ADDIS ABABA UNIVERSITY

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THE DYNAMIC RELATION SHIP BETWEEN CARBON DIOXIDE EMISSION, ENERGY CONSUMPTION, ECONOMIC GROWTH AND FOREIGN DIRECT INVESTMENT IN ETHIOPIA: AN ARDL APPROACH

BY

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June, 2016

Addis Ababa, Ethiopia

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This is to certify that the thesis prepared by Dagmawit ketsela entitled: *the dynamic relationship between carbon dioxide emission, energy consumption, economic growth and foreign direct investment in Ethiopia:* an ARDL approach and submitted in partial fulfilment of the requirements of the Degree of Masters of Science in Economics (Environmental Economics) complies with the regulations of the university and meets the accepted standards with respected originality and quality.

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Acronyms

ARDL=Auto regressive distributed lag

CSA=Central Statistics Agency

EKC=Environmental Kuznets curve

FDI= Foreign direct investment

GHG=Green House Gas

UNDEP=United Nation Development and Economic program

UNDP= United Nation Development Program

UNFCCC=United Nation Frame work Convention on Climate Change

UNCTAD=United Nation Commission on Trade and Development

Abstract

The dynamic relationship between co2 emission, energy consumption economic growth and foreign direct investment

Dagmawit ketsela

Addis Ababa University, 2016

In this paper the main objective of the study was to assess the dynamic relationship between CO_2 emission, economic growth, energy consumption and Foreign direct investment from the year 1973/4- 2011/12 E.C by using ARDL approach based on secondary data obtained from both published and unpublished document from concerned organizations of World Development Indicators the official website of World Bank, UNCTAD stat and from national bank of Ethiopia. Co-integration test approves the existence of one co-integrating equation .It is found that CO_2 emissions, energy consumption, economic growth, and foreign direct investment are co-integrated. The pair wise Granger causality test between foreign direct investment and carbon dioxide emission suggested that Granger causality runs one way from carbon dioxide emission to Foreign direct investment which implies that the relatively lower environmental standards has attracted foreign direct investment .There is bidirectional causality between real GDP per capita and energy consumption and there is unidirectional causality between energy consumption and CO_2 emission Whereas there is no causality between CO_2 and economic growth. In order to reduce CO_2 emission Ethiopia should implement strategy of increasing the level investment in energy infrastructure and a need for proper utilization of resources. The implementation of more severe laws that require the usage of energy efficient technologies such as hydro and geo thermal energies and supplying them at affordable price should reduce CO_2 emission level. Ethiopia should attract FDI inflow in order to reduce the level of emission.

Chapter one

1.1. Back ground of the study

Environment quality has many dimensions. Our lives are affected by the air we breathe, the water we drink, the beauty we observe in nature and the diversity of species which we come into contact. The productivity of our resource in producing goods and services is influenced by climate, rainfall and the nutrients in the soil (Grossman and Krueger, 1995)

The most important reason behind the global warming is Green House Gas (GHG) and this gas is totally exposed by human activities. CO_2 gas which is exposed by the fossil fuel usage constitutes more than 60% of the GHG (IEA, 2013).

One of the prominent reasons for the level of increase in CO_2 emission is the increasing amount of production and consumption, adding up with the amount of energy used in production. Especially foreign direct investment can also affect the level of CO_2 emission level of countries in the globalization process.(ibid)

Current global greenhouse gas emission levels are considerably higher than the levels in 2020 that are in line with meeting the 1.5° C or 2° C targets, and are still increasing. In 2010, in absolute levels, developing countries accounted for about 60 percent of global greenhouse gas emissions. The most recent estimates of global greenhouse gas emissions are for 2010 and amount to 50.1 gigatonnes of carbon dioxide equivalent (GtCO2e) per year (range: 45.6–54.6 GtCO2e per year). This is already 14 percent higher than the median estimate of the emission level in 2020 with a likely chance of achieving the least cost pathway towards meeting the 2° C target (44 GtCO2e per year).(UNDP Report ,2011)

The energy sector is responsible for two-thirds of GHG emissions, and the costs of climate change in terms of adaptation are estimated to reach USD 50-170 billion by 2030, half of which could be borne by developing countries. (UNDEP, 2011)

In forestry, the impact of human activities is a large source of carbon dioxide emissions. The forestry sector is a significant contributor of GHG emissions but it also offers a high abatement potential that even surpasses the estimated increase in emissions by 2030.Ethiopia's forestry emissions are driven by deforestation for agriculture (49% of all forestry-related emissions) and forest degradation due to fuel wood consumption and logging (47%). As a result, forestry-based emissions are expected to grow from 25 Mt in 2010 to almost 45 in 2030 conversion of forested areas to agricultural land and from around 25 Mt in 2010 to more than 40 in 2030 as a result of unsustainable fuel wood use.

Soil-based GHG emissions in Ethiopia are significant and come from three main sources: from using synthetic fertilizers (58%), from applying manure to cropland; and from reintroducing crop residues into the soil. (UNDP,2011)

1.2. Statement of the problem

Developed countries begin to specialize in the products of clean industries. In a sense, they are simply exporting their pollution to these developing countries. This is certainly the less hopeful possibility because it suggests that cleaner environments in more developed countries come at the expense of dirtier environments in developing countries. (Brian, 2007)

Poor economic development has also contributed to air pollution by creating dependence on old vehicles and dirty fuels. Some countries, mostly developed ones, require periodic inspection of vehicles to eliminate those that do not meet stipulated standards. The old, polluting vehicles that cannot be used in those countries are sometimes exported to developing countries that do not have standards or inspection systems. Studies have shown that every dollar invested in cleaner fuels and vehicles can yield up to $40 in health and other economic benefits. (African review report, 2009)

Firms using economic resources such as materials and energy to produce goods and services, in which some of the input used in the production process return to the environment as wastes. These wastes are mainly like carbon monoxide, carbon dioxide, sulfur dioxide and solid waste and wastewater, causing pollution or imposing external costs on society.(HamidAmadeh and ParisaKafi ,2015). Since any economic activity requires energy, it is perceived as a driving factor for economic and social development as well as the improvement in the quality of human life.

The Industry sector in Ethiopia will be the highest growth in GHG emissions up to 2030. Under BAU scenario, emissions will increase from 4 Mt CO_2e in 2010 to 71 Mt CO_2e in 2030. For this sector, 37 abatement levers were evaluated for 12 industry segments, with total gross abatement potential of 22 Mt CO_2e in 2030. The vast majority of the emission growth and abatement potential is in the cement industry, which has a gross abatement potential of 16 Mt CO_2e. In addition to cement industry levers such as clinker substitution, increased use of efficient biomass use (e.g. agri residues),energy efficiency equipment, and waste heat recovery are some of key abatement levers prioritized.(UNDP,2011)

CO_2 is considered to be the major contributor to global warming.CO_2concentration in the air is responsible for more than 60% of the green gas content .Therefore in today's world of rapid economic development ,it is an important issue for the researchers to find out the link concerning carbon dioxide emission.(sakib bin and etal,2014)

Palamalai and etal (2014)investigated on the Relationship between energy consumption,co_2 emission, economic growth and trade in india Using perron unit root test, co-integration test and vector error correction model concluded that increase in CO_2 emissions leads to achieve high level of economic activity in India. In addition, they found that foreign trade influences the various sources of non-renewable energy consumption in the long-term.

Blanco and etal (2012) investigated the Impact of FDI on CO_2 Emissions in Latin America using Granger causality test found the causality running from FDI in polluting intensive industries("the dirty sector") to CO_2 emissions per capita. Thus, in line with MacDermott's (2006) analysis for Mexico, their results suggest that there may be a significant negative environmental impact of FDI inflows in dirty sectors for the Latin American region. This result is robust to controlling for other factors associated with CO_2 emissions and using the ratio of CO_2 emissions to GDP. For other sectors, they found no robust evidence that FDI causes CO_2 emissions.

Haider Mahmood and A.R. Chaudhary(2015)studied FDI, Population Density and Carbon Dioxide Emissions in a Case of Pakistan using ARDL and its error correction model the long run relationship in the model but short run relationship did not exist and foreign direct investment, manufacturing value added and population density have positive impact on carbon dioxide emissions.

