicated that the structural deficits in the economy at the ,free market economic policies were inept to achieve the required capacity to bring fast ,sustainable and broad based economic development .The government then adopted developmental state (a state which makes its primary goal to enhance economic growth and transformation) approach that uses the market as an instrument rather than a sole mechanism for fostering long term investment as a result the government get involved in huge and basic social and infrastructure investments which the private sector is unable to engage in along with promoting private sector participation in productive investment .

The primary goal of the Ethiopian government is to eradicate poverty by delivering economic growth and transforming the structure of the economy. To this end, the government has developed three successive blueprints that have been implemented with varying degrees of success: the Sustainable Development and Poverty Reduction Program (SDPRP), implemented from 2002/03 to 2004/05, the Plan for Accelerated and Sustained Development to End Poverty (PASDEP), implemented from 2005/06 to 2009/10 and the Growth and Transformation Plan (GTP), covering 2010/11 to 2014/15.

Unlike the SDPRP for the rest, infrastructure development is among the strategic pillars of the plan which shows that infrastructural development have major role in economic prosperity. The SDPRP,PASDEP and GTP are directed towards achieving the Millennium Development Goals(MDGs),Ethiopia's long term vision and sustaining the rapid ,broad based and equitable economic growth anchored on the experiences that have been drawn from implementing pro poor and pro-growth development policies and strategies undertaken since 2000 (MOFED ,2014).

Based on the report from national bank of Ethiopia, for the fiscal year between 2003/04 to 2013/14, GDP at constant price grows by 10.13 percent, for which the agriculture sector's contribution was higher until it give the lion share to services sector in 2007/08.

2.1.5. Transport Strategy and Transport Infrastructure in Ethiopia

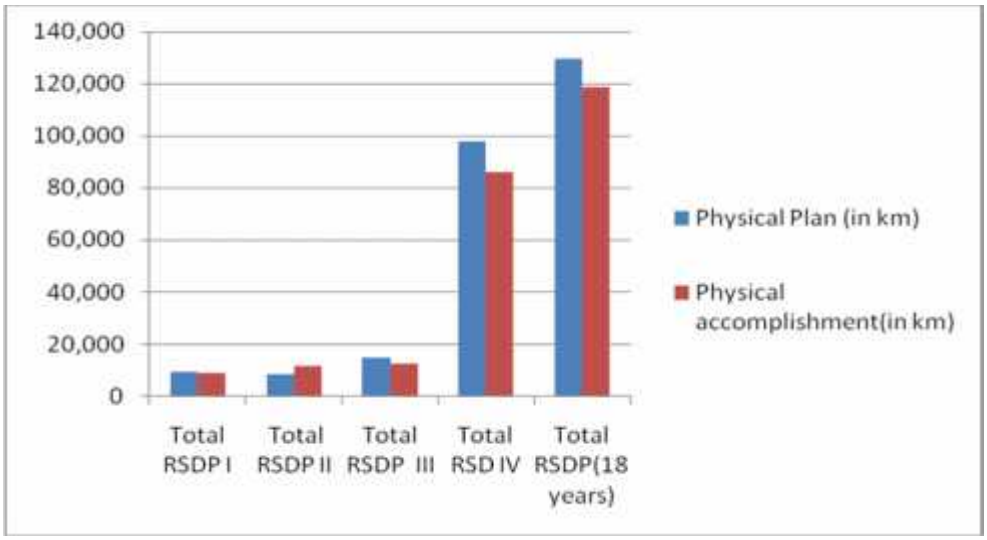
The transport sector strategy aims to develop the transport system in view of supporting the national development goals and to addresses the most critical issues in the sector having priorities of provides emphasis on the road development to rural feeder (community) road and construction and rural-urban transport linkages, improve road safety, scale up transport facilities ,create an enabling strategy to release the potential of private sector ,promote passenger transport , and provide efficient and effective transport system to respond the requirements of improved industrial and agricultural productions. Moreover, the strategy points out the need to expand air transport and build effective and efficient dry port and facilities in order to reduce cost of business (MOFED, 2014)

Ethiopia has been engaged in extensive investment in infrastructure development to sustain economic growth, improve product competitiveness and encourage private investors. The development of road transport, which is the dominant mode of transport in Ethiopia, is believed to create a network over a wide array of infrastructural facilities so as to improve the accessibility and mobility of agricultural and industrial products. Accordingly, in 2014/15, the total stock of road network reached 110,414 Km, which showed a 10.9 percent annual expansion, of the total roads 27,606 Km was Federal, 30,641 Km rural, 5,357 Km Urban and 46,810 Km Woreda roads. The Federal road includes 13,551 Km (49.1 percent) asphalt and 14,055 Km (50.9 percent) gravel road depicting a 7.2 percent annual expansion and 1.1 percent reduction, respectively. The asphalt road network in 2014/15 constituted about 12.3 percent of the total stock of road network in the country. It includes 85 Km Addis- Adama Express Way, the first of its kind in the country, which was completed in 2013/14 (NBE, 2014/15).

According to Ethiopian roads authority (ERA) to address the problems in the road sector; the Government launched the Road Sector Development Program (RSDP) in 1997 and has implemented four phases of RSDP i.e. RSDP I(July 1997 to June 2002), II(July 2002 to June

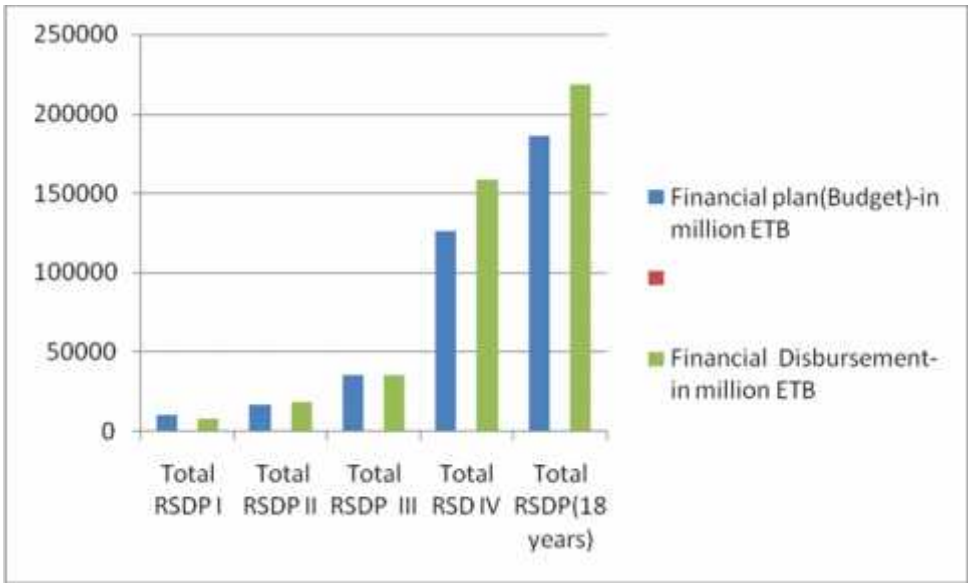
2007), III(July 2007 to June 2010)& IV(July 2010 to June 2015) .Over the Eighteen years(July 1997 to June 2015) of the RSDP, the total budget for the planned works amounted to ETB 185.9 billion (USD 12.7 billion). The total amount disbursed in the same period, is ETB 218.7 billion (USD 14.3).Physical and financial performance over the past 18 years against plan is 92% and 118% respectively(ERA,2015)

Figure 2.1.: physical plan vs. actual accomplishment of the 18 year RSDP



Source: computed based on data from Ethiopian Road Authority (ERA) 2015

Figure 2.2: financial plan vs. actual disbursement of the 18 year RSDP



Source: own computation based on data from ERA 2015

Around 80% of the RSDP financing over the last eighteen years came from the internal sources, where the government of Ethiopia has financed 70.8%,6.9%from the office of the road fund and the community has contributed 2% of the total finance of RSDP. The remaining 20% was pooled from the development partners.

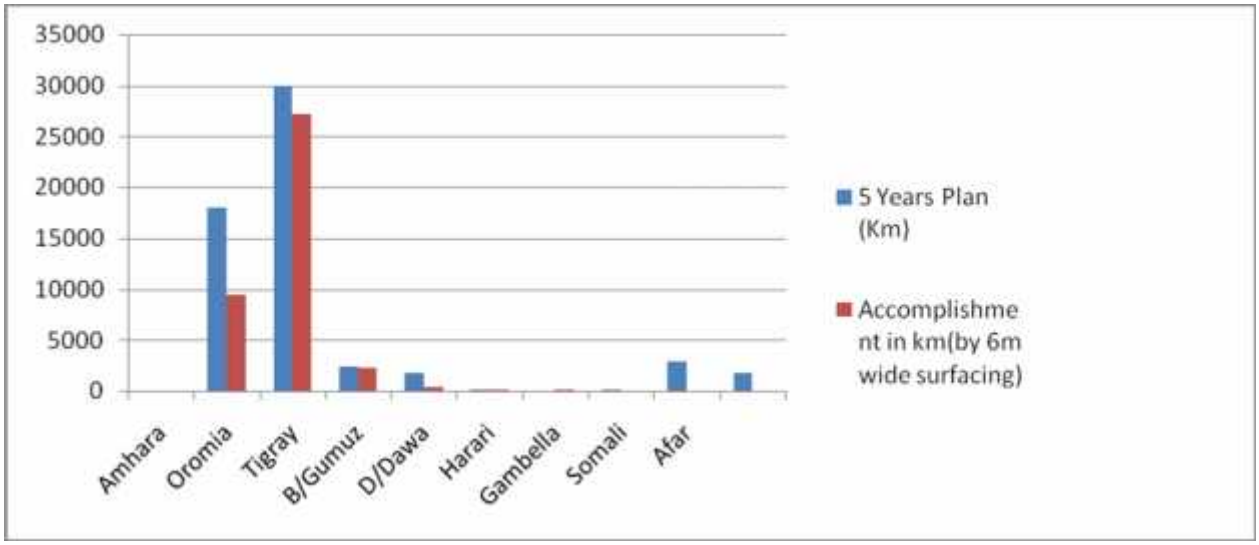
The eighteen years performance of RSDP has brought significant improvements in the restoration and expansion of Ethiopia's road network. Physical achievements have been matched by significant improvements in the condition of the network, strengthening of the management capacity of the road agencies and delivery on policy reform (ERA, 2015)

A total of 118,553 km of major physical road works excluding routine maintenance was carried out of which 31,821 km was on federal roads, 24,319 km was on regional roads construction and 62,413 km Universal Rural Road Access Program (URRAP) roads. Overall physical accomplishment against plan was 92%. Total disbursement was about ETB 218.7 billion and this disbursement was 118% of the plan (ERA, 2015).

As a major component of the RSDP-IV, URRAP was launched envisaging connecting all Kebeles by standard and affordable all-weather roads that provide year round access. During the first year

of implementation, which was largely a year of preparation, only 854 km of roads were constructed. Regions managed to construct 46,810 km of (by 6m wide) all weather roads, which is 65% of planned for the period of the 5 years. In addition, regions have also managed to maintain 535 km of the constructed URRAP roads.