I have found a study by Endegtekalign (2014) examining Energy consumption, carbon dioxide emissions and economic growth in Ethiopia using a VAR analysis approach concluded that Economic Growth in Ethiopia can be achieved without degrading the quality of the environment coming from CO_2emissions .Yohannes Hailu and Zenebe Gebreegziabher(2006) using the Auto Regressive Distributed Lags investigated Energy, Growth and Environmental Interaction in the Ethiopian Economy found that economic growth in Ethiopia is co-integrated with energy consumption .But there is no study found that include foreign direct investment effect on CO_2 emission. Thus, there is a lack of information whether there is a dynamic relationship between CO_2emission, economic growth, energy consumption and FDI or not in case of Ethiopia, or is there causality between them. I apply ARDL in the model approach.

FDI contributes to the countries' economic development, which in turn affecting their energy demand and environmental degradation (Minh Nguyen &Nurul Amin, 2002,Jian, W. and Rencheng, T. (2007)).

Therefore, it is very important to understand the relationship between them in order to design effective energy, investment and environmental policies. The study seeks to answer the following key research question:

1) What does the relationship between CO_2emission energy consumption; economic growth and FDI look like in Ethiopia?

1.3. Objectives of the study

The main objective of the study was to assess the dynamic relationship between CO_2emission, economic growth, energy consumption and FDI.

Specific objectives:

- To identify the existence of co-movement among energy consumption, carbon dioxide emission, economic growth and Foreign direct investment.
- To show the trends of CO_2 emission in Ethiopia.
- To show the carbon dioxide –Foreign direct investment nexus.

1.4. Hypothesis of the study

H1: FDI have a significant positive effect on CO_2 emission.

H2: FDI, economic growth, CO_2 emissions and energy consumption exhibit causal relationships with each other in Ethiopia.

1.5. Scope of the study

Geographically, the area of the study was Ethiopia. The research would be conducted in Ethiopia in which the research problem focuses on the dynamic relationship between CO_2 emission ,economic growth, energy consumption and Foreign direct investment from the year 1973/4- 2011/12 E.C. Energy consumption sub divided in to renewable and non renewable sources but this study considers the aggregate cases in terms of energy use kg of oil equivalent per capita. Carbon dioxide emissions include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. So, this study measures emission in terms of metric tons per capita, foreign direct investment in terms of inflow measured by US dollars at current prices and current exchange rate and urbanization in terms of urban population growth . The proxy for economic growth is GDP per capita.

1.6. Significance of the study

- It contributes to the country by having clear information.
- It contributes to other researchers to give insight for further studies as a source of document.
- It contributes to the policy makers to draw policy implication.
- To apply the recommended solution.

1.7. Organization of the study

The whole paper organized in to five chapters. The first chapter contains: introduction of the study, statement of the problem and significance of the study, scope of the study, and the organization of the paper. In chapter two theoretical and empirical findings literature in the study area are discussed. In Research methodology part of chapter three, model specification, data issues and estimation procedures will be discussed in detail. In Chapter four empirical results of data analysis will be evaluated. In the last chapter Discussion and Implications with possible policy implication will be forwarded based on empirical findings of the study.

1.8. Limitation of the study

Lack of available firm-level data on FDI inflows to made a direct test on the pollution haven and pollution halo hypotheses.

Chapter two

2. Literature review

2.1. Theoretical literature

2.1.1. Definition of carbon dioxide emission

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

2.1.2. Drivers of the economy-environment relationship

It can broadly be divided into three effects:

• **The scale effect** – economic growth has a negative effect on the environment, where increased production and consumption causes increased environmental damage;

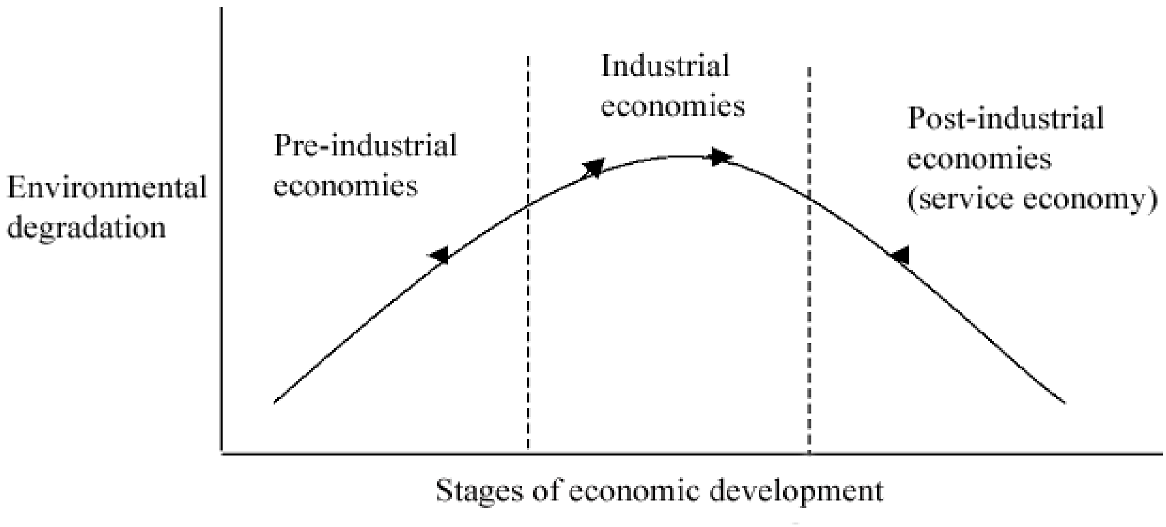
• **The composition effect** – the composition of production changes along the growth path: initially economic growth leads to industrialisation (and as the goods balance shifts from agriculture to manufactured products, environmental damage increases); but the balance then shifts from producing manufactured goods to producing services, due to both demand- and supply-side changes, reducing the level of domestic environmental damage;

• **The technical effect** – technological developments lead to a change in the environmental impacts of production. Whilst this often means reductions in environmental intensity, for example improvements in energy efficiency, it could also represent technological advances that lead to greater environmental damage (such as through increased energy use). Changes in the preferences of society may also drive changes in environmental damage, for example through encouraging changes in the stringency of environmental regulation of industry. The relative size of these effects determines the relationship between economic growth and the environment.

2.1.3. Environmental degradation

Environmental degradation is the disintegration of the earth or deterioration of the environment through consumption of assets, for example, air, water and soil; the destruction of environments and the eradication of wildlife. It is characterized as any change or aggravation to nature's turf seen to be pernicious or undesirable. Ecological effect or degradation is created by the consolidation of an effectively substantial and expanding human populace, constantly expanding monetary development or per capita fortune and the application of asset exhausting and polluting technology. It occurs when earth's natural resources are depleted and environment is compromised in the form of extinction of species, pollution in air, water and soil, and rapid growth in population.

At low levels of development, both the quantity and the intensity of environmental degradation are limited to the impacts of subsistence economic activity on their source base and to limited quantities of biodegradable wastes. As agriculture and resource extraction intensifies and industrialization takes off both resource depletion and waste generation accelerate. Depletion of resources and waste production increases as industrialization decreases and resource discovery and agricultural activities intensify. At higher levels of development, structural change towards information-based industries and services, more efficient technologies, and increased demand for environmental quality result in leveling-off and a steady decline of environmental degradation.



Source Panayotou

Figure 1 economic growth and environment

In the above figure environmental degradation first goes through a monotone increase and then decreases in the same monotonic way. A monotonic increase of environmental degradation with economic growth calls for strict environmental regulations and even limits on economic growth to ensure a sustainable scale of economic activity within the ecological life-support system. A monotonic decrease of environmental degradation along a country's development path suggests that policies that accelerate economic growth lead also to rapid environmental improvements and no explicit environmental policies are needed; indeed, they may be counterproductive if they slow down economic growth and thereby delay environmental improvement.(Panayotou,2003)

2.1.4. Greenhouse Gas Emissions of Ethiopia

Evidences that could be associated with climate change have already started appearing in Ethiopia. It is reported that in the last 50 years only, the annual average minimum temperature over the country has been increasing by 0.2 °c every decade. Climate change related events like the occurrences of frequent and extensive droughts in recent decades, spreading of malaria in high land areas which have never experienced before, loss of biodiversity and decline in wild life number have been observed. Even the country has recently experienced flood hazard which has killed more than 500 people in 2006. This was associated with extreme weather event related to climate changes according to some sources (UNEP, 2006).

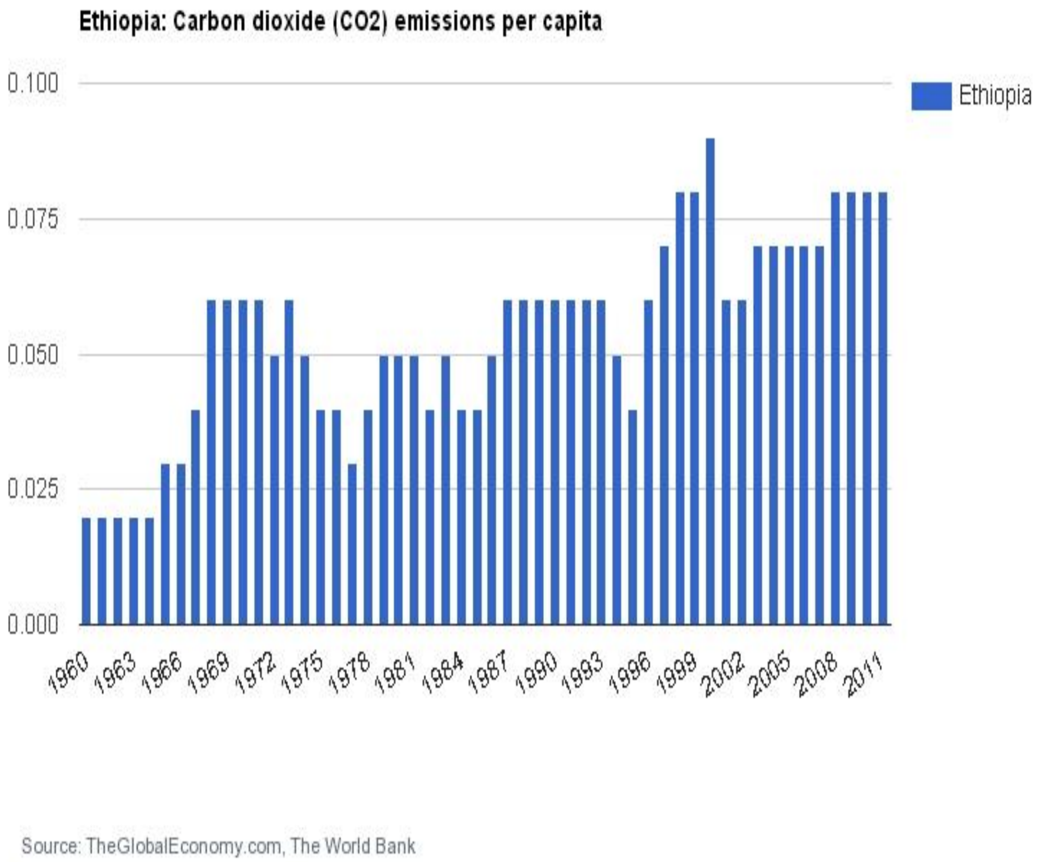


Figure 2 Ethiopia carbon dioxide emissions per capita

CO_2 emission (million metric tons)

The value CO_2 emission (million metric tons) in Ethiopia was 0.07as of 2010.over the past 50 years this indicator reached a maximum value of 0.09 in 2000 and a minimum value 0f 0.02 in 1961. (http//www.indexmundi.com/)

CO_2 emission from residential buildings and commercial and public services (million metric tons)

The value CO_2 emission from, residential buildings and commercial and public services (million metric tons) in Ethiopia was 0.10as of 2003.over the past 40 years this indicator reached a maximum value of 0.49 in 2009 and a minimum value of 0.04 in 1971.

Co_2 emission from electricity and heat production total (million metric tons)

The value CO_2 emission from, electricity and heat production (million metric tons) in Ethiopia was 0.04 as of 2011.over the past 40 years this indicator reached a maximum value of 0.49 in 2009 and a minimum value 0f 0.01 in 2003.

Co_2 emission from manufacturing industries and construction (million metric tons)

The value CO_2 emission from manufacturing industries and construction, (million metric tons) in Ethiopia was 1.52 as of 2011.over the past 40 years this indicator reached a maximum value of 0.51 in 2011 and a minimum value 0f 0.24 in 1972.CO_2 emission from manufacturing industries and construction contain the emissions from fuels in industry.

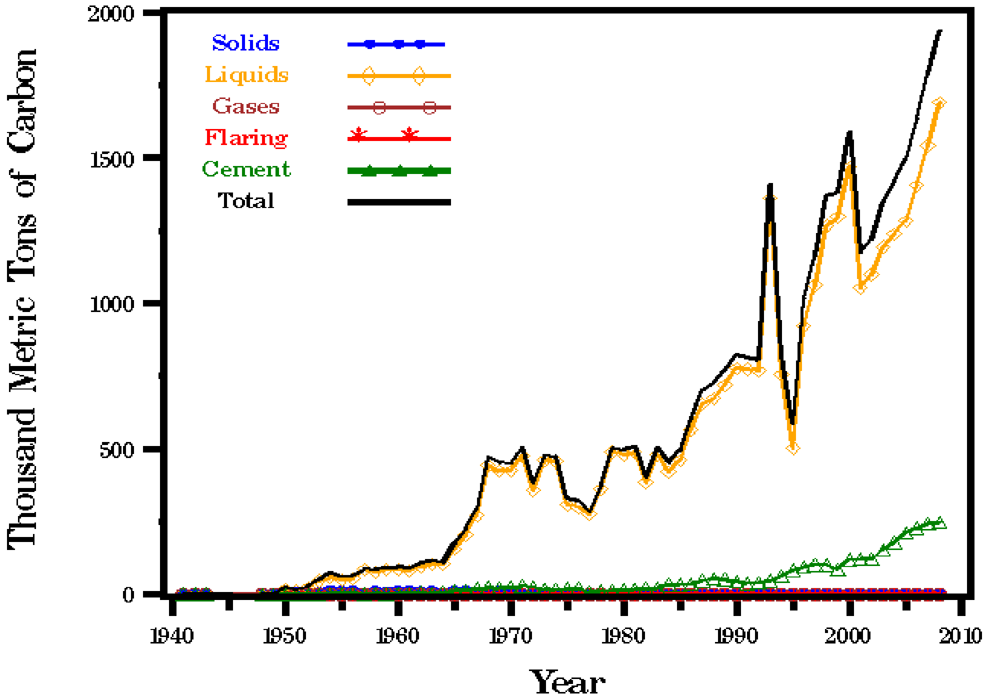
Co_2 emission from other sectors, excluding residential buildings and commercial and public services (million metric tons)

The value CO_2 emission from other sectors, excluding residential buildings and commercial and public services (million metric tons) in Ethiopia was 0.51 as of 2011.over the past 40 years this indicator reached a maximum value of 0.51 in 2011 and a minimum value of 0.04 in 1971.CO_2 emission from other sectors, less residential buildings and commercial and public services contain the emission from commercial/institutional activities, residential agriculture/forestry and fishing.

CO_2 emissions from transport (million metric tons)

The value for CO_2 emissions from transport (million metric tons) in Ethiopia was 2.87 as of 2011.over the past 40 years this indicator reached a maximum value of 2.87 in 2011 and a minimum value of 0.51 in 1972. CO_2emission from transport contains emissions from the combustion of fuel for all transport activity, regardless of the sector except for international marine bunkers and international aviation .this includes domestic aviation, domestic navigation ,road ,rail and pipeline transport.(http//www.indexmundi.com)

Figure 3 CO_2 emission of Ethiopia



2.1.5. Energy-related CO_2 emissions

Sub-Saharan Africa accounts for only a very small share of cumulative historical energy related CO_2 emissions: in the 1900 to 2012 period, the region was responsible for 1.8% of the global total (0.6% if South Africa is excluded). In the New Policies Scenario, energyrelatedCO_2 emissions double in sub-Saharan Africa, reaching 1.2 giga tonnes (Gt) in 2040.The region's share of global emissions increase from 2% to 3%, while emissions per capita barely change, remaining below 0.7 tonnes per capita in 2040, around 15% of the global average. The economies of sub-Saharan Africa in 2040 are, on average, only half as carbon intensive as they are today, as economic growth encompasses a shift towards less energy-intensive economic activity, including services. Rising levels of access to modern energy have a negligible impact on emissions, with the improvement in electricity access accounting for around 10% of the increase in sub-Saharan emissions (around 70 Mt) or just over 1% of the increase in global emissions from now to 2040. The nature and scale of the challenge is subject to a broad range of uncertainty, but existing climate models suggest that, in scenarios broadly consistent with the outcomes of the New Policies Scenario, annual average temperatures across the continent will rise between 3 °C and 6 °C by 2100, compared to the 1986-2005 average (IPCC, 2014). The African continent, already prone to weather extremes, would be affected in several ways, including droughts in some areas, extreme precipitation in others and rising sea-levels affecting coastal areas (where many large populations are based and substantial components of economic output are concentrated). (International energy agency,2014)