Figure 2.3: physical plan vs physical accomplishment for URRAP



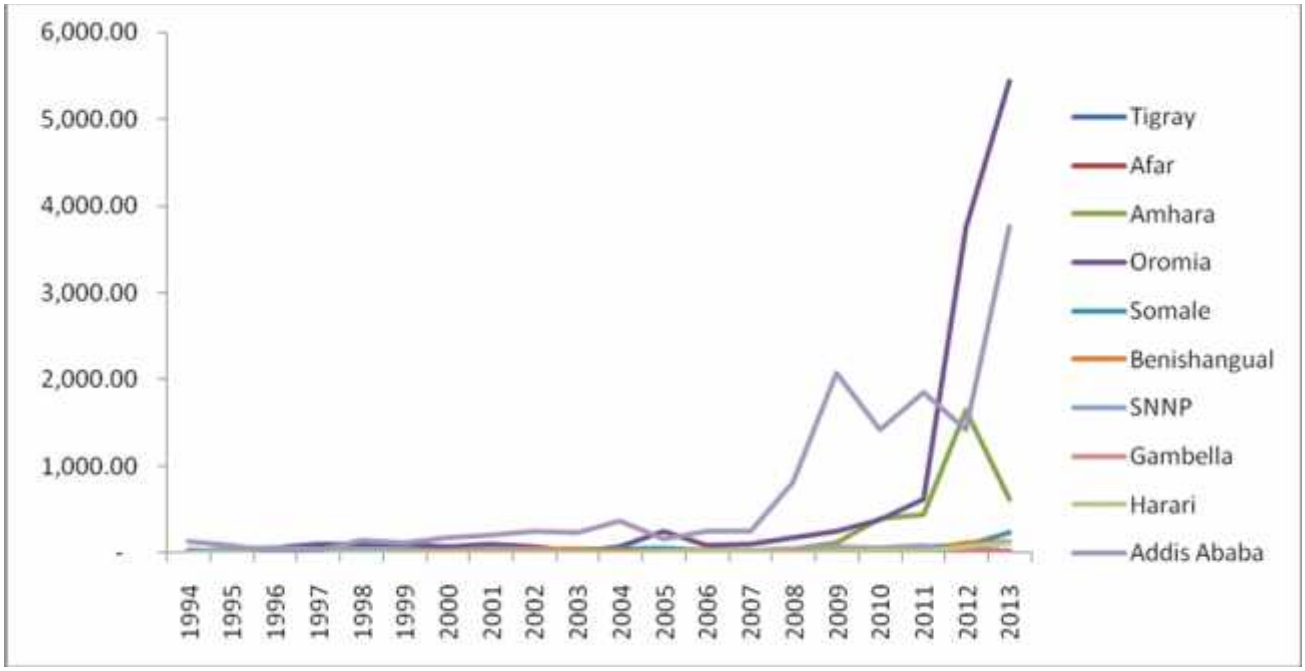
Source: own computation based on data from ERA 2015

As from the graph above Oromomia ,Amahara and South Nations Nationalities and People region (SNNPR) have high magnitude both in plan and accomplishment of URRAP. As far as the overall financial performance of URRAP is concerned, including the community contribution is about ETB 28 billion is expended so far. This fairly substantiates the extent of low cost per km investment on URRAP roads. Including all direct (construction) and indirect (training, supervision, operational, etc) costs; the per km cost of roads under URRAP is around ETB 689,025. The program is fully financed by the Government of Ethiopia (ERA, 2015).

Generally speaking 18 years RSDP have had different challenges like budget shortage and capacity gaps in both from the implementing agencies (regional road authorities) and the implementers (consultants and contractors) which results in projects deviation from the intended quality, time, and cost. As from the appendix III the trends of government regional (Dire Dawa is excluded due to data unavailability) expenditure on road construction expenditure shows an increment in

most of the regions .From the regions under consideration, Addis Ababa, Oromia and Amhara regions are the three top regions having a total of 13,830.992, 11748.102 and 3884.233 million birr total expenditure respectively in between 1994 and 2013.Moreover the three regions (i.e. Addis Ababa, Oromia and Amhara) have an average annual road construction expenditure of 691.55,587.41 and 194.21 million birr respectively in between 1994 and 2013.On the other the three regions having the least amount of total annual road construction expenditure are Harari ,Tigray and Afar region having annual average expenditure of 15.06,16.22 and 17.40 million Birr.

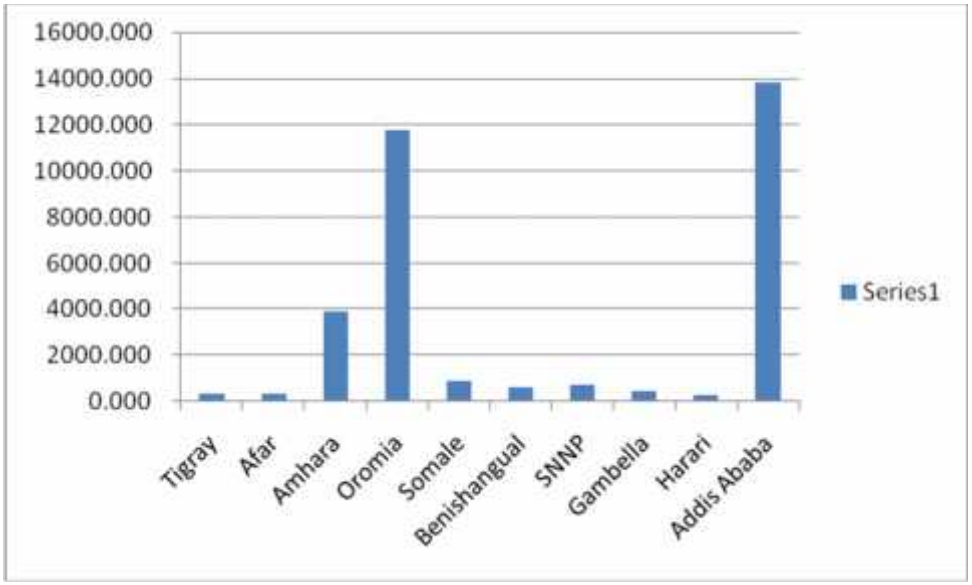
Figure 2.4: Annual regional road construction expenditure (in million Birr)



Source: own computation based on data from MOFED

As from the figure the trend in government regional expenditure for road construction from 1994 to 2005 there is similar trend in terms of their annual expenditure trend with the exception of Oromia region that shows increase starting from 1999 .On the other hand there is upward trend specially from 2007 onwards for the three regions ,even if there is decline in Oromia and Amhara for some period .

Figure :2.5. Total regional road construction expenditure between 1994-2013 (in million birr)



Source: own computation based on data from MOFED

In terms of total expenditure for the period between 1994 and 2013 the two extreme regions are Harari and Addis Ababa having the lowest and highest figure respectively .The total road construction expenditure shows that there is a big variation among regions in terms of the total budget directed for the sector implying the variations in transport infrastructure expansions and developments.

2.1.6. Theories of Economic Growth

The goal of growth theory is to give explanation about the determinants of the economic growth in a given country and the reason for difference in economic growth rates and per-capita income across countries (Dornbush &Fisher,1992,pp.269).

Interest in the study of economic growth has experienced remarkable ups and downs in the history of economics .It was central in classical political economy from Adam Smith to David Ricardo, and then in its critique by Karl Marx ,but moved to periphery during the so called marginal revolution .John von Neumann's growth model and Roy Harrod's attempt to generalize Keynes's principle of effective demand to the long run re-ignited interest in growth theory .Following the publication of a paper by Robert Solow and Nicholas kaldor in the mid-

1950,growth theory become one of the central topics of the economics profession until the early 1970s.After the decades of dormancy ,since the mid-1980s ,economic growth has once again become a central topic in economic theorizing .The recent theory is called 'endogenous growth theory ,since according to it the growth rate is determined from within and is not given as an exogenous variables (Salvadori ,2003).

I. The Classical Theory of Economic Growth

Analysis of the process of economic growth was central feature of the work of the English classical economist as represented by Adam smith, Thomas Malthus and David Ricardo .Despite speculation of others before them; they must be regarded as the main precursors of modern growth theory. An important achievement was their recognition that the accumulation and productive investment of the part of the social product is the main driving force behind economic growth and that, under capitalism ,this takes the form mainly of the reinvestment of profits .They added the increase in the supply of labor available for production through growth of population . Thus, Classic theory of economic growth is based on the existence of an economic activity that generate surplus. The success of the growth process depends on the reinvestment of this surplus. This surplus also represents the main sources of government income. The classical economist identified three factors of production: land, labor and capital (Harris,1988 and Lanza ,2012).

II. Keynesian Growth Theory

Keynesian economics gets its name, theories, and principles from British economist John Maynard Keynes (1883–1946), who is regarded as the founder of modern macroeconomics. The central tenet of this school of thought is that Government intervention can stabilize the economy. Keynes intended government to play a much larger role in the economy. His vision was one of reformed capitalism, managed capitalism—capitalism saved both from socialism and from itself. He talked about a "somewhat comprehensive socialization of investment" and the state's taking "an ever greater responsibility for directly organizing investment." Fiscal policy would enable wise managers to stabilize the economy without resorting to actual controls. The bulk of decision making would remain with the decentralized market rather than with the central planner. Keynes provided both a specific rationale for government's taking a bigger role in the economy and a more general confidence in the ability of government to intervene and manage effectively. So that

the inadequacy of private investment will be replaced by the government investment (Yergin & Stanislaw, 1998 and Jahan,et al.2014).

In the Keynesian model, increase in government expenditure (on infrastructures) leads to higher economic growth. Contrary to this view, the neo-classical growth models argue that government fiscal policy does not have any effect on the growth of national output. However, it has been argued that government fiscal policy (intervention) helps to improve failure that might arise from the inefficiencies of the market (Sharma, 2002).

III. The Solow Growth Model

Solow swan growth model or simply the Solow model named after Robert (Bob) Solow and Trevor swan come in to existence after they published two path breaking article in 1956 (Acemoglu,2007,pp.37).

The Solow model focuses on four variables: output (Y), capital (K), labor (L) and knowledge or the effectiveness of labor (A).At some time the economy has some amounts of capital, labor and knowledge and these are combined to produce output.

The production function takes the form :$Y(t)=F[K(t),A(t)L(t)]$,where t denote time .

The output will change if the inputs to production change .In particular the amount of output obtained from quantities of capital and labor rises overtime -there is technological progress -only if the amount of knowledge increase .AL implies that effective labor (Romer,2006,pp. 9-14).

Higher saving /investment rate leads to accumulation of more capital per worker and hence more output per worker. On the other hand ,high population growth has a negative effect on economic growth simply because a higher fraction of saving in economies with high population growth has to go to keep the capital labor ratio constant .In the absence of technological change and innovation ,an increase in capital per worker would not be matched by a proportional increase in output per worker because of diminishing returns .Hence capital deepening would lower the rate of return on capital (Nkiru and daniel, 2013).

IV. **Endogenous Growth Theory**

The phrase endogenous growth embraces a diverse body of theoretical and empirical work that emerge in the 1980s .This work distinguish itself from neoclassical system growth emphasizing the economic growth is an endogenous outcome of an economic system ,not the result of forces that impinge from outside (Romer,1994).

Historically, the engine of growth as depicted in Solow's seminal work on the topic (1956) was the assumption of exogenous technical change. Thus, initially, growth Models aimed at being consistent with growth facts, but gave up on the possibility Of explaining them. Moreover, this approach has weaknesses in two distinct areas. First, it is difficult using the exogenous growth model to explain the observed long run differences in performance exhibited by different countries. Second, the productivity changes that are assumed exogenous in the Solow model are, in fact, the result of conscious decisions on the part of economic agents. The important difference between the exogenous and endogenous growth models is that in the former the steady-state growth rate is determined exogenously, e.g., technical change. In the latter, it is determined endogenously. The models are interesting because they often leave a role for policy (Ickes, Jones & Manuelli, 2005).

It is easy to think of investments in infrastructure that make private production more profitable because with higher investment, and thus income, there is more government spending, which, since it is productive, makes for higher growth. But individual investors do not take into account the effect on growth from their investments (Ickes, 1996).

2.2. Empirical Literature

A number of empirical studies report evidence supporting the significant contribution of infrastructure to macro-economic growth and the societal wellbeing, still there are also studies showing the insignificant and even negative effect of investment on infrastructure.

A study on the Côte d'Ivoire economy using annual data for the period 1970 and 2002 using co integration and causality tests reveal that there exists unidirectional causality running from GDP to public investment both in the short and long run .The study explained the non-significant growth effect of public investment in transport infrastructure by not only the short supply but the

relatively poor quality of the total road network. For this the study advise that private participation in infrastructure besides accelerated investments infrastructure freed government from heavy administrative and fiscal burdens which can take the form of green field projects, complete or partial privatization, management and lease contracts or concessions mentioning the experience from Asian countries like china ,India ,Indonesia ,Malaysia ,Philippines and Thailand which have long recognized the need to improve the quality and quantity of their physical infrastructure that plays a crucial role in facilitating economic growth and competitiveness (Keho & Echui,2011).

A study on the Nigerian economy for 1984 and 2013 ,using auto regressive distributive lag model (bound test co integration approach) ,revealed that government expenditure on defense retards the economic growth and government expenditure on education and transport /communication have no impact on the economic growth in the long run. In the short run nosne of the government expenditure on these sectors contributes to the growth objective which is not unconnected with to the fact that the level of fiscal indiscipline in those sectors is outrageous to the extent that it serves as drag to the economic growth (Aremu,et al.,2015).

The relationship between public infrastructure investment and economic growth has always been an eye catching issue for china since Chinese government have devoted most of public fund to financing infrastructure after the economic reform .Using Cobb-Douglas [C-D] production function ,both the theoretic and practical analysis indicates that infrastructure capital stock exerts a positive impact on economic growth and it will increase long term economic growth rate which could verify the appropriateness of the current "infrastructure stressed" investment policies of Chinese government (Nannan & Jianing, 2012).On the other hand a study on Nepal economy revealed that due to political instability, internal inability and week governance situation capital expenditure is unable to influence on economic growth and development (Sharma, 2012).