2.1.6. FDI and pollution havens

One of the most contentious issues debated today is whether inter-country differences in Environmental regulations are turning poor countries into "pollution havens." or not. The main argument is that stringent environmental standards in industrial countries drive firms to close plants at home and establish them instead in developing countries, where standards are relatively weaker. Since more pollution intensive industries will have a larger incentive to move, a haven of such industries will build up in poor countries. On the other hand developing countries may purposely undervalue environmental damage, in order to attract more foreign direct investment (FDI). (M. Dean and etal, 2004)

Now a day, it is generally believed that FDI is good for economic development. Consequently, developing countries adopt policies in order to attract more FDI. Over the two past decades FDI inflows to developing countries have increased rapidly. For instance, average FDI inflows to Sub-Saharan Africa as ratio of the region's GDP rose from 0.5% in the 1980s to 1.46% in the 1990s and 3.94% in 2000-2010. In the same time, global warming has become a major global concern as a result of accumulation of human made greenhouse effect gases. There are concerns that African countries purposely undervalue their environment in order to attract more FDI. The pollution haven hypothesis asserts that multinational firms, particularly those engaged in highly polluting activities move their activities in countries with weaker environmental standards. This hypothesis suggests that FDI inflows to developing countries are associated with higher levels of pollution, which may have negative effects on welfare. (Grossman and Krueger 1991 cited in Yaya Keho). Thus, the relationship between FDI and the environment is theoretically ambiguous.

On the empirical level, many studies have investigated the FDI-environment relationship and tested the pollution haven hypothesis.

2.2. Empirical literature

Sharif Hossain (2012) investigated an econometric analysis for CO_2 emissions, energy consumption, economic growth, foreign trade and urbanization of Japan the Short-run unidirectional causalities are found from energy consumption and trade openness to carbon dioxide emissions, from trade openness to energy consumption, from carbon dioxide emissions to economic growth, and from economic growth to trade openness. The test results also support the evidence of existence of long-run relationship among the variables in the form of Equation (1) which also conform the results of bounds and Johansen conintegration tests. It is found that over time higher energy consumption in Japan gives rise to more carbon dioxide emissions as a result the environment will be polluted more. But in respect of economic growth, trade openness and urbanization the environmental quality is found to be normal good in the long-run.

Viktoraskulionis (2013)investigated the relationship between renewable energy consumption, co2 emissions and economic growth in Denmark using annual data from 1972-2012. The causal relationship between variables is examined using Granger causality test in VAR framework. Results of unit root tests show that all variables are non-stationary in their level form and stationary in first difference form. Cointegration analysis following Johansen (1992) approach shows that there is no evidence of cointegration among the test variables. The empirical results from Granger causality Toda-Yomamoto test and Granger causality test using first differences strongly supports a unidirectional causality coming from renewable energy consumption to CO_2 emissions. The results of this study also indicate that there is no statistically significant causality between the economic growth and renewable energy consumption, which supports the neutrality hypothesis and implies that energy conservation policies should not have a significant impact on economic growth. The empirical results also reveal that there is no causality between economic growth and CO_2 emissions.

Wendy N. Cowan, and etal investigated the nexus of electricity consumption, economic growth and CO_2 emissions in the BRICS countries using panel causality analysis. There is no evidence of Granger causality between GDP and CO_2 emissions in India and China. Furthermore, electricity consumption is found to Granger cause CO_2 emissions in India and While there is no Granger causality between electricity consumption and CO_2 emissions in Brazil, Russia, China and South Africa.

Chandra Ghosh and etal (2014)studied Economic growth, CO_2 emissions and energy consumption in case of Bangladesh using cointegration test They obtain results indicated that energy consumption has a positive and significant impact on economic growth while carbon emission has a negative and insignificant effect, ensuring that economic growth in Bangladesh can be achieved without degrading the quality of the environment.

Haider Mahmood and A.R. Chaudhary(2015)investigated FDI, Population Density and Carbon Dioxide Emissions: A Case Study of Pakistan ARDL and its error correction model .The study found the long run relationship in the model but short run relationship did not exist. Foreign direct investment, manufacturing value added and population density have positive impact on carbon dioxide emissions.

Dinh Hong Linh and Shih-Mo Lin(2014)co2 Emissions, Energy Consumption, Economic Growth and foreign direct investment in Vietnam. The empirical results do not support the environment Kuznets curve theory in Vietnam. However, the cointegration and Granger causality test results indicate a dynamic relationship among CO_2 emissions, energy consumption, foreign direct investment and economic growth. The short run bidirectional relationship between Vietnam's income and foreign direct investment inflows implies that the increase in Vietnam's income will attract more capital from overseas. Inversely, foreign direct investment inflow is also driver of national income growth

Prashanta K. Banerjee and Matiur Rahman investigated some Determinants of CO_2 Emissions in Bangladesh and the estimates of ARDL model lend support to the existence of a cointegrating relationship among the variables. Augmented Dickey-Fuller Test .The estimates of the Vector Error-Correction Model depict a strong long-run causal flow from industrialization and population growth to CO_2 emissions in Bangladesh while that from growth in FDI is relatively subdued and statistically insignificant. CO_2 emissions, industrial output growth, population growth and FDI inflows in natural log are non stationary in terms of both ADF and KPSS tests with different orders of integration.

Bin Amin and etal(2012)studied the Causal Relationship among Energy Use, CO_2 Emissions and Economic Growth in Bangladesh multivariate vector error correction modelto check the stationarity properties, they have employed Augmented Dickey Fuller (ADF) test and found that variables are stationary either at their level or at first differences. Using Johansen cointegration method, the empirical findings indicate that there exists long run cointegration among the variables. The study points out that there is no causal relationship between

Economic Growth and CO_2, ensuring that economic growth in Bangladesh can be achieved without degrading the quality of the environment.

Palamalai and etal(2014)investigated the Relationship between energy consumption,co2 emission, economic growth and trade in India Using perron unit root test, co-integration test and vector error correction model .The study exhibits a long-run relationship between various sources of energy consumption, economic growth, CO_2 emissions and trade in India. The findings reveal that increase in CO_2 emissions leads to achieve high level of economic activity in India. In addition, the study finds that foreign trade influences the various sources of non-renewable energy consumption in the long-term. However, the energy consumption do not significantly contributes towards promoting foreign trade, except crude petroleum, in the short-run.

Sahbi Farhani and Jaleleddine Ben Rejebstudied Energy Consumption, Economic Growth and CO_2 Emissions for MENA Region applies the panel unit root tests, panel cointegration methods and panel causality test and The finding of this study reveals that there is no causal link between GDP and EC; and between CO_2 emissions and EC in the short run. But they found a short-run causality running from energy consumption to economic growth and CO_2 emissions .The results indicate that an increase in energy consumption may lead to increase in the income and the CO_2 emission. Furthermore, we can say that the policies attempting to consume more efficient energy may not retard economic growth and income. However, in the long run, there is a unidirectional causality running from GDP and CO_2 emissions to EC.

Seetanah Boopen and Sannassee Vinesh studied On the Relationship between Co2 Emissions and Economic Growth for Mauritius both the augmented Dickey-Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) unit-roots tests employed results suggest that the carbon dioxide emission trajectory is closely related to the GDP time path. They showed that emissions elasticity on income has been increasing over time. By estimating the EKC for the period 1975-2008, they were unable to prove the existence of a reasonable turning point and thus no EKC “U” shape was obtained. Their result suggests that Mauritius could not curb its carbon dioxide emissions in the last three decades. Thus as hypothesized the cost of degradation associated with GDP grows over time and it suggests that the economic and human activities are having increasingly negative environmental impacts on the country relative to their economic prosperity.

Yi Yanchuninvestigated FDI and China’s Carbon Dioxide Emissions: a time series regression analysis employs the OLS method to run the time series data regressions In a time series regression analysis, the author finds that foreign capital penetration has a significant negative effect on the growth of CO_2 emissions, which is due to the spill-over effect. The author finds negative effect of domestic investment and agriculture shares on total CO_2 emissions over the same period. Srinivasan Palamalai, Inder Siddanth Ravindra and Karthigai Prakasam(2015) investigated the relationship between energy consumption ,co2 emission economic growth and trade in india using the Perron unit root test, Gregory and Hansen cointegration test and Vector Error Correction Model. The study exhibits a long-run relationship between various sources of energy consumption, economic growth, CO_2 emissions and trade in India. By and large, the empirical results confirm that economic growth fuels rate of various sources of energy consumption i.e. coal, crude petroleum, electricity and natural gas. The findings reveal that increase in CO_2 emissions leads to achieve high level of economic activity in India. In addition, the study finds that foreign trade influences the various sources of non-renewable energy consumption in the long-term. However, the energy consumption do not significantly contributes towards promoting foreign trade, except crude petroleum, in the short-run.

Joysri Acharyya (2009)investigated FDI, growth and the environment evidence from India on CO_2 emission duringthe last two decades find a statistically significant long run positive, but marginal, impact of FDI inflow on GDP growth in India during 1980-2003. On the other hand, the long run growth impact of FDI inflow on CO_2 emissions is quite large. The actual impact on the environment, however, may be larger because CO_2 emission is one of the many pollutants generated by economic activities.

Soheilakhoshnevis and yazdinikos mastorakis investigated the Dynamic Links between Economic Growth, Energy Intensity and CO_2 Emissions in Iran using the ARDL The empirical results show that the energy intensity and urbanization increases CO_2 emissions in the long run. The results confirm the existence of an environmental Kuznets curve between real GDP and CO_2 emissions, which means that higher levels of economic growth, environmental impact decreases over time.

Soheila Khoshnevis Yazdi and etal studied renewable, Non-Renewable Energy Consumption, Economic Growth and CO_2 emission: Evidence for Iran ARDL approach. The empirical results suggest that the variables are co-integrated in the case of Iran. In other words, there is a long-run relationship between CO_2 emissions, economic growth and. Granger causality test reveal a strong evidence of bidirectional causality running from economic growth to CO_2 emissions. Moreover, there is bidirectional causality between economic growth and renewable energy consumption in the short and long run.

AnisOmri(2015) studied CO_2 Emissions, Energy Consumption and Economic Growth Nexus in MENA countries: 1990-2011 Evidence from Simultaneous Equations Model using Generalized Method of Moments .The empirical results show that there exists bidirectional causal relationship between energy consumption and economic growth. However, the results support the occurrence of unidirectional causality from energy consumption to CO_2 emissions without any feedback effects, and there exists bidirectional causal relationship between economic growth and CO_2 emissions for the region as a whole.

Jamal Othman and etalstudiedeconomic growth, foreign direct investment, macroeconomic conditions and sustainability in Malaysia and they estimated the impact of FDI on conventional GDP and GS growth as well as on the GDP-GS gap for Malaysia from 1974-2009. The potential nonlinearities associated with the impact of FDI are captured using a macroeconomic conditions indicator as a threshold variable. The result demonstrate stronger FDI impacts on Malaysian GDP and GS (genuine saving) growth as well as on reducing the GDP-GS gap once the general macroeconomic conditions in the country reaches a particular level. The results may suggest that FDIs will be more impactful in accelerating future economic growth and sustainability if a country is able to maintain a particular state of macroeconomic conditions.

Hussain Ali Bekhet and Nor Salwatibt Othman(2014)investigated the Long-Run Elasticities of Electricity Consumption, FDI, Export and GDP in Malaysia applied ADF, PP and KPSS tests and the results are compared among each others for consistency purposes and robostness. The F-Bound test was employed to estimate the long run relationship among the variables and logarithmic multiple regression model to determine the magnitude of changes in electricity consumption when there is a changes in economic activities. It shows a significant long run relationship among electricity consumption, FDI, export and industrial value added. This means that all the aforesaid variables achieve equilibrium in the long run and there is a possibility of causal relationship among variables at least in one direction.

NazirahWahid.and etal(2013)studied Energy Consumption, Economic Growth and CO_2 emissions in Selected ASEAN Countries Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test were used to determine the stationary state of the series Cointegration test

The causality result shows evidence of unidirectional causality from CO_2 emissions to energy consumption and from energy consumption to economic growth in Malaysia. While, there were unidirectional granger causality runs from economic growth to CO_2 emissions and energy consumption to economic growth in Indonesia. In Singapore economic growth and energy consumption showed no granger cause to CO_2 emissions but openness and industrialization had granger caused CO_2 emissions. This has proven that Singapore can maintain the economic growth without compromising environmental damage. For Malaysia and Indonesia, the policy implications are very important to ensure economic growth and development that does not adversely affect the environment.

Chaido Dritsaki and Melina Dritsaki (2014)investigated the Causal Relationship between Energy Consumption, Economic Growth andCO_2 Emissions: A Dynamic Panel Data Approach .The FMOLS and DOLS are then used to estimate the long run relationship between the variables. The findings of this study reveal that there is a short-run bilateral causal link between the examined variables. However, in the long run, there is a unidirectional causality running from CO_2 emissions to energy consumption (EC), and economic growth (GDP) and a bilateral causality between energy consumption and economic growth. This indicates that energy is a force for economic growth both in short and long run as it is driven from economic growth. Moreover, to face the heterogeneity on the three countries of Southern Europe, they use the FMOLS and DOLS estimation methods.

Cheng Kuo, and etal ((2014)investigated on The Causal Relationship between GDP, Energy Consumption and CO_2 Emissions in Hong Kong Augmented Dickey-Fuller ,unit root test , co-integration test, the Granger causality test used, results indicate that there is a unidirectional causality running from CO_2 emissions to energy consumption and CO_2

emissions to GDP in Hong Kong. Moreover, there is bidirectional causality between GDP and energy consumption existing.

Blanco and etal (2011)investigated the Impact of FDI on CO_2 Emissions in Latin America using Granger causality test .They find causality running from FDI in polluting intensive industries("the dirty sector") to CO_2 emissions per capita. Thus, in line with MacDermott's (2006) analysis for Mexico, their results suggest that there may be a significant negative environmental impact of FDI inflows in dirty sectors for the Latin American region. This result is robust to controlling for other factors associated with CO_2 emissions and using the ratio of CO_2 emissions to GDP. For other sectors, they find no robust evidence that FDI causes CO_2 emissions.

Cumabozkurt and Yusuf Akan(2014) studied Economic Growth, CO_2 Emissions and Energy Consumption The Turkish Case by using cointegration test and the obtained empirical results from this paper indicated that CO_2 emissions effect negatively economic growth while energy consumption effect positively it.

Eteng Ibiang Eteng investigated on what is the relationship between CO_2 emissions and economic growth in the uk? Using the cointegration, error correction model and the granger causality test .The study discovers a short and long run causality running between the variables observed. It also found a unidirectional causality from CO_2 to RGDP; RGDP to foreign trade ratio; foreign trade ratio to CO_2 and Foreign trade ratio to Final energy consumption. The results further reveals an inverted U-shape relationship between CO_2 and GDP, thus, EKC hypothesis confirmed in the UK. The conclusions, however, are a cut in CO_2 emissions can affect GDP negatively and the influence of trade openness can increase CO_2 emissions to have an N-shape relationship with GDP.

Dinh Hong Linh and Shih-Mo Lin(2015)investigated the Causal Relationships among CO_2 Emissions, Energy Consumption, Economic Growth and FDI in the most Populous Asian Countries1980 -2010, Granger causality test. The panel sample shows evidence that supports the Environmental Kuznets Curve (EKC), and that CO_2 emissions begin to decline when income level reaches to 8.9341 (in logarithms). Applying Granger causality test, they find the existence of both short and long-run causality relationships among these variables, and economic growth, FDI, energy consumption and CO_2 emissions of 12 Asian most populous countries have relationships with Japanese income. However, FDI inflows are found significantly that does not intensify the environment degradation within these 12 Asian countries as a panel sample.