According to the ADB(2012) report on the Asian economy over the years ,Asia's economy has grown rapidly and the number of poor people has dropped significantly .Gross domestic product per capita more than doubled from $2,490 in 2000 to $5,489 in 2009 and the number of people - based on the $1.25perday poverty line -is estimated to have declined from 903.4 million in 2005

to 754.0 million in 2008 .The back bone of this economic progress is infrastructure development ,which has become synonymous with economic growth and overall development .

Infrastructure plays a critical role in society and the economy by providing services to household and industries .The availability of transport, electricity, safe water and sanitation and other key facilities such as school and hospitals has a tremendous impact on improving the quality of life of house hold especially poor ones. For business, infrastructure services facilitate production, transport and transactions that spur growth, which in turn helps raise incomes and reduce poverty .conversely lack of infrastructure development signals barrier to growth and over all development.

A research on Saudi Arabia, on the relationship between government spending and economic growth, which is measured as the growth rate of real non-oil per capita GDP, while focusing on seven government spending categories; namely, housing, education, defense, health care, current and capital expenditures, and public investment. The finding shows that in the short-run the main determinants of growth are private domestic investment, openness to trade, public investment, and expenditures on health care and education.

The co integration analysis, on the other hand, showed that the main driving forces behind long-run growth are private domestic investment, Capital expenditures, and spending on health care which includes human capital (Alshahrani & Alsaadiq, 2014)

According to the study by Boopen (2006) ,which analyzed the contribution of transport capital to growth for two different data sets for sample of sub-Saharan African countries and also for developing states using both cross sectional and panel data analysis ,in both sample case transport capital has been a contributor to the economic progress of these countries. A study on the European Union (EU) countries finds that some types of public spending and taxation affects economic growth specifically government outlays on infrastructure (economic affairs and general public services) and property rights protection (defense, public order-safety) exert a positive impact on per capita growth. On the contrary, government expenditures on human capital enhancing activities (education, health, housing-community amenities, environment protection, recreation culture-religion) and social protection do not have a significant effect on growth (Benos ,2009)

A study in Kenya by Moyaki & John (2015) for the period 1963 to 2014 address the questions on the impacts of infrastructure network on the overall economic growth rate using ordinary least square method. The finding shows that for every one shilling spent on road infrastructure by the government GDP per capita increases by Kshs. 572.753 holding other factors constant. However, the GDP per capita is not very responsive to the private sector investment in the road infrastructure as it is for the public road expenditure.

Menyah and Wolde-Rufael(2013) investigated the relationship between government expenditure and economic growth in Ethiopia for the period between 1950 -2007 .Using the bounds test approach to co-integration ,they found robust evidence of a long run relationship between government expenditure and GDP. They obtained elasticities ranging from 1.73 to 1.79 implying that a 1% increase in income leads to a 1.73 % to 1.79% increase in government expenditure.

Nurudeen & Usman (2010) studied the effects of government spending on economic growth by employing a disaggregated analysis. The paper uses the co integration and error correction methods to analyze the relationship. The result was that total government expenditure and expenditure on education have negative effect on economic growth and on the contrary, rising expenditure on transport and communication and health results to an increase in economic growth.

As shown in the empirical literature review the role of government infrastructure expenditure in general and on transport infrastructure in particular is inconclusive and open for further research work.

CHAPTER THREE: DATA and METHODOLOGY

3.1. Model Specification, Variables Definition and Data Source

The model developed in order to examine the relationships between transport infrastructure expenditure and economic growth that is a variant of co-integration and error correction model is based on the work of Nurudeen and Usman (2010).Whereas the theoretical foundation of the study is based on the growth theories discussed on the literature review that is , the Keynesian growth theory , the Solow growth model and the endogenous growth model in which transport infrastructure expenditure is treated as explanatory variable that causes economic growth which is represented by the real GDP.

From the Keynesian growth model an increase in government expenditure (on infrastructure) leads to higher economic growth and improve failure that might arise from the inefficiencies of the market. From the endogenous growth model different public expenditure and government activity (policy) has an importance in the economic growth.

According to the Solow growth model economic growth is a function of capital, labor and knowledge.

The production function takes the form:

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

Where;

Y = aggregate real output,

K =capital stock,

A =efficiency factor,

L= labor,

t= time.

This can be modified based on the endogenous growth model in which transport infrastructure affects economic growth .Using a Cobb-Douglas (C-D) production function:

$$Y_t = A_t K_t^{\alpha} TI_t^{\beta} (L_t)^{1-\alpha-\beta}$$

The reduced form of the above equation (taking logarithm on both sides)

$$logY_t = \alpha \, logK_t + \beta logTI_t + (1-\alpha-\beta)\log(A_t L_t)$$

Where $logY_t$ log of real is output proxied by log of GDP (log GDP)

$logK_t$ is log capital stock proxied by log of gross capital formation(log GCF)

$logTI_t$ is log of transport infrastructure proxied by government expenditure on transport infrastructure

Log $L_t$is the log of labor force

A_t Is exogenously determined aggregate productivity or total factor productivity

The above model can also be written as: GDP=F (K, L.TI, A)

$\ln GDP = \alpha_0 + \alpha_1 lnLt + \alpha_2 lnKt + \alpha_3 lnTIt$; assuming that $\alpha = \alpha_1, \alpha_2 = \beta$ and $\alpha_3 = 1-\alpha-\beta$.

Priorily it is expected that $\alpha_0, \alpha_1, \alpha_2 and \alpha_3 are all greater than$ zero (positive). As explained earlier the objective of this study is to investigate the impact of transport infrastructure proxied by the government transport infrastructure expenditure on economic growth peroxide by the growth of real GDP .Hence the study shows the impact that transport infrastructure expenditure has on the economic growth of Ethiopia both in the long run and short run. To achieve this, the study uses co integration and error correction modeling based on the Keynesian and endogenous growth model theory. Thus, the economic growth model is a function of government transport infrastructure expenditure. In order to capture the growth of government expenditure and to avoid biases the study also includes government expenditure on agriculture, human capital, culture & sport and defense which takes the lion share of government expenditure .

The model for this paper is formulated on the following augmented function(among those research work that uses such model is the wok of Makdad et al., (2014), Nurudean and Usman(2010)).

$Y_t = f(TIe, AGe, EHe, CSe, DEe)$---------- [3.1]

Where;

Y_t - real GDP-calculated by dividing nominal GDP to consumer price index (CPI) and it implies the market value of goods and services produced by the economy over

TIe - is the government expenditure for transport and communication and the expected sign for this variable is positive,

AGe –is government expenditure for the agricultural economic sector and its sign of expectation is positive ,

EHe-is the educational and health expenditure of government that represent human capital and more of such expenditure leads to economic expansion and thus positive sign is expected from expenditure on education .Representing human capital with expenditure on education and health is also used by different researcher like Torruam and Abur(2014) and Gebru (2015),

CSe - is the government expenditure for culture and sport and its expected sign is positive, and

DEe -is the government expenditure for defense and the expected sign is positive.

All expenditure data are obtained from the ministry of finance and economic development (MOFED).Additionally data on GDP and CPI are from the national bank of Ethiopia (NBE) .All variables are in real terms which is obtained by dividing their annual nominal value to CPI for the period between 1975 and 2015.

For estimation purpose, equation (3.1.) is expressed in the following logarithmic equation. The log transformation avoids the hetroscedasticity (Gujarati, 2004).

lnY_t =bo+b1lnAGe+b2lnCSe+ b3lnEHe++ b4lnDFe+ b5lnTIe+ et----------[3.2]

In order to estimate the short run relationship among the variables, the corresponding vector error correction model (VECM) for ΔlnYt is estimated as follows:

Δln Y_t =bo+b1ΔlnAGe+b2ΔlnCSe+ b3ΔlnEHe+ b4ΔlnDFe+ b5ΔlnTIe+ b6et-1+Ut------[3.3]

Where Δ stands for the first difference operator ,Ut is the random disturbance term,et-1 is the error correction term and b6(the coefficient for et-1) measure the speed of adjustment towards the long run equilibrium (the speed at which it correct the previous period disequilibrium) and ECM is essential to see whether an economy is converging towards equilibrium in the long run or not and it shows short run deviation(Verbeek,2004).

3.2. Econometric Techniques

3.2.1. Co Integration and Error Correction Model

The theory of co integration and error correction model is used as it helps to examine the long run and short run relationship between the time series variables.

A) Co- integration

The notion of Co integration, which was given a formal treatment in Engle and Granger (1987) makes a regression involving an I (1) variables potentially meaning full. It addresses the issue of integrating short run dynamics with long run equilibrium .The presence of co integration implies that even if the dependent and the explanatory variables are non-stationary, the deviations are stationary. According to the Engle and Granger, if there is co-integration, the error correction model for long run equilibrium and short run dynamics best estimate the equation with non-stationary variables.

Co integration refers to a situation of long run equilibrium relationship between variables that don't drift to far apart overtime.

In a two variable case ,say yt and xt are two I(1) process (integrated of same order) ,then ,in general $y_t - \beta x_t$ (linear combination of x and y) is an I(0) process for any number β.Neverthless,it is possible that for some $\beta \neq 0$, $y_t - \beta x_t$ $is\ an\ I(0) process$,which means that it has constant mean ,constant variance and autocorrelations that depend only on the time distance

between any two variables in the series and it is asymptotically uncorrelated .If such a β exists, we say that y and x are co integrated and β is called co integration parameter (Wooldridge,2004).

In a multivariate case, there will be co integration if the following conditions are fulfilled:

1) The variables are integrated of same order,

2) The order of integration of dependent variable is not greater than that of the order of integration of any explanatory variables integrated to an identical order or higher than that of the dependent variable.

Engle Granger procedure has two steps: the first step is explanation of the equilibrium part of the error correction model in order to establish whether variables are co integrated ,so that the long run static model of the I(1) variables are estimated and the residuals are obtained .If residual which is the linear combination of the variables are stationary ,then the variables are said to be co integrated .If variables are I(0),then the generating process can always be written in an error correction form.

The second step in the Engle Granger procedure is to estimate the error correction model ,in which the first difference of the dependent variables is regressed on the first difference of explanatory variables with their appropriate lags and the first lags of the residual is obtained in the first step.

In order to say that co integration exists among the variables, we have to get high R^2,significant coefficient, non-zero co integration regression Durban Watson(DW) statistics and significant Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) tests of residual from the levels' regression .The coefficient estimate from the levels' or static regression can be interpreted as long run effects.

In this paper econometric model applied in order to examine the short run and long run relationship that government expenditure has on economic growth specifically the expenditure on transport infrastructure by applying co integration test and the associated error correction model.

Initially to test for the unit roots of the time serious variables ,DF and ADF technique are used .Then in the second stage ,the Error correction model (ECM) is estimated to see whether the

economy is approaching equilibrium in the long run or not and to examine the short run dynamics of the co integrated time series variables (Verbeek,2004).

B) Error Correction Mechanism (ECM)

The error correction mechanism developed by Engle and Granger is a means of reconciling the short run behavior of economic variables with its long run behavior .If x and y are co integrated; that is there is a long term ,or equilibrium ,relationship between the two. Of course in the short run there may be disequilibrium .The error correction mechanism corrects for the disequilibrium. Thus an ECM provide a room for considering both long run and short run factors while modeling differenced series. In a two variable case ECM takes the form: $\Delta y_t = r\Delta x_t + \alpha(y_{t-1} - \beta x_{t-1}) + \mu_t$ for the short run relationship. It relates the change in y to change in x and $e_{t-1} = (y_{t-1} - \beta x_t)_{t-1}$.The coefficient α shows the degree of adjustment of the dependent variable to its long run solution and its sign is expected to negative and less than unity. It serves to influence the short run movement of the dependent variable.(Gujrati,2004)

3.2.2. Stationary Tests

Even if the standard method of estimation is based on assumption that all variables are stationary, most economic variables are non-stationary at level that results a spurious regression .So that before running any econometric regression it is important to test for stationary of time series variables.

From the different methods of testing for the presence of unit root in the variable, Dickey Fuller (DF) and Augmented Dickey Fuller (AGF) are used.

$y_t = \pi y_{t-1} + u_t$----------3.4

Subtracting y_{t-1} *from both sides will give*

$\Delta y_t = \delta y_{t-1} + u_t$----------3.5

Where $\delta = \pi - 1$

The test for stationarity is done on the parameter delta .If $\delta = 0 \; or \; \pi = 1$,it implies that the variable y is stationary.