Ahmed Saddam (2015) studied the Variance Decomposition of Emissions, FDI, Growth and Imports in GCC (UAE, Bahrain, Saudi Arabia, Oman, Qatar and Kuwait) countries: A Macroeconomic Analysis the method adopted is based on the Vector Error Correction Model (VECM) found that FDI inflows have a significant variance to GDP. And the increase of level of carbon dioxide emissions is highly related to FDI and commodity imports in which GCC economies have not taken into account in their environmental consideration. Furthermore, FDI inflows and commodity imports are correlated more than other variables studied, such as CO_2 and GDP.

Suyi Kim studied CO_2 Emissions, Energy Consumption, GDP, and Foreign Direct Investment in ANICS Countries. The study examines the causal relationship between CO_2 emissions, energy consumption, output and FDI (foreign direct investment) in ANICs (Asian newly industrialized countries: Hong Kong, Republic of Korea, Singapore, Taiwan) from 1971 to 2011. The result based on VECM (Vector Error Correction Model) implied that there is a long run cointegrated relationship between CO_2 emissions, energy consumption, output and FDI. The result supports the environmental Kuznets curve hypothesis in this region. Short run dynamics show the Granger Causality from economic growth to CO_2 emissions. There is an also indirect causality from FDI (inward FDI and outward FDI) to CO_2 emissions in the short run. In the long run, there was unidirectional granger causality from the other variables to CO_2 emissions.

Monika Papiez(2013) studiedCO_2 emissions, energy consumption and economic growth in the Visegrad Group countries based on a panel data analysis and The paper examines causal relationships between carbon dioxide emissions, energy consumption and economic growth using panel vector error correction modelling techniques based on the panel data for the Visegrad Group countries over the period 1992–2010. Panel cointegration tests show the existence of long-run relationships among carbon dioxide emissions, energy consumption and economic growth. The long-run equilibrium indicates that energy consumption has a positive and statistically significant impact on emissions. However, the results obtained cannot confirm the Environmental Kuznets Curve (EKC) hypothesis for the Visegrad Group countries. The results of panel short-run Granger causality tests reveal the existence of bidirectional causality between CO_2 emissions and economic growth. Also, the short-run dynamics suggests unidirectional causality from energy consumption to carbon dioxide emissions and from energy consumption to economic growth in the Visegrad Group countries. The findings indicate that there is no causality running from carbon dioxide emissions to energy consumption and from economic growth to energy consumption.

Younes Nademi and Ali Asghar Salem(2011)studied CO_2 Emissions and Economic Growth in some Developed Countries the paper is to estimate and evaluate the relationship between Pollution Index (CO_2emissions) and economic growth in selected developed countries consist of Austria, Belgium, Canada, Chile, Denmark, France, Ireland, Japan, Korea Rep., Sweden and United States. Results indicate that the nonlinearities effect of Economic Growth on CO_2 emissions exists in these countries at 2000-2007 as an inverse Kuznets Curve. Results show that, before the threshold value of economic growth (3.15%), the effect of Economic Growth on CO_2 is negative but after the threshold value of economic growth (3.15%), the effect of Economic Growth on CO_2 is positive. Therefore, the Kuznets Curve hypothesis is rejected in Austria, Belgium, Canada, Chile, Denmark, France, Ireland, Japan, Korea Rep., Sweden and United States countries at 2000-2007 periods.

Muftau and etal (2014)investigated An Empirical Analysis of the Relationship between CO_2 Emission and Economic Growth in West Africa Using a Fixed Effects panel regression Model executed within a vector error correction framework and results of cointegration indicate that there is a long-run equilibrium relationship between CO_2 emission, Gross domestic product and other relevant covariates. The empirical results indicate that in the long run, there is an N-shape relationship between income and CO_2 emission and that the EKC hypothesis is not supported for West Africa.

Chebbi H. E and Boujelbene Y.(2008)studiedCO_2 emissions, energy consumption and economic growth in Tunisia Statistical findings indicate that economic growth, energy consumption and CO_2 emission are related in the long-run and provide some evidence of inefficient use of energy in Tunisia, since environmental pressure tends to rise faster than economic growth and in the short run, results support the argument that economic growth exerts a positive “causal” influence on energy consumption growth. In addition, results from impulse response do not confirm the hypothesis that an increase in pollution level induces economic expansion**.**

Nkengfack Hilaire and Herve Kaffo Fotio(2015)investigated the Effects of Economic Growth on CO_2 Emissions in the “Congo Basin”Countries Cointegration tests by the distributed lags or Auto Regressive Distributed Lags(ARDL) developed by Pesaran et al. (1997, 2001) is appliedThe result Indicates the existence of a long term relationship between the variables. The results show that the economic growth has a positive impact on CO_2emissions in these countries. Also, the consumption of energy, population density and industrial activities increase CO_2 emissions significantly in these countries, while the commercial opening does not have a significant impact.

Stephen Akpo Ejuvbekpokpo(2014) studied the impact of carbon emissions on economic growth in Nigeriausing a multiple regression model. The method of data analysis is the ordinary least squares (OLS) technique. The result reveals that carbon emissions have negative impact on economic growth in Nigeria. The study has shown that cement production is rapidly becoming a major source of carbon emissions in the country.

Jonathan D. Danladi and Kehinde John Akomolafe (2013) studied Foreign Direct Investment, Economic Growth, and Environmental Concern: Evidence from Nigeria using Granger causality test The results revealed that there is no causality between the growth rate of GDP and FDI, growth rate of GDP and CO_2. The only causality found is a unidirectional causality between the growths of FDI grows and the growth rate of pollution. The direction is from growth rate of FDI to the growth rate of pollution.

Michael Hubler and Andreas Keller(2008),investigated Energy Savings via FDI? Empirical Evidence from Developing Countries for the period 1975-2004 applies panel estimation techniques and tests. They use macro level data on 60 developing countries including other potential determinants of energy intensities. The results do not confirm the hypothesis that FDI inflows reduce energy intensities of developing countries in general. Interactions of FDI with country-specific characteristics do not show significant effects, either.

Eleazar Zerbo (2015)studied co2 emissions, growth, energy consumption and foreign trade in sub-Sahara African countries The period covered by the data varies across countries: 1981-2010 using the ARDL bound testing approach to cointegration .The findings show the existence of a long run relationship only in South Africa and Togo. The results show that energy consumption has an effect in increasing CO_2 emissions in Botswana, Kenya, South Africa and Togo in the short term. Trade openness is not sufficient to improve environment quality in Kenya while it does in South Africa. Furthermore, the study apply the Toda and Yamamoto (1995) Granger causality test, and find that Kenya is dependent on energy while economic growth and energy consumption have a neutral relationship in Cameroon, Senegal, South Africa and Togo, suggesting that an energy efficiency policy may be implemented. However, the econometric results should be interpreted with care, as the variables are found to be weakly stable over the study period.

Arminen, Heli and Kivyiro, Pendo(2014) ,studied Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa based on an autoregressive distributed lag model The results based on an autoregressive distributed lag model imply that the variables move together in the long run (cointegration) in all of the countries. The results also support the environmental Kuznets curve hypothesis in the cases of DRC, Kenya and Zimbabwe. Moreover, FDI appears to increase CO_2 emissions in some of the countries, while the opposite impact can be observed in others. The most common unidirectional Granger causality relationships run from the other variables to CO_2 emissions, with different variables Granger causing CO_2 emissions in different countries, and from GDP (gross domestic product) to FDI. Granger causality running to CO_2 emissions appears more likely in the countries where the evidence supports the environmental Kuznets curve hypothesis. Otherwise, the causality relationships vary greatly between the countries.

ChaliNondo, Mulugeta S.Kahsai and Peter V. Schaeffer(2010) studied Energy Consumption and Economic Growth: Evidence from COMESA Countries panel unit root tests are applied to test the degree of integration between economic growth and energy consumption , panel cointegration and a dynamic panel error correction model The study examines the degree of integration between GDP and energy consumption and find that the variables are integrated of order one. In the second step, they investigate the long-run relationship between energy consumption and GDP; our results provide strong evidence that GDP and energy consumption move together in the long-run. In the third step, they estimate the long-run relationship and test for causality using panel-based error correction models and find a long-run bidirectional relationship between GDP and energy consumption.

Tiwari Aviral Kumar(2011),studied Primary Energy Consumption, CO_2 Emissions and Economic Growth: Evidence from India using Granger's approach (in VAR framework. The study finds evidence of no cointegration relationship among the test variables in the presence of structural breaks. Further, static analysis shows that primary energy consumption does not granger-cause GDP, whereas GDP granger-causes primary energy consumption. The dynamic analysis shows conflicting results on the causal relationship between energy consumption and GDP. Since GDP explains 75.9% of the forecast error variance of primary energy consumption, whereas primary energy consumption explains only 0.96% of the forecast error variance of GDP.

Dipa Adhikari and Yanying Chen(2013)studied Energy Consumption and Economic Growth: A Panel Cointegration Analysis for Developing Countries methods of panel unit root test, panel cointegration test and panel dynamic ordinary least squares (DOLS) are applied In this study80 countries are divided into three income groups, namely, upper middle income countries, lower middle income countries and low income countries. The empirical results reveal a long-run cointegrated relationship between energy consumption and economic growth for the whole panel of countries as well as for each group of countries. They find the strong relation running from energy consumption to economic growth for upper middle income countries and lower middle income countries, and a strong relation which runs from economic growth to energy consumption for low income countries. These findings clearly indicate that energy consumption had a positive and statistically significant impact on economic growth in the long-run for these countries.

Aminu Muhammad Mustapha and Aminu Muhammad Fagge(2015)studied on Energy Consumption and Economic Growth in NigeriaApplying Granger causality test, impulse response and variance decomposition analysisA multivariate frame work by including labour and capital in the causality analysis. Applying Granger causality test, impulse response and variance decomposition analysis; the results of the causality test reported absence of causality and that of variance decomposition found that capital and labour are more important in affecting output growth compared to energy consumption.

Pendokivyiro and Heliarminen studied Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa The results based on an autoregressive distributed lag mode The results based on an autoregressive distributed lag model imply that the variables move together in the long run (cointegration) in all of the countries. The results also support the environmental Kuznets curve hypothesis in the cases of DRC, Kenya and Zimbabwe. Moreover, FDI appears to increase CO_2 emissions in some of the countries, while the opposite impact can be observed in others. The most common unidirectional Granger causality relationships run from the other variables to CO_2 emissions, with different variables Granger causing CO_2 emissions in different countries, and from GDP (gross domestic product) to FDI. Granger causality running to CO2 emissions appears more likely in the countries where the evidence supports the environmental Kuznets curve hypothesis. Otherwise, the causality relationships vary greatly between the countries.

Marcel Kohler(2013)investigated CO_2 Emissions, Energy Consumption, Income and Foreign Trade: A South African Perspective1960-2009 The autoregressive distributed lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. (2001) is employed The main finding is the existence of a long run relationship between environmental quality, levels of per capita energy use and foreign trade in SA. As anticipated per capita energy use has a significant long run effect in raising the country's CO_2 emission levels, yet surprisingly higher levels of trade act to reduce these emissions. Granger causality tests confirm the existence of a positive bidirectional relationship between per capita energy use and CO_2 emissions. Whilst we also find positive bidirectional causality between trade and income per capita and between trade and per capita energy use, it appears that SA trade liberalisation has not contributed to a long run growth in pollution-intensive activities nor higher emission levels.

Yohannes Hailu and Zenebe Gebreegziabher(2006) using the Auto Regressive Distributed Lags investigated Energy, Growth and Environmental Interaction in the Ethiopian Economy. The study finds that economic growth in Ethiopia is co-integrated with energy consumption implying long run relationship between the two (stable relationship or equilibrium exists). Moreover, Granger causality test based on vector error correction model (VECM) shows unidirectional causality running from energy consumption to economic growth. That is, energy consumption Granger causes economic growth in Ethiopia. In addition, regression results on substitution possibilities among different alternative energy inputs reveal that the imported petroleum and wood fuel are substitutes to electricity while the demand for electricity is less sensitive to its own price and disposable income.

Catia Cialania(2014) investigated CO_2 Emissions, GDP and trade a panel cointegration approach. The results from the error correction model suggest that there are long-term relationships between the variables for the whole sample and for Non-OECD countries. Finally, Granger causality tests show that there is bi-directional short-term causality between per capita GDP and international trade for the whole sample and between per capita GDP and CO_2 emissions for OECD countries.

Endegtekalign (2014) investigated Energy consumption, carbon dioxide emissions and economic growth in Ethiopia using a VAR analysis approach .The finding indicates variables of interests are integrated of the same order 1(1). Co-integration test approves 'existence of one co-integrating equation. The Validity of the model was approved by diagnostic tests. The long run relationship and causality result shows energy consumption causes Economic Growth in Ethiopia. The functional relationship supports growth hypothesis. In the long run model there is no significant relation between Co_2 emissions and economic growth as well as in causality result. The result shows Economic Growth in Ethiopia can be achieved without degrading the quality of the environment coming from CO_2emissions. Based on the outcome shocks to energy consumption have a negative impact on economic growth.

Cemil Serhat Akin(2014) studied the Impact of Foreign Trade, Energy Consumption and Income on Co_2 Emissions panel data cointegration analysis According to the results positive relationship is found between CO_2 emissions and energy consumption, per capita income and trade openness. On the other hand, trade openness can reduce CO_2 emissions in the long run. Findings indicate that in the short run unidirectional causality from CO_2 emissions to trade openness (TRD).Also there is unidirectional causality from per capita income (GDP) to CO_2

emissions and energy consumption (EN). Short run dynamics suggest bidirectional causality from GDP to TRD and TRD2(is the square of LTRD to test increasing effect of trade volume).According to the coefficient on the lagged ECT, implying that there are two long-run panel causality links that run from LGDP, LTRD and LEN, to LCO_2 and from LGDP, LTRD and LCO_2 emissions to LEN.

Seetanah Boopen and Sannassee Vinesh investigated On the Relationship between Co2 Emissions and Economic Growth: The Mauritian Experience. Using rigorous econometrics analysis, their result suggests that the carbon dioxide emission trajectory is closely related to the GDP time path. We show that emissions elasticity on income has been increasing over time. By estimating the EKC for the period 1975-2009, we were unable to prove the existence of a reasonable turning point and thus no EKC “U” shape was obtained. Their results suggest that Mauritius could not curb its carbon dioxide emissions in the last three decades.

While the interest of this study were to investigate the dynamic relationship between CO_2emission, energy consumption, economic growth and foreign direct investment in case of Ethiopia .it is very important to understand the relationship between them in order to design effective energy, investment and environment policies and help to find the implication of FDI, economic growth and energy consumption on CO_2 emission.

Chapter Three

3. Methodology

3.1. Data type and source

The study used secondary data. The secondary data was obtained from both published and unpublished document from concerned organizations. The data for energy consumption and carbon dioxide emission and urbanization obtained from World Development Indicators of the official website of World Bank. Data on foreign direct investment was collected from UNCTAD stat and real GDP per capita was collected from national bank of Ethiopia.

3.2. Definition and Measurements of the variables

The study used the following proxy variables: real GDP per capita measured in Birr as economic growth, kilogram of oil equivalent for energy consumption per capita, carbon dioxide emissions per capita is measured in metric tons .Annual FDI inflows and stock at current price and exchange rate measured by US dollar and urbanization measured as urban population growth .

Real Gross domestic product (RGDP) per capita is the main and mostly used growth indicator is obtained by taking the ratio of real GDP to the population.

CO_2emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport as stated in the world development indicators.

Foreign direct investment (FDI**):** to measure the FDI, the net inflow of FDI was used. It includes the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital measured by us dollar at current price and exchange rate.

Urbanization, which is measured as percentage of urban population growth, in case of most cities are growing at a faster rate due to workers are migrating from rural area to urban area for better jobs, better life, better education, better treatment, etc. Thus urban populations pressure on urban resources and environment which leads to the environment to be polluted. Thus we expect that there is a positive impact of urbanization on CO_2 emissions.