The hypothesis is formulated as follows

H0: $\delta = \pi - 1 = 0$

H1: $\delta < 0 \; or \; \pi < 1$

If including a constant [drift] to the regression is suggested, that is

$$\Delta y_t = \alpha + \delta y_{t-1} + u_t \text{----------3.6.}$$

Where α is a constant

If the series contain a deterministic trend ,it is important to incorporate time trends as well ,which as follows :

$$\Delta y_t = \alpha + \delta y_{t-1} + Bt + u_t \text{----------3.7.}$$

Where t is the time trend element?

In this equation ,the parameter delta is used while testing for the stationary where the decision is made using the t-statistics .If the t *calculated is* less than the critical value ,the null hypothesis is accepted and not otherwise .However the Dickey Fuller (DF) test may suffer from residual autocorrelation .to come up with this draw back DF is augmented with additional lagged first difference on the dependent variable which is known as ADF tests .thus incorporating the lagged values of dependent variable in the above equation gives us:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{k} \theta \, i \Delta y_{t-1} + u_t \text{----------3.8}$$

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{k} \theta \, i \Delta y_{t-1} + u_t, \text{ ----------3.9}$$

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{k} \theta \, i \Delta y_{t-1} + Bt + u_t \text{----------3.10}$$

as explained above α is constant, t is trend and k is the lag length and the error term u_t is a white noise (u-IID(0,δ^2)) (Verbeek,2004).

3.2.3. Lag Length Selection Criteria

To determine the optimal lag length different information criteria can be used .The most popular information criteria Akaike (1973)information criteria (AIC),Schwarez's(1978) Bayesian information criterion (SBIC) and Hannan-Quinn information criterion (HQIC).The lag length which is selected by most of these criteria will be included in the VAR system .The next concern is in co-integration analysis is the determination of the rank(r)of the long run matrix .This implies, the determination of the number of different linear combination of the variables (or the number of independent co integrating vectors) that are stationary.

In order to know the rank of the long run matrix ,that is the number of co integrating vector ,the paper uses the two likelihood ratio which are the trace (λ_{trace}) and the maximal Eigen value (λ_{max}) statistics which area given as follows

$\lambda_{trace}(r)=-T\sum_{i=r+1}^{n}\ln(1-\lambda_i^{\sim})$ ----------3.11

what we test here is that (m-r) smallest Eigen values are jointly zero or not.

$\lambda_{max}(r,r+t)=-T\ln(1-\lambda_{i+1}^{\sim})$----------3.12

Where r is the number of co integrating vector under the null and $\lambda_i^{\sim}$is estimated characteristics root and t is the number of observation.

The trace test (λ_{trace}) is the joint test where the null hypothesis is that the number of co integrating vector is less than or equal to r, against the unspecified alternative that there are more than r. on the other hand, the maximum Eigen value test (λ_{max}) test the null hypothesis that the number of co integrating vector is r against the alternative r+1(Verbeek, 2004).

CHAPTER FOUR : RESULSTS and DISCUSSION

4.1. Descriptive Statistical Analysis

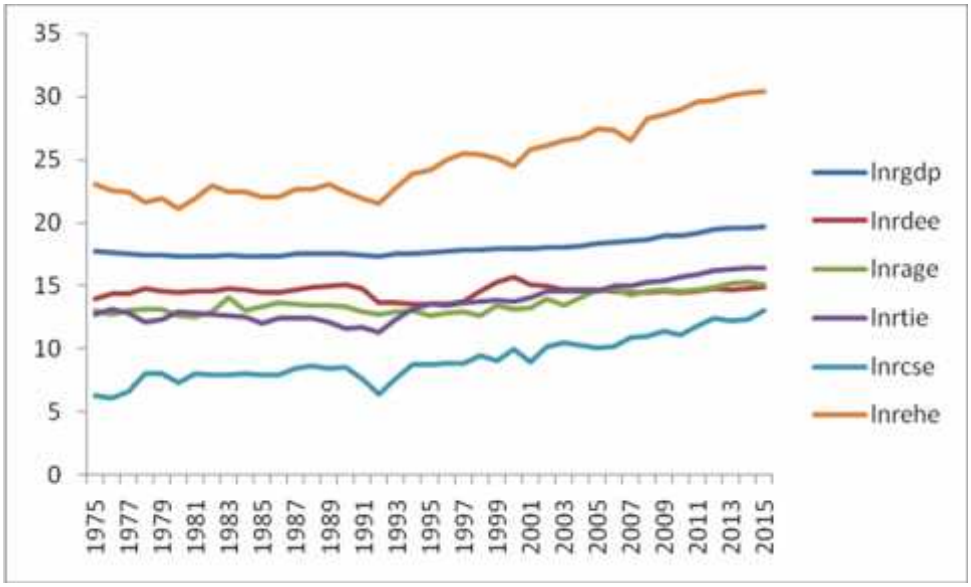
The study examined the relationship between economic growth and government expenditure for the period 1975 to 2015 .In order to have the overall look at the variables (both dependent and independent) of the study this section provides their descriptive statistical analysis using table and graph.

As can be seen from figure 4.1 the government expenditure is increasing on the sectors under consideration together with the country GDP during the period from 1991onwards with some exceptions. However, there were no significant increase in government expenditure prior to 1991 .Instead there were decrease specially on the transport infrastructure.

The figure shows that in the period 1991/1992 the government transport infrastructure expenditure is higher than the expenditure on agriculture ,defense, culture and sport .More specifically from 1997 onwards it increase continuously which is the period that the government starts implementing the Road Sector Development Program (ERA,2015).

During the period prior to 1991,next to human capital expenditure the lion share of the government budget goes to defense sector but the expenditure on transport infrastructure decreases specially in between 1979 and 1991(as depicted on Appendix III).

Figure 4.1. Trends of GDP and government expenditure on transport infrastructure, defense, agriculture, human capital and culture &sport.



Source: own computation based on data from MOFED and NBE (Appendix III) (vertical axis is natural logarithm of the variables in million Birr)

Table 4.1. shows the result of all variables calculated values of mean, standard deviation, minimum and maximum .For all variables the number of observation is 41.

Table 4.1: descriptive statistics of variables

Variables	Obs	Mean	Std dev.	Min.	Max.
LNRGDP	41	17.98784	.72266281	17.32456	19.66116
LNRDEE	41	14.52081	.4779016	13.5365	15.68575
LNRAGE	41	13.59014	.8350271	12.48951	15.30404
LNRTIE	41	15.60486	1.175024	11.58686	17.726
LNRCSE	41	9.122684	1.786854	6.043668	12.99234
LNREHE	41	24.89172	2.872545	21.15768	30.40515

Source: own computation based on data from NBE and MOFED(Appendix III) using Eviews 7

As from table above the mean value for the dependent variable (natural log of real gross domestic product) is 17.99 with standard deviation 0.72 and its maximum and minimum value is 17.32 and 19.66 respectively.

From the explanatory variables, the government expenditure for transport infrastructure has a mean value of 15.6 which is the highest mean value of government expenditure next to human capital expenditure from the variables under consideration.

The mean value for human capital ,agriculture ,defense ,culture and sport expenditures of government for the study period is 24.89,13.59,14.52&9.12 respectively .On the other hand the maximum expenditure value for human capital is 30.41 ,for agriculture 15.3 ,for defense 15.67and for culture and sport 12.99 and the minimum expenditure values for human capital 21.16, ,for agriculture 12.49,for defense 13.54 and for culture and sport 6.04

In order to see the relationship that government expenditure has with economic growth in Ethiopia, based on the model specified in the previous chapter, different test are done on the variables under consideration using different statistical techniques and econometric regression results are presented as follows.

4.2. Unit Root Test

In order to avoid spurious regression the time series variables in the regression analysis are tested for the existence of unit root using the standard augmented dickey fuller (ADF).

Table 4.2.unit root test result using ADF

Variables	Critical value	Adf statistics	Order of integration
D[LNRAGE]	1%=-3.655588	-6.808792	I(1)
	5%=-2.941145		
	10%=-2.609066		
D[LNRCSE]	1%=-3.610453	-7.478633	I(1)
	5%=-2.938987		
	10%=-2.607932		
D[LNRDEE]	1%=-3.610453	-4.503834	I(1)
	5%=-2.938987		
	10%=-2.607932		
D[LNREHE]	1%=-3.610453	-6.085531	I(1)
	5%=-2.938987		
	10%=-2.607932		
D[LNRGDP]	1%=-3.610453	-4.076610	I(1)
	5%=-2.938987		
	10%=-2.607932		
D[LNRTIE]	1%=-3.61453	-17.36235	I(1)
	5%=-2.938987		
	10%=-2.607932		

Sources: computed based on data from MO FED & NBE (Appendix III) using Eviews 7

From the result above all values of critical values are less than the ADF statistics in absolute value. Thus we reject the null hypothesis of having unit root problem. This implies that our variables which are real GDP, real government expenditure on agriculture, education & health ,transport infrastructure ,culture &sport and defense are stationary after first differencing(I(1)) . The stationary of the variables under consideration implies that there is long run relationship between economic growth and the government expenditure.

Table 4.3. Co integration test

Hypothesized no.of CE(s)	Eigen value	Max eigen statistics	0.05 critical value	Prob
none*	0.705128	47.62730	40.07757	0.0059
At most 1	0.451383	23.41381	33.87887	0.4991
At most 2	0.399992	19.92171	27.58434	0.3466
At most 3	0.292713	13.50642	21.13162	0.4068
At most 4	0.177135	7.603552	14.26460	0.4204

Max-eigenvalue test indicate 1 co integrating equation (s) at the 0.05 level

* denotes the rejection of the hypothesis at 0.05 level.

Sources: own computation on data from MOFED & NBE (Appendix III) using Eviwes 7

Hypothesized no.of CE(s)	Eigen value	Trace statistics	0.05 critical value	Prob
none*	0.705128	113.4062	95.75366	0.0018
At most 1	0.451383	65.77894	69.81889	0.1007
At most 2	0.399992	42.36512	47.85613	0.1488
At most 3	0.292713	22.44342	29.79707	0.2745
At most 4	0.177135	8.936995	15.49471	0.3712

Trace test indicate 1 co integrating equation (s) at the 0.05 level.

* denotes the rejection of the hypothesis at 0.05 level.

Sources: own computation based on data from MOFED & NBE (Appendix III) using Eviews 7

From the results of Johansen, we reject the null hypothesis that there is no co integration and all variables are co integrated i.e. they have long run association and thus we can run a vector error correction model (VECM).

Table 4.4.Unit Root Test for Residual (U)

Augmented dickey-fuller(ADF) test statistics		t-statistics	Prob
		-3.977895	0.0037
Test critical values	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

Sources: computed based on data from MOFED & NBE (Appendix III) using Eviwes 7

Null hypothesis: u has unit root

Alternative hypothesis: u has no unit root

The residual of our model is stationary based on the result from the ADF (as the absolute value of ADF statistics is greater than the absolute value Engle Granger critical value at 5% which is 3.34 so we can reject null hypothesis which means that our residual is stationary) .This implies that our model is not spurious (nonsense) model. Even if the variables under the model are non-stationary at level, still we can run the regression model provided the residual of the model is stationary and they are stationary at first difference which is true as from table above.

The stationary of the residual term(u) implies also that LNRGDP and LNRAGE LNRCSE,LNCSE,LNRDEE,LNREHE &LNRTIE are co-integrated which means that they have long run relationship .

4.3. Long Run Analysis

From the previous test of co integration using Johansen test and the unit root test for the residual we found that there is a co integration (long run relationship) between the variables. In order to see the long run relationship between economic growth and government expenditures the estimated model is presented as follows.

Dependent variable =LNRGDP

Sample: 1975-2015

Included observation: 41

Table 4.5. Long run regression result

Variables	Co efficient	Std.error	t-statistics	Prob.
LNRAGE	0.345502	0.114390	3.0203	0.0046
LNRCSE	-0.318551	0.068505	-4.650026	0.0000
LNRDEE	0.430701	0.084731	5.083169	0.0000
LNREHE	0.276539	0.052829	5.234630	0.0000
LNRTIE	0.195831	0.089905	2.178204	0.0360

R-squared= 0.836452

Adjusted R-Squared =0.818280

Durban Watson Stat. =1.039110

Sources: own computation based on data from MOFED & NBE(Appendix III) using Eviwes 7

From the regression outcome government expenditure on transport infrastructure is significant in explaining economic growth in Ethiopia in the long run. This result support the Keynesian theory of economic growth where by the government intervention can improve economic growth by stabilizing the economy which might arise from market failure like the transport infrastructure investment due to its nature of public good .Thus, transport infrastructure investment positively affect the economic growth by reducing the effect of distance and increasing business efficiency supporting cluster and agglomeration of the economic activity (Jahan et al.,2014) .Similarly, result of study by Boopen (2006) on Sub Saharan Africa (SSA) shows transport capital has improving impact on economic growth . The regression result is also in line with similar studies like Carlsson, et al. (2013), Nannan & Jianing (2012) , Nurudeen & Usman (2010) but it deviate from the results of study by kayode et al. (2013) .

In the long run the level of government expenditure on human capital and agriculture has positive and significant economic growth contribution .This result is in line with finding of Schutt (2003) and Musila& Belassi (2004) whereby the increasing government expenditure on human capital and agriculture positively contributes for economic expansion. In the long run the level of government expenditure on human capital and agricultural sector of the economy has positive and

significant impacts on the economy which implies that increasing a government agricultural and human capital expenditure increase the economic growth.

From the long run regression result the other government expenditure sector which has positive and significant economic growth impact is the expenditure on defense . This is in line with study result of Awaworyi& Yew (2014). "Defense expenditure provides internal and external security and safety for a country's citizens ,and creates a worldwide environment for trade and investment and also encourage innovations .It ensures the safety of the people and property from internal and external threats .that is ,in the long run its boosts economic growth." Wang, et al.(2012).

On the other hand the negative impact of expenditure on culture and sport sector may results in as expenditure on culture will result in getting different ethnicity and social group respected their culture and the sport sector is not developed and thus there will be no value they will add on economic growth .

4.4. Short Run Analysis

Table 4.6 serial correlation test

. Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.204816	Prob. F(2,31)	0.0543
Obs*R-squared	6.853456	Prob. Chi-Square(2)	0.0325

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 10/11/16 Time: 20:00
Sample: 1976 2015
Included observations: 40
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003479	0.013902	0.250222	0.8041
D(LNRAGE)	0.009442	0.034147	0.276526	0.7840
D(LNRCSE)	0.006460	0.025560	0.252748	0.8021
D(LNRDEE)	-0.029420	0.051889	-0.566972	0.5748
D(LNREHE)	-0.022269	0.026563	-0.838354	0.4082
D(LNRTIE)	-0.001082	0.023362	-0.046314	0.9634
U(-1)	-0.007622	0.053731	-0.141861	0.8881
RESID(-1)	0.338673	0.189384	1.788284	0.0835
RESID(-2)	0.214420	0.185455	1.156188	0.2564

R-squared	0.171336	Mean dependent var	2.43E-18
Adjusted R-squared	-0.042512	S.D. dependent var	0.076097
S.E. of regression	0.077698	Akaike info criterion	-2.076868
Sum squared resid	0.187146	Schwarz criterion	-1.696870
Log likelihood	50.53736	Hannan-Quinn criter.	-1.939473
F-statistic	0.801204	Durbin-Watson stat	1.992726
Prob(F-statistic)	0.606160		

Sources: own computation based on data from MOFED & NBE (Appendix III) using Eviwes 7

As p value for observed R2 is less than 5%, we accept the null hypothesis that the residual of ECM s serially correlated .In order to solve the problem of serial correlation of residual lagged values of the dependent variable is included in the VECM and the result is presented below.

Table: 4.7. Test of serial correlation test after the inclusion of residual lagged values of the dependent variable

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.617123	Prob. F(2,29)	0.5464
Obs*R-squared	1.592088	Prob. Chi-Square(2)	0.4511

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 10/11/16 Time: 20:49

Sample: 1977 2015

Included observations: 39

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.007470	0.015805	-0.472673	0.6400
D(LNRAGE)	0.006611	0.032268	0.204875	0.8391
D(LNRCSE)	0.002182	0.026198	0.083276	0.9342
D(LNRDEE)	-0.012273	0.052712	-0.232830	0.8175
D(LNREHE)	-0.002605	0.028014	-0.092982	0.9266
D(LNRTIE)	-0.001074	0.072541	-0.014811	0.9883
D(LAGLNRGDP)	0.158375	0.205459	0.770834	0.4470
U(-1)	0.020661	0.055944	0.369316	0.7146
RESID(-1)	-0.284933	0.286213	-0.995526	0.3277
RESID(-2)	-0.151021	0.200296	-0.753990	0.4569

R-squared	0.040823	Mean dependent var	-1.07E-17
Adjusted R-squared	-0.256853	S.D. dependent var	0.065381
S.E. of regression	0.073298	Akaike info criterion	-2.172010
Sum squared resid	0.155806	Schwarz criterion	-1.745456
Log likelihood	52.35420	Hannan-Quinn criter.	-2.018966
F-statistic	0.137138	Durbin-Watson stat	2.063613
Prob(F-statistic)	0.998114		

Sources: own computation based on data from MOFED & NBE (Appendix III) using Eviwes 7

As p value for observed R2 is greater than 5%,we reject the null hypothesis that the residual of ECM s serially correlated and accept the alternative hypothesis i.e. there is no serial correlation and thus we can run VECM.

Table 4.8: Vector Error Correction Model (VECM)

Dependent variable D (LNRGDP)

Method: least square

Variables	Co efficient	Std.error	t-statistics	Prob.
C	0.013395	0.014070	0.952038	0.3484
D(LNRAGE)	0.061609	0.031315	1.967360	0.0581
D(LNRCSE)	0.019112	0.025796	0.740886	0.4643
D(LNRDEE)	0.012202	0.050483	0.241700	0.8106
D(LNREHE)	0.028901	0.027447	1.052971	0.3005
D(LNRTIE)	0.130475	0.070362	1.854321	0.0732
D(LAGLNRGDP)	0.345659	0.135351	1.553796	0.0158
U(-1)	-0.45748	0.51458	-0.88904	0.03808

R-squared =0.511745

Adjusted r-squared =0.401494

Durban watson stat.=2.167394

Prob(f-statistics)=0.001

Sources: own computation based on data from MOFED & NBE (Appendix III) using Eviwes 7

Estimation results of ECM:

$\Delta LN\ Y_t$ =BO+B1ΔLNAGE+B2ΔLNCSE+ B3ΔLNDEE+ B4ΔLNREHE+ B5ΔLNRTIE+ B6$\Delta LAGLNRGDP$+ B7et-1+Ut

D(LNRGDP)=C(0)+C(1)*D(LNRAGE)+C(2)*D(LNRCSE)+C(3)*D(LNRDEE)+C(4)D(LNREHE)+C(5)*D(LNRTIE)+C(6)*D(LAGLNRGDP)+C(7)*U(1)

When we substitute coefficient from the ECM:

D(LNRGDP)=0.013395+0.061609D(LNRAGE)+0.019112D(LNRCSE)+0.012202D(LNRD

(0.014070) (0.031315) (0.025796) (0.050483)

EE)+0.028901D(LNREHE)+0.130475D(LNRTIE)+0.345659D(LNLAGLNRGDP)-

(0.027447) (0.070362) (0.135351)

0.45748U (-1)

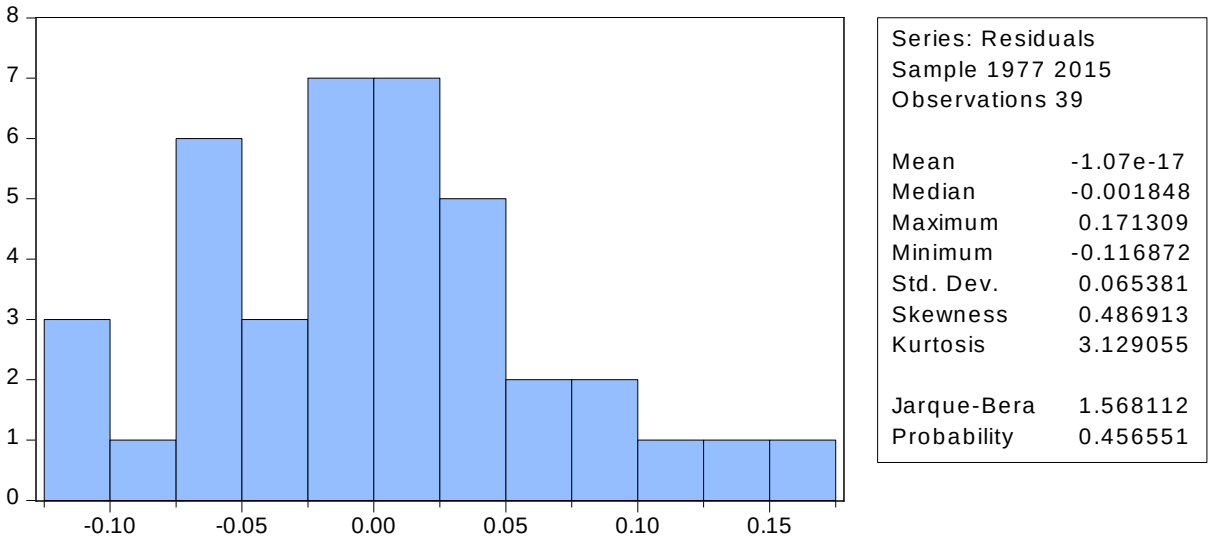
(0.51458)

As from VECM result government transport infrastructure expenditure and expenditure on agricultural sector of the economy is significant at 10% in explaining economic growth whereas expenditure on human capital, defense and culture and sport are all insignificant in the short run. The error correction term, which is the speed of adjusting the previous period disequilibrium, is 45.478%.

4.5. Residual Diagnostics Test

In order to see appropriateness of the VECM, residual diagnostics test is performed. i.e. tests of Normality.

The normality tests are used to find whether a data set is well modeled by a normal distribution or not .The normality test tell us about the type of distribution of residuals.(Makdad,2014)



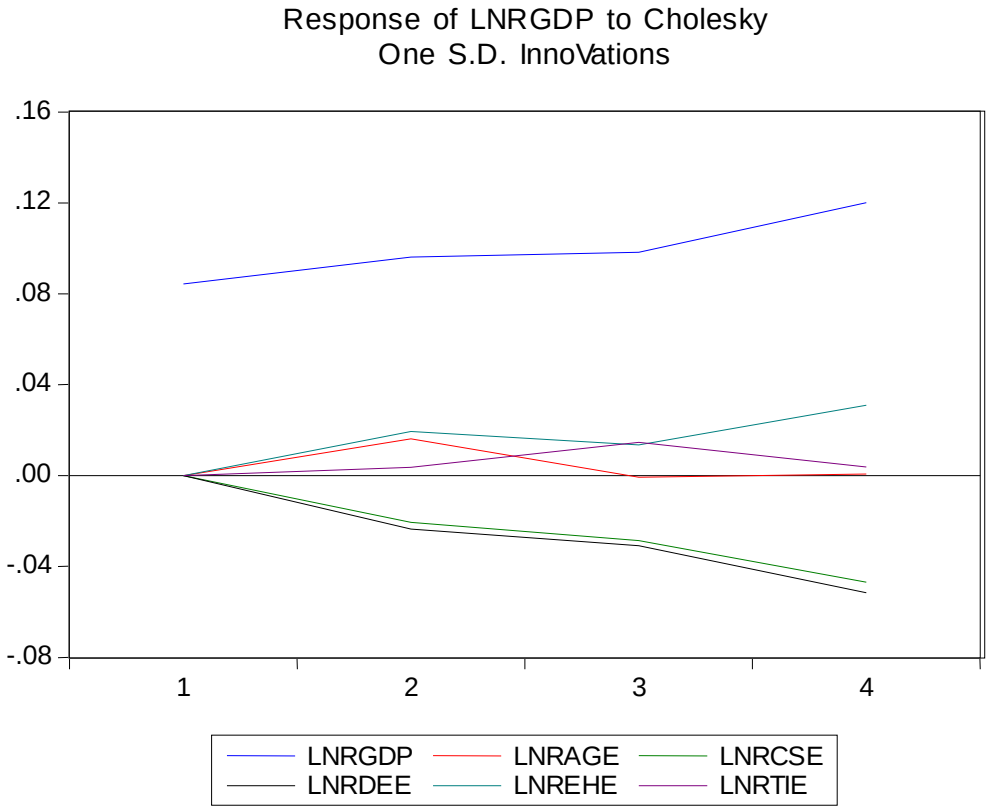
Sources: computed based on data from MOFED & NBE (Appendix III) using Eviwes 7

Based on the Jarque -Bera test of normality and the corresponding p value (which is more than 5%), the residuals are normally distributed (Verbeek, 2004).

4.6 Impulse Response Function

In order to make results of this study more concrete, the impulse response of real GDP to the shocks in government transport infrastructure expenditure is shown in figure 4.2. An impulse response function traces the response of the endogenous variable in the system to a shock in one variable (trace out the effects of counterfactual increases in the shocks).This means it measure the importance of next period shocks for future values of a time series .In order to see the response of economic growth to a shock from transport infrastructure expenditure the impulse response function employed (Ludvigson, 2015 and Parkyn, & Vehbi, 2014).

Figure 4.2.: Impulse response of LNRGDP to shock from other variables



From the above figure (4.2), a positive shock occurring on real public transport infrastructure expenditure has a positive impact on real gross domestic product implying that the effect of one standard deviation shock of real public transport infrastructure expenditure on real gross domestic

product is positive. This result is consistent with the result we have got in the VECM analysis. Similar results happen from government expenditure on human capital and agriculture.

On the other hand a positive shock occurring on real culture and sport expenditure has a negative impact on real gross domestic product growth Which means the effect of one standard deviation shock of culture and sport expenditure on real gross domestic product is negative in the short run .This result is not consistent with the result we have got in the VECM analysis. However, such-effects may occur due to the fact that in the short run the involvement of the government in expanding culture and sport expenditure may lower available finance for its activity and there by leading to increasing in taxes levied on private sector there by discouraging economic growth.

CHAPTER FIVE: CONCLUSION and POLICY IMPLICATION

5.1. Conclusion

Attaining a sustained economic growth is a prime objective of every nation over the entire world and infrastructure investment is seen as an important prerequisite for sustainable economic growth. Due to its very nature (being public good results market failure) and the low level of development of the private sector demands the government of developing nations to take active role in the expansion of such infrastructure .Does such involvement of the government is affecting the economic growth positively or not is an empirical question. In this regard a result of previous empirical studies and theory is not consistent. Keynesian theory of economic growth support the active role of government in stabilizing economic growth .According to this theory fiscal policy would enable wise managers to stabilize the economy without resorting to actual control where the bulk of decision making would remain with decentralized market rather than with central planner. In this theory increase in government expenditure leads to higher economic growth which is contrary to neoclassical.

On the other hand, the classical school recognizes that accumulation and productive investment of the part of the social product is the main driving force behind economic growth, under capitalism, this takes the form mainly of the reinvestment of profits. And also increase in supply of labor available for production through growth of population .Thus, the success of economic growth process depends on the reinvestment of the economic surplus which represents the main sources of government income.

The Solow growth model, which comes after 1956, says that higher saving /investment rates leads to accumulation of more capital per worker and hence more output per worker whereas high population growth has negative effect on economic growth simply because a higher fraction of saving in the economies with high population growth has to go to keep the capital labor ratio constant .

Empirical studies shows also different results in regards to the government intervention on economic growth and the sources difference in country's economic performance .Study on Nigerian economy revealed that government expenditure on defense retard economic growth and expenditure on education and transport have no impact on economic growth in the long run.

However , study on sub-Saharan African shows that transport capital has been a contributor to economic progress. According to the Asian development bank report the back bone of Asia's economic progress is infrastructure development, which has become synonymous with economic growth and overall development .A study in China indicates that indicates that infrastructure capital stock exerts a positive impact on economic growth. According to a study made in Kenya road infrastructure expenditure supports economic growth positively.

Therefore, neither the theoretical nor the empirical work shows clear effects of government expenditure on economic growth.

Having the objective of exploring the effects of the government transport infrastructure expenditure on economic growth in Ethiopia between 1975 and 2015 the study employed co integration and error correction model. In order to avoid spurious regression stationary test is done for all variables under consideration and result shows that all variables are stationary after first differencing (I(1)) implying that there s long run relationship between economic growth and government expenditure .

The empirical result shows that in the long run government transport infrastructure expenditure is significant in explaining economic growth and statistically significant at 5 percent level for the period between 1975 and 2015 in Ethiopia .A 1 percent increase in transport infrastructure expenditure leads to 0.19 percent increase in real GDP in the long run .Similarly a one percent increase in agriculture ,defense and human capital sector leads to 0.34,0.43,and 0.27 percentage increase in GDP respectively which are all significant at 1 percent level. However, the study found that government culture and sport expenditure (CSE) has negative effect on GDP growth in the long run which is statistically significant at 1 percent level. A 1 percent increase in CSE leads to 0.31 percent decrease in real GDP.

Results from impulse response function implies that a positive shock occurring on real public transport infrastructure expenditure has positive impact on real GDP implying that the effects of one standard deviation shocks of real public transport infrastructure expenditure on real GDP is positive. This result is consistent with results we have got in the VECM analysis.

5.2. Policy Implication

Based on the finding the following recommendations are forwarded:

Even if there is improvement on the transport infrastructure development in Ethiopia, still more is left to be done so that the government should do more in expanding the current transport infrastructure coverage.

The study found that the economic growth is positively elastic to the expansion of government transport infrastructure expenditure for the period under consideration .So it is better for government to expand its budget more to the productive sector including transport infrastructure.

Based on the result from this study the government should also expand its expenditure on human capital, agriculture and defense and lesser for culture and sport.

The study examined the effects of government transport infrastructure expenditure together with expenditure on human capital, agriculture, defense and culture and sport on economic growth for the period 1975 and 2015 because of resource and time limitation .Therefore researcher may address this limitation by including more variables that affect economic growth like foreign direct investment, export, population growth and other variables and by expanding the time coverage as well.

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Appendixes: I.

1) unit root test result

For LNRAGE

a) At level

Null Hypothesis: LNRAGE has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.055884	0.7236
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRAGE)

Method: Least Squares

Date: 10/11/16 Time: 05:38

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRAGE(-1)	-0.085557	0.081029	-1.055884	0.2977
C	1.211578	1.099953	1.101482	0.2776

R-squared	0.028503	Mean dependent var	0.052161
Adjusted R-squared	0.002937	S.D. dependent var	0.409137

S.E. of regression	0.408536	Akaike info criterion	1.096233
Sum squared resid	6.342263	Schwarz criterion	1.180677
Log likelihood	-19.92467	Hannan-Quinn criter.	1.126766
F-statistic	1.114891	Durbin-Watson stat	2.364051
Prob(F-statistic)	0.297688		

Null Hypothesis: LNRGDP has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.380634	0.8515
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP)

Method: Least Squares

Date: 10/11/16 Time: 05:44

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	-0.045959	0.033289	-1.380634	0.1757
C	0.715999	0.563772	1.270015	0.2120
@TREND(1975)	0.007681	0.001935	3.968567	0.0003

R-squared	0.460210	Mean dependent var	0.048670
Adjusted R-squared	0.431032	S.D. dependent var	0.095717
S.E. of regression	0.072200	Akaike info criterion	-2.346729
Sum squared resid	0.192872	Schwarz criterion	-2.220063
Log likelihood	49.93457	Hannan-Quinn criter.	-2.300930
F-statistic	15.77258	Durbin-Watson stat	1.939053
Prob(F-statistic)	0.000011		

Null Hypothesis: LNRAGE has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.742075	0.8708
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRAGE)

Method: Least Squares

Date: 10/11/16 Time: 05:44

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRAGE(-1)	0.003541	0.004771	0.742075	0.4625

R-squared	-0.002515	Mean dependent var	0.052161
Adjusted R-squared	-0.002515	S.D. dependent var	0.409137
S.E. of regression	0.409651	Akaike info criterion	1.077662
Sum squared resid	6.544759	Schwarz criterion	1.119884
Log likelihood	-20.55324	Hannan-Quinn criter.	1.092928
Durbin-Watson stat	2.507219		

b) At first difference

Null Hypothesis: D(LNRAGE) has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.808792	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRAGE,2)

Method: Least Squares

Date: 10/11/16 Time: 05:46

Sample (adjusted): 1978 2015

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRAGE(-1))	-1.707402	0.250764	-6.808792	0.0000
D(LNRAGE(-1),2)	0.351835	0.156447	2.248911	0.0309
C	0.098873	0.064107	1.542315	0.1320

R-squared	0.677061	Mean dependent var	-0.012612
Adjusted R-squared	0.658608	S.D. dependent var	0.656143
S.E. of regression	0.383376	Akaike info criterion	0.996057
Sum squared resid	5.144209	Schwarz criterion	1.125340
Log likelihood	-15.92509	Hannan-Quinn criter.	1.042055
F-statistic	36.68985	Durbin-Watson stat	1.992933
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRAGE) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.001919	0.0000
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRAGE,2)

Method: Least Squares

Date: 10/11/16 Time: 05:47

Sample (adjusted): 1978 2015

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRAGE(-1))	-1.774040	0.253365	-7.001919	0.0000
D(LNRAGE(-1),2)	0.387704	0.157255	2.465447	0.0189
C	-0.058704	0.135847	-0.432129	0.6684
@TREND(1975)	0.007519	0.005732	1.311870	0.1984

R-squared	0.692620	Mean dependent var	-0.012612
Adjusted R-squared	0.665498	S.D. dependent var	0.656143
S.E. of regression	0.379488	Akaike info criterion	0.999311
Sum squared resid	4.896366	Schwarz criterion	1.171688
Log likelihood	-14.98690	Hannan-Quinn criter.	1.060641
F-statistic	25.53745	Durbin-Watson stat	2.033855
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRAGE) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.948464	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNRAGE,2)
Method: Least Squares
Date: 10/11/16 Time: 05:48
Sample (adjusted): 1977 2015
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRAGE(-1))	-1.242717	0.156347	-7.948464	0.0000

R-squared	0.624408	Mean dependent var	0.004239
Adjusted R-squared	0.624408	S.D. dependent var	0.655948
S.E. of regression	0.402001	Akaike info criterion	1.040583
Sum squared resid	6.140990	Schwarz criterion	1.083239
Log likelihood	-19.29138	Hannan-Quinn criter.	1.055888
Durbin-Watson stat	2.115266		

For LNRCSE

a) At level

Null Hypothesis: LNRCSE has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.616928	0.8555
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE)

Method: Least Squares

Date: 10/11/16 Time: 05:56

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRCSE(-1)	-0.036291	0.058825	-0.616928	0.5410
C	0.496636	0.540032	0.919642	0.3636

R-squared	0.009916	Mean dependent var	0.169075
Adjusted R-squared	-0.016138	S.D. dependent var	0.618593
S.E. of regression	0.623565	Akaike info criterion	1.941979
Sum squared resid	14.77566	Schwarz criterion	2.026423
Log likelihood	-36.83958	Hannan-Quinn criter.	1.972511
F-statistic	0.380600	Durbin-Watson stat	2.322195
Prob(F-statistic)	0.540961		

Null Hypothesis: LNRCSE has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.819261	0.1991
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE)

Method: Least Squares

Date: 10/11/16 Time: 05:56

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRCSE(-1)	-0.388983	0.137974	-2.819261	0.0077
C	2.538377	0.887251	2.860947	0.0069
@TREND(1975)	0.055690	0.020033	2.779885	0.0085

R-squared	0.180976	Mean dependent var	0.169075
Adjusted R-squared	0.136705	S.D. dependent var	0.618593
S.E. of regression	0.574758	Akaike info criterion	1.802302
Sum squared resid	12.22282	Schwarz criterion	1.928968
Log likelihood	-33.04605	Hannan-Quinn criter.	1.848101
F-statistic	4.087872	Durbin-Watson stat	1.965851
Prob(F-statistic)	0.024888		

Null Hypothesis: LNRCSE has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.576519	0.9698
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE)

Method: Least Squares

Date: 10/11/16 Time: 05:57

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRCSE(-1)	0.016898	0.010719	1.576519	0.1230

R-squared	-0.012119	Mean dependent var	0.169075
Adjusted R-squared	-0.012119	S.D. dependent var	0.618593
S.E. of regression	0.622330	Akaike info criterion	1.913991
Sum squared resid	15.10451	Schwarz criterion	1.956213
Log likelihood	-37.27982	Hannan-Quinn criter.	1.929257
Durbin-Watson stat	2.394140		

b) At first difference

Null Hypothesis: D(LNRCSE) has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.478633	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE,2)

Method: Least Squares

Date: 10/11/16 Time: 05:58

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRCSE(-1))	-1.209670	0.161750	-7.478633	0.0000
C	0.210692	0.102160	2.062370	0.0462

R-squared	0.601851	Mean dependent var	0.023067
Adjusted R-squared	0.591090	S.D. dependent var	0.967147
S.E. of regression	0.618452	Akaike info criterion	1.926728
Sum squared resid	14.15189	Schwarz criterion	2.012038
Log likelihood	-35.57119	Hannan-Quinn criter.	1.957336
F-statistic	55.92996	Durbin-Watson stat	2.067125
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRCSE) has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.395714	0.0000
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE,2)

Method: Least Squares

Date: 10/11/16 Time: 05:58

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRCSE(-1))	-1.211545	0.163817	-7.395714	0.0000
C	0.147862	0.213058	0.693999	0.4921
@TREND(1975)	0.003006	0.008912	0.337281	0.7379

R-squared	0.603105	Mean dependent var	0.023067
Adjusted R-squared	0.581055	S.D. dependent var	0.967147
S.E. of regression	0.625995	Akaike info criterion	1.974855
Sum squared resid	14.10731	Schwarz criterion	2.102821
Log likelihood	-35.50966	Hannan-Quinn criter.	2.020768
F-statistic	27.35203	Durbin-Watson stat	2.070846
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRCSE) has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.902984	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRCSE,2)

Method: Least Squares

Date: 10/11/16 Time: 05:59

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRCSE(-1))	-1.127749	0.163371	-6.902984	0.0000

R-squared	0.556081	Mean dependent var	0.023067
Adjusted R-squared	0.556081	S.D. dependent var	0.967147
S.E. of regression	0.644383	Akaike info criterion	1.984260
Sum squared resid	15.77873	Schwarz criterion	2.026916
Log likelihood	-37.69308	Hannan-Quinn criter.	1.999565
Durbin-Watson stat	1.975456		

For LNRDEE

a) At Level

Null Hypothesis: LNRDEE has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.206564	0.0271
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE)

Method: Least Squares

Date: 10/11/16 Time: 05:59

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRDEE(-1)	-0.313813	0.097866	-3.206564	0.0028
D(LNRDEE(-1))	0.452744	0.145128	3.119630	0.0036
C	4.563176	1.421348	3.210456	0.0028

R-squared	0.297190	Mean dependent var	0.014067
Adjusted R-squared	0.258145	S.D. dependent var	0.317972
S.E. of regression	0.273873	Akaike info criterion	0.321497
Sum squared resid	2.700226	Schwarz criterion	0.449463
Log likelihood	-3.269191	Hannan-Quinn criter.	0.367410
F-statistic	7.611474	Durbin-Watson stat	2.132957
Prob(F-statistic)	0.001750		

Null Hypothesis: LNRDEE has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.226159	0.0943
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE)

Method: Least Squares

Date: 10/11/16 Time: 06:00

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRDEE(-1)	-0.320973	0.099491	-3.226159	0.0027
D(LNRDEE(-1))	0.459825	0.146935	3.129451	0.0035
C	4.617594	1.437225	3.212854	0.0028
@TREND(1975)	0.002355	0.003965	0.593895	0.5564

R-squared	0.304202	Mean dependent var	0.014067
Adjusted R-squared	0.244562	S.D. dependent var	0.317972
S.E. of regression	0.276369	Akaike info criterion	0.362752
Sum squared resid	2.673286	Schwarz criterion	0.533374
Log likelihood	-3.073664	Hannan-Quinn criter.	0.423970
F-statistic	5.100649	Durbin-Watson stat	2.156868
Prob(F-statistic)	0.004931		

Null Hypothesis: LNRDEE has a unit root

Exogenous: None

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.068134	0.6986
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE)

Method: Least Squares

Date: 10/11/16 Time: 06:01

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRDEE(-1)	0.000231	0.003385	0.068134	0.9460
D(LNRDEE(-1))	0.306955	0.154205	1.990565	0.0540

R-squared	0.095971	Mean dependent var	0.014067
Adjusted R-squared	0.071538	S.D. dependent var	0.317972
S.E. of regression	0.306388	Akaike info criterion	0.521990
Sum squared resid	3.473318	Schwarz criterion	0.607301
Log likelihood	-8.178801	Hannan-Quinn criter.	0.552599
Durbin-Watson stat	1.933911		

b) At first difference

Null Hypothesis: D(LNRDEE) has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.503834	0.0009
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:01

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRDEE(-1))	-0.693827	0.154053	-4.503834	0.0001
C	0.007711	0.049152	0.156876	0.8762

R-squared	0.354101	Mean dependent var	-0.006694
Adjusted R-squared	0.336645	S.D. dependent var	0.376081
S.E. of regression	0.306305	Akaike info criterion	0.521450
Sum squared resid	3.471445	Schwarz criterion	0.606761
Log likelihood	-8.168281	Hannan-Quinn criter.	0.552059
F-statistic	20.28452	Durbin-Watson stat	1.933049
Prob(F-statistic)	0.000065		

Null Hypothesis: D(LNRDEE) has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.431953	0.0057
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:02

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRDEE(-1))	-0.692551	0.156263	-4.431953	0.0001
C	-0.009213	0.105478	-0.087344	0.9309
@TREND(1975)	0.000805	0.004421	0.182019	0.8566

R-squared	0.354695	Mean dependent var	-0.006694
Adjusted R-squared	0.318845	S.D. dependent var	0.376081
S.E. of regression	0.310387	Akaike info criterion	0.571812
Sum squared resid	3.468253	Schwarz criterion	0.699779
Log likelihood	-8.150343	Hannan-Quinn criter.	0.617726
F-statistic	9.893793	Durbin-Watson stat	1.937118
Prob(F-statistic)	0.000377		

Null Hypothesis: D(LNRDEE) has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.562100	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRDEE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:02

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRDEE(-1))	-0.692255	0.151740	-4.562100	0.0001

R-squared	0.353672	Mean dependent var	-0.006694
Adjusted R-squared	0.353672	S.D. dependent var	0.376081
S.E. of regression	0.302348	Akaike info criterion	0.470833
Sum squared resid	3.473753	Schwarz criterion	0.513489
Log likelihood	-8.181247	Hannan-Quinn criter.	0.486138
Durbin-Watson stat	1.934682		

For LNRHE

a) At level

Null Hypothesis: LNREHE has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.611671	0.9883
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE)

Method: Least Squares

Date: 10/11/16 Time: 06:03

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREHE(-1)	0.022009	0.035981	0.611671	0.5444
C	-0.363131	0.896090	-0.405239	0.6876

R-squared	0.009750	Mean dependent var	0.181670
Adjusted R-squared	-0.016309	S.D. dependent var	0.617061
S.E. of regression	0.622073	Akaike info criterion	1.937188
Sum squared resid	14.70504	Schwarz criterion	2.021632
Log likelihood	-36.74375	Hannan-Quinn criter.	1.967720
F-statistic	0.374142	Durbin-Watson stat	1.990915
Prob(F-statistic)	0.544398		

Null Hypothesis: LNREHE has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.782251	0.2118
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE)

Method: Least Squares

Date: 10/11/16 Time: 06:04

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREHE(-1)	-0.231470	0.083195	-2.782251	0.0084
C	4.577996	1.696114	2.699109	0.0104
@TREND(1975)	0.065046	0.019701	3.301584	0.0021

R-squared	0.235096	Mean dependent var	0.181670
Adjusted R-squared	0.193750	S.D. dependent var	0.617061
S.E. of regression	0.554068	Akaike info criterion	1.728980
Sum squared resid	11.35869	Schwarz criterion	1.855646
Log likelihood	-31.57961	Hannan-Quinn criter.	1.774779
F-statistic	5.686039	Durbin-Watson stat	1.996104
Prob(F-statistic)	0.007026		

Null Hypothesis: LNREHE has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.923725	0.9855
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE)

Method: Least Squares

Date: 10/11/16 Time: 06:05

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREHE(-1)	0.007516	0.003907	1.923725	0.0617

R-squared	0.005470	Mean dependent var	0.181670
Adjusted R-squared	0.005470	S.D. dependent var	0.617061
S.E. of regression	0.615371	Akaike info criterion	1.891500
Sum squared resid	14.76858	Schwarz criterion	1.933722
Log likelihood	-36.83000	Hannan-Quinn criter.	1.906766
Durbin-Watson stat	1.953494		

b) At first difference

Null Hypothesis: D(LNREHE) has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.085531	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:05

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNREHE(-1))	-0.982504	0.161449	-6.085531	0.0000
C	0.197044	0.103950	1.895573	0.0658

R-squared	0.500228	Mean dependent var	0.015275
Adjusted R-squared	0.486720	S.D. dependent var	0.867891
S.E. of regression	0.621788	Akaike info criterion	1.937486
Sum squared resid	14.30496	Schwarz criterion	2.022796
Log likelihood	-35.78097	Hannan-Quinn criter.	1.968094
F-statistic	37.03369	Durbin-Watson stat	2.021994
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNREHE) has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.348812	0.0000
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:06

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNREHE(-1))	-1.055338	0.166226	-6.348812	0.0000
C	-0.074191	0.208967	-0.355035	0.7246
@TREND(1975)	0.013558	0.009108	1.488470	0.1453

R-squared	0.529202	Mean dependent var	0.015275
Adjusted R-squared	0.503046	S.D. dependent var	0.867891
S.E. of regression	0.611819	Akaike info criterion	1.929044
Sum squared resid	13.47563	Schwarz criterion	2.057011
Log likelihood	-34.61636	Hannan-Quinn criter.	1.974957
F-statistic	20.23294	Durbin-Watson stat	2.007162
Prob(F-statistic)	0.000001		

Null Hypothesis: D(LNREHE) has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.596987	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREHE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:07

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNREHE(-1))	-0.894566	0.159830	-5.596987	0.0000

R-squared	0.451693	Mean dependent var	0.015275
Adjusted R-squared	0.451693	S.D. dependent var	0.867891
S.E. of regression	0.642654	Akaike info criterion	1.978886
Sum squared resid	15.69416	Schwarz criterion	2.021542
Log likelihood	-37.58828	Hannan-Quinn criter.	1.994190
Durbin-Watson stat	2.013250		

For LNRGDP

a) At level

Null Hypothesis: LNRGDP has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.373271	1.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP)

Method: Least Squares

Date: 10/11/16 Time: 06:07

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	0.067601	0.020040	3.373271	0.0017
C	-1.164500	0.359893	-3.235679	0.0025

R-squared	0.230441	Mean dependent var	0.048670
Adjusted R-squared	0.210190	S.D. dependent var	0.095717
S.E. of regression	0.085065	Akaike info criterion	-2.042092
Sum squared resid	0.274971	Schwarz criterion	-1.957648
Log likelihood	42.84183	Hannan-Quinn criter.	-2.011559
F-statistic	11.37896	Durbin-Watson stat	1.535390
Prob(F-statistic)	0.001720		

Null Hypothesis: LNRGDP has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.380634	0.8515
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP)

Method: Least Squares

Date: 10/11/16 Time: 06:08

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	-0.045959	0.033289	-1.380634	0.1757
C	0.715999	0.563772	1.270015	0.2120
@TREND(1975)	0.007681	0.001935	3.968567	0.0003

R-squared	0.460210	Mean dependent var	0.048670
Adjusted R-squared	0.431032	S.D. dependent var	0.095717
S.E. of regression	0.072200	Akaike info criterion	-2.346729
Sum squared resid	0.192872	Schwarz criterion	-2.220063
Log likelihood	49.93457	Hannan-Quinn criter.	-2.300930
F-statistic	15.77258	Durbin-Watson stat	1.939053
Prob(F-statistic)	0.000011		

Null Hypothesis: LNRGDP has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.356747	0.9996
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP)

Method: Least Squares

Date: 10/11/16 Time: 06:08

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	0.002803	0.000835	3.356747	0.0018

R-squared	0.018415	Mean dependent var	0.048670
Adjusted R-squared	0.018415	S.D. dependent var	0.095717
S.E. of regression	0.094832	Akaike info criterion	-1.848741
Sum squared resid	0.350730	Schwarz criterion	-1.806519
Log likelihood	37.97481	Hannan-Quinn criter.	-1.833475
Durbin-Watson stat	1.123898		

b) at first difference

Null Hypothesis: D(LNRGDP) has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.076610	0.0029
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP,2)

Method: Least Squares

Date: 10/11/16 Time: 06:09

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP(-1))	-0.583510	0.143136	-4.076610	0.0002
C	0.032507	0.015346	2.118251	0.0409

R-squared	0.309943	Mean dependent var	0.004297
Adjusted R-squared	0.291293	S.D. dependent var	0.101611
S.E. of regression	0.085541	Akaike info criterion	-2.029732
Sum squared resid	0.270736	Schwarz criterion	-1.944421
Log likelihood	41.57977	Hannan-Quinn criter.	-1.999123
F-statistic	16.61875	Durbin-Watson stat	2.238833
Prob(F-statistic)	0.000233		

Null Hypothesis: D(LNRGDP) has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.857681	0.0001
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP,2)

Method: Least Squares

Date: 10/11/16 Time: 06:10

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP(-1))	-0.992971	0.169516	-5.857681	0.0000
C	-0.055663	0.028104	-1.980592	0.0553
@TREND(1975)	0.005141	0.001441	3.566965	0.0010

R-squared	0.490140	Mean dependent var	0.004297
Adjusted R-squared	0.461814	S.D. dependent var	0.101611
S.E. of regression	0.074543	Akaike info criterion	-2.281087
Sum squared resid	0.200038	Schwarz criterion	-2.153121
Log likelihood	47.48119	Hannan-Quinn criter.	-2.235174
F-statistic	17.30377	Durbin-Watson stat	1.966348
Prob(F-statistic)	0.000005		

Null Hypothesis: D(LNRGDP) has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.497719	0.0038
Test critical values:	1% level	-2.628961	
	5% level	-1.950117	
	10% level	-1.611339	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRGDP,2)

Method: Least Squares

Date: 10/11/16 Time: 06:10

Sample (adjusted): 1979 2015

Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP(-1))	-0.229494	0.153229	-1.497719	0.1434
D(LNRGDP(-1),2)	-0.483430	0.180468	-2.678761	0.0113
D(LNRGDP(-2),2)	-0.337912	0.159087	-2.124069	0.0410

R-squared	0.377620	Mean dependent var	0.004806
Adjusted R-squared	0.341009	S.D. dependent var	0.103718
S.E. of regression	0.084197	Akaike info criterion	-2.033717
Sum squared resid	0.241029	Schwarz criterion	-1.903102
Log likelihood	40.62376	Hannan-Quinn criter.	-1.987669
Durbin-Watson stat	1.998811		

For LNRTIE

a) **at level**

Null Hypothesis: LNRTIE has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.432967	0.0155
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE)

Method: Least Squares

Date: 10/11/16 Time: 06:17

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRTIE(-1)	-0.251322	0.073208	-3.432967	0.0015
C	4.061991	1.141498	3.558475	0.0010

R-squared	0.236722	Mean dependent var	0.153479
Adjusted R-squared	0.216636	S.D. dependent var	0.588465
S.E. of regression	0.520838	Akaike info criterion	1.581951
Sum squared resid	10.30834	Schwarz criterion	1.666394
Log likelihood	-29.63901	Hannan-Quinn criter.	1.612483
F-statistic	11.78526	Durbin-Watson stat	0.921305
Prob(F-statistic)	0.001456		

Null Hypothesis: LNRTIE has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.063466	0.0001
Test critical values:	1% level	-4.205004	
	5% level	-3.526609	
	10% level	-3.194611	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE)

Method: Least Squares

Date: 10/11/16 Time: 06:18

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRTIE(-1)	-0.694970	0.114616	-6.063466	0.0000
C	9.924530	1.592651	6.231451	0.0000
@TREND(1975)	0.050585	0.011169	4.528994	0.0001

R-squared	0.508948	Mean dependent var	0.153479
Adjusted R-squared	0.482404	S.D. dependent var	0.588465
S.E. of regression	0.423366	Akaike info criterion	1.190879
Sum squared resid	6.631831	Schwarz criterion	1.317544
Log likelihood	-20.81757	Hannan-Quinn criter.	1.236677
F-statistic	19.17420	Durbin-Watson stat	0.458212
Prob(F-statistic)	0.000002		

Null Hypothesis: LNRTIE has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.413612	0.9584
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE)

Method: Least Squares

Date: 10/11/16 Time: 06:18

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRTIE(-1)	0.008509	0.006020	1.413612	0.1654

R-squared	-0.017625	Mean dependent var	0.153479
Adjusted R-squared	-0.017625	S.D. dependent var	0.588465
S.E. of regression	0.593628	Akaike info criterion	1.819555
Sum squared resid	13.74338	Schwarz criterion	1.861777
Log likelihood	-35.39110	Hannan-Quinn criter.	1.834821
Durbin-Watson stat	1.159399		

b) At first difference

Null Hypothesis: D(LNRTIE) has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.36235	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:19

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRTIE(-1))	-1.007464	0.058026	-17.36235	0.0000
C	0.067583	0.035311	1.913950	0.0634

R-squared	0.890678	Mean dependent var	-0.089151
Adjusted R-squared	0.887724	S.D. dependent var	0.636239
S.E. of regression	0.213189	Akaike info criterion	-0.203358
Sum squared resid	1.681628	Schwarz criterion	-0.118047
Log likelihood	5.965487	Hannan-Quinn criter.	-0.172749
F-statistic	301.4512	Durbin-Watson stat	1.528829
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRTIE) has a unit root

Exogenous: Constant, Linear Trend

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.58804	0.0000
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:20

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRTIE(-1))	-0.991067	0.056349	-17.58804	0.0000
C	-0.059739	0.071663	-0.833612	0.4100
@TREND(1975)	0.005942	0.002946	2.017121	0.0512

R-squared	0.901780	Mean dependent var	-0.089151
Adjusted R-squared	0.896323	S.D. dependent var	0.636239
S.E. of regression	0.204862	Akaike info criterion	-0.259155
Sum squared resid	1.510867	Schwarz criterion	-0.131188
Log likelihood	8.053517	Hannan-Quinn criter.	-0.213242
F-statistic	165.2611	Durbin-Watson stat	1.713120
Prob(F-statistic)	0.000000		

Null Hypothesis: D(LNRTIE) has a unit root

Exogenous: None

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-16.87181	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNRTIE,2)

Method: Least Squares

Date: 10/11/16 Time: 06:20

Sample (adjusted): 1977 2015

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRTIE(-1))	-0.979072	0.058030	-16.87181	0.0000

R-squared	0.879855	Mean dependent var	-0.089151
Adjusted R-squared	0.879855	S.D. dependent var	0.636239
S.E. of regression	0.220533	Akaike info criterion	-0.160235
Sum squared resid	1.848118	Schwarz criterion	-0.117579
Log likelihood	4.124575	Hannan-Quinn criter.	-0.144930
Durbin-Watson stat	1.410962		

Unit root test for u

Null Hypothesis: U has a unit root

Exogenous: Constant

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.977895	0.0037
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(U)

Method: Least Squares

Date: 10/11/16 Time: 16:05

Sample (adjusted): 1976 2015

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
U(-1)	-0.559474	0.140646	-3.977895	0.0003
C	-0.006695	0.040599	-0.164910	0.8699

R-squared	0.293991	Mean dependent var	-0.005584
Adjusted R-squared	0.275411	S.D. dependent var	0.301641
S.E. of regression	0.256765	Akaike info criterion	0.167395
Sum squared resid	2.505271	Schwarz criterion	0.251839
Log likelihood	-1.347892	Hannan-Quinn criter.	0.197927
F-statistic	15.82365	Durbin-Watson stat	1.712897
Prob(F-statistic)	0.000302		

2)

Appendix II.

variance decompositions of LNRGDP

Period	S.E.	LNRGDP	LNRAGE	LNRCSE	LNRDEE	LNREHE	LNRTIE
1	0.085080	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.137619	97.99151	0.978557	0.379910	0.488404	0.053920	0.107698
3	0.194865	94.27655	0.545514	1.247767	1.772798	1.071960	1.085407
4	0.251118	90.64001	0.333578	2.917801	3.459230	1.512144	1.137239

Appendix III.

Table 2.1.regional road construction expenditure trend(in million Birr)

Road construction expenditure (in million Birr)										
year	Tigray	Afar	Amhara	Oromia	Somale	Benishangual	SNNP	Gambella	Harari	Addis Ababa
1994	25.76	0.90	4.39	12.28	11.61	2.05	14.44	5.25	0.89	135.43
1995	32.68	2.43	7.32	26.24	0.50	8.31	63.30	1.06	1.00	97.01
1996	32.50	29.83	57.34	59.94	29.15	8.69	64.14	5.87	1.49	16.47
1997	32.67	19.96	84.01	92.07	32.36	7.85	51.05	4.44	2.09	32.18
1998	26.72	11.35	92.66	103.24	21.59	11.47	49.65	4.25	1.01	150.23
1999	20.63	17.68	78.31	98.50	24.04	23.49	48.39	13.81	0.01	117.90
2000	10.05	21.62	71.48	61.47	21.70	23.83	21.80	21.10	2.00	176.93
2001	30.84	20.50	35.53	104.14	54.89	34.86	21.84	38.01	0.41	214.90
2002	15.39	24.09	31.60	75.26	30.71	43.61	12.67	39.71	4.00	250.61
2003	18.99	11.75	44.70	8.47	45.31	46.59	8.95	17.88	2.71	243.25
2004	30.45	9.51	37.92	75.25	47.72	26.80	1.01	0.26	2.42	364.94
2005	1.33	9.35	12.55	238.96	65.12	17.73	20.02	26.21	8.58	160.30
2006	5.55	4.46	10.68	78.62	31.52	42.40	15.19	28.29	8.05	248.34
2007	2.88	7.62	28.23	102.53	19.05	9.32	34.19	30.36	9.53	248.85
2008	2.58	10.48	45.66	168.61	5.74	30.38	51.53	32.43	6.90	818.77
2009	11.76	18.23	123.53	238.77	12.09	15.59	73.46	34.50	14.46	2078.32
2010	3.14	7.44	404.00	382.07	54.85	1.60	69.95	36.57	25.52	1420.06
2011	6.40	42.50	445.48	623.15	74.23	26.17	93.50	38.64	20.41	1860.91
2012	6.81	43.33	1640.31	3754.20	92.13	117.38	1.07	16.27	73.76	1428.07
2013	7.21	34.89	628.56	5444.36	237.68	139.83	33.64	24.23	115.92	3767.54
average	16.22	17.40	194.21	587.41	45.60	31.90	37.49	20.96	15.06	691.55

Source: Ministry Of Finance and Economic Development (MOFED)

Appendix :Natural logarithm of data [in million Birr] between 1975 and 2015

year	lnrgdp	lnrdee	lnrage	Lnrtie	lnrcse	Lnrehe
1975	17.71435	13.9502	13.05628	11.58686	6.22935	23.13835
1976	17.60808	14.31142	12.72962	15.13554	6.043668	22.5942
1977	17.54609	14.30776	13.04753	15.06286	6.539176	22.48172
1978	17.42957	14.74489	13.15224	14.93115	8.022915	21.64821
1979	17.41929	14.50923	13.13375	14.87053	7.993746	21.92029
1980	17.3617	14.49424	12.58435	14.98975	7.270082	21.15768
1981	17.36403	14.5193	12.48951	14.93132	8.033699	21.95378
1982	17.34749	14.58808	12.92542	14.79551	7.837687	23.01948
1983	17.41165	14.79049	14.02418	14.82823	7.854765	22.4828
1984	17.3449	14.66974	13.03334	14.90477	8.008783	22.48824
1985	17.34653	14.48748	13.30596	14.70629	7.83435	22.05207
1986	17.34253	14.44545	13.60748	14.84981	7.842065	22.08129
1987	17.50021	14.62907	13.52485	14.87069	8.43152	22.68338
1988	17.51828	14.88928	13.47666	14.83666	8.589021	22.72372
1989	17.47699	15.0085	13.40084	15.03154	8.403338	23.05103
1990	17.49323	15.0651	13.37303	14.77469	8.47362	22.5002
1991	17.43518	14.76328	12.87736	14.38856	7.612589	21.93441
1992	17.32456	13.6187	12.66889	14.07853	6.325008	21.59708
1993	17.47838	13.59468	12.91064	14.83793	7.619573	22.82295
1994	17.52708	13.55661	12.98213	15.21461	8.725487	23.89224
1995	17.58082	13.5365	12.61227	15.46731	8.699926	24.25175
1996	17.68459	13.57372	12.80489	15.47803	8.807366	24.97783
1997	17.83987	13.75354	12.86793	15.86174	8.771705	25.51815
1998	17.87982	14.53178	12.63359	15.84916	9.381717	25.41444
1999	17.92239	15.28588	13.46539	15.78811	9.000653	25.1026

2000	17.95588	15.68575	13.16311	15.87715	9.976358	24.49874
2001	17.97931	15.062	13.22425	15.90357	8.881858	25.82329
2002	18.06951	14.94328	13.94258	16.06408	10.17899	26.12432
2003	18.0643	14.71244	13.41369	16.0785	10.39476	26.56083
2004	18.15948	14.62135	14.01398	16.27009	10.24779	26.78875
2005	18.30612	14.70479	14.68924	16.43677	10.04018	27.45884
2006	18.41757	14.52129	14.75928	16.51242	10.14458	27.3473
2007	18.53992	14.50273	14.25023	16.49589	10.86632	26.51993
2008	18.68164	14.41622	14.53281	16.52633	10.91649	28.22766
2009	18.94366	14.52464	14.70446	16.71275	11.37808	28.59437
2010	18.98462	14.43302	14.61732	17.01809	11.07704	29.0273
2011	19.18864	14.52095	14.65153	17.42785	11.76415	29.54418
2012	19.49014	14.75503	14.92028	17.52499	12.35231	29.70431
2013	19.56198	14.68427	15.17829	17.50048	12.18855	30.09396
2014	19.59986	14.75987	15.30404	17.6542	12.27842	30.35356
2015	19.66116	14.86004	15.14271	17.726	12.99234	30.40515