3.3. Model specification

To allow for causality and dynamics and given that not all of our time-series are stationary to the same order (some are I(0) while others are I(1)), the cointegration technique suggested by Pesaran et al. (2001), the autoregressive distributed lag model (ARDL) procedure will be used. The functional equation is based on the assumption that FDI contributes to a countries economic growth and economic growth is driven by high energy consumption that is likely to produce CO_2 emission. Based on following the extant literature, a model is specified to perform the relationships between CO_2 emissions, energy consumption, economic growth and FDI as follow:

CO_2=f(ec,rgdppc,fdi,urb)

lnCepct=β0+β1lnecpct+β2lnrgdppct+β3lnfdit+β4urbt+et.......................................(1)

Where $t = 1 \ldots\ldots\ldots T$ denotes the time period, $Xt$is the vector of explanatory variables and et is the error term which is assumed to be serial uncorrelated with explanatory variables.

Cepc=carbon dioxide emission per capita

ecpc=energy consumption per capita

rgdppc=real GDP per capita

fdi=foreign direct investment inflow and stock at current price and exchange rate measured by US dollar

urb=urbanization

The natural logarithmic form permits us to estimate the constant elasticity from each estimated coefficient, which expresses constant relative change between a regressor and dependent variable. We expect the signs of *ln*ecpct, *ln*rgdppctto be positive, since CO_2 emissions increase when energy consumption increases. *ln*fdit a positive sign since CO_2 emission increases when foreign direct investment increases. Urbanization is of urban population growth used as an explanatory variable of a model in this paper. In case of most cities are growing at a faster rate, due to this workers are migrating from rural area to urban area for better jobs, better education, better treatment, better life, etc. Thus urban populations pressure on urban resources and environment as a result of this the environment is polluted. Thus we expect that there is a positive impact of urbanization on CO_2 emissions.

In this analysis, the time series data collected from 1974 to 2011 was used which corresponds to 37 years. There are five variables used in this study, which is CO_2 emissions , gross domestic product (GDP) ,foreign direct investment (FDI) and energy consumption (EC)and urbanization(urb).

3.4. Econometric Approach of the Study

This study used ARDL method in order to examine the dynamic relationship between CO_2emission, energy consumption economic growth and FDI in Ethiopia from 1974-2011**.**

The Augmented Dickey -Fuller statistics applied to study stability and instability of variables. In order to find a long-run relationship between the variables, Johansson Juselius Cointegration method (Cointegration) was used in this study. Based on co-integration and Granger causality tests the study tries to show the dynamic relationship between CO_2 emission, energy consumption, economic growth and foreign direct investment. The data is analyzed through econometric models of analysis. In econometric method of analysis the dependent variable of the study is examined based on its determinant variables.

In the econometrics model the methodology based on secondary data analysis of Johnson co-integration analysis framework: it includes lag length selection, unit root test, and co-integration, identification of long run model and diagnostic test of validity which includes the test for the serial autocorrelation in the residual. And if it finds any evidence of any serial autocorrelations the paper tries to fix it buy adding or removing lags of the variables. All the analysis in the study was conducted using Eviews 9 version software. All the variables are transferred to log form to reduce heteroscedasticity in the model.

Econometric Estimation criteria

There are three steps involved in estimating the relationship between the variables. The first step is to test the stationary of the series or their order of integration in all variables. A time series is not stationary if the mean and the variance of time series is increasing over time depending on the time. Otherwise, a time series is said to be stationary if the mean and its variance are fixed over time. Stationarity of a variable is usually determined by Augmented

Dickey-Fuller test (Dickey and Fuller, 1979). In this paper, Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test were used to determine the stationary state of the series. The second step is to examine the presence of a long run relationship among all variables in the equation. In this case, the co-integration tests will be conducted to investigate the existence of long-run relationships between the variables. Co-integration test is a combination of the linear relationship of the variables that are not stationary. Co-integrated variable would indicate that the variables have the same stochastic trend and thus have the same direction of movement within in the long run. Co-integration test is an extension of the stationary test. For co-integration test, we need to ensure that the data used is stationary or not. If there are one or more variables that have different levels of integration, the variables cannot be co-integrated (Engle and Granger, 1987). Co-integration relationship can be estimated through two test by Johansen (1988) test, the trace (Trace Test) and maximize the value-Eigen Test (Maximum Eigen value Test). Engle and Granger (1987) stated that once the variables are determined to be co-integrated, there always exists a corresponding error correction representation, implying that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship captured by the error correction term (ECT). The ECT is the method to correct the **Co-integration and Error-correction Mechanisms.** The Granger representation theorem (Engle and Granger, 1987) states that if a set of variables are co-integrated, then there exists a valid **error-correction representation** of the data. Thus, if Ytand Xtare both I (1) and have a co-integrating vector (1,−β) , there exists an error-correction representation, with$Zt = Yt - \beta Xt$, of the form

θ(L)ΔYt= $\delta + \phi \ L \ \Delta Xt - 1 - \gamma Zt - t + \alpha \ L \ + \varepsilon t$..*(1)*

where$\varepsilon t$is white noise and where *θ(L), φ(L)* and *α(L)* are polynomials in the lag operator *L* (with $\theta_0 \equiv 1$). Let us consider a special case of (1),

$$\Delta Yt = \delta + \phi(l)\Delta Xt - 1 - \gamma\ \ Yt - 1 - \beta Xt - 1\ \ + \varepsilon t \text{..}(2)$$

Where the error term has no moving average part and the systematic dynamics are kept as simple as possible. Intuitively, it is clear why the Granger representation theorem should hold. If *Yt*and *Xt*are both *I* (1) but have a long-run relationship, there must be some force which pulls the equilibrium error back towards zero. The error-correction model does exactly this: it describes how *Yt* and *Xt* behave in the short-run consistent with a long-run co-integrating relationship. If the co-integrating parameter β is known, all terms in (2) are *I* (0) and no inferential problems arise: we can estimate it by OLS in the usual way.

When $\Delta Yt = \Delta Xt - 1 = 0$ we obtain the 'no change' steady state equilibrium

$$Yt - \beta Xt = \delta/\gamma \text{...}3$$

which corresponds with if $\alpha = \delta/\gamma$. In this case the error-correction model can be written as

$$\Delta Yt = \varphi 1\Delta Xt - 1 - \gamma\ \ Yt - 1 - \alpha - \beta Xt - 1\ \ + \varepsilon t \text{...}(4)$$

where the constant is only present in the long-run relationship. If, however, the error correction model (2) contains a constant that equals$\delta = \alpha\gamma + \lambda$, with $\lambda \neq 0$, this implies deterministic trends in both *Yt*and *Xt*and the long-run equilibrium corresponds to a steady state growth path with $\Delta Yt = \Delta Xt - 1 = \frac{\lambda}{1-\varphi 1}$(Gujarati ,2004),

3.5. ARDL Model Testing Procedure

The ARDL model testing procedure starts with conducting the bound test for the null hypothesis of no co-integration. The calculated F-statistic is compared with the critical value tabulated by Pesaran (1997) or Pesaran et al. (2001). If the test statistic exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected regardless of whether the underlying orders of integration of the variables are zero or one. Similarly, if the test statistic falls below a lower critical value, the null hypothesis is not rejected. However, if the sample test statistic falls between these two bounds, the result is inconclusive. When the order of integration of the variables is known and all the variables are I(1), the decision is made based on the upper bound. Similarly, if all the variables are I(0), then the decision is made based on the lower bound.

3.6. ARDL Models

This choice is due to the fact that this technique has the advantage of being more efficient for studies with a small sample and applies to series that are integrated of order 1,level 0 or mutually integrated ,unlike the traditional tests such as Engle and granger, Johansen and Juselius and etc. The ARDL model has some advantages over other cointegration approaches. Firstly, this technique is comparatively more robust in small or finite samples consisting of 30 to 80 observations. Secondly, it can be utilized irrespective of whether regressors are of I(0) or I(1) or mutually integrated, There is still perquisite that none of the explanatory variables is of I(2) or higher order, *i.e.* the ARDL procedure will, however, be inefficient in the existence of I(2) or higher order series.

Thirdly, the ARDL Model applies general-to-specific modeling framework by taking sufficient number of lags to capture the data generating process. It estimates $(p + 1)k$ number of regressions in order to obtain an optimal lag length for each variable, where p is the maximum lag to be used, and k is the number of variables in the equation. The model is selected on the basis of different criteria like SBC, AIC, RBC and HQC.(ibid)

3.7. The Unit Root Test

A test of stationarity (or nonstationarity) that has become widely popular over the past several years is the unit root test**.**

3.7.1. The Augmented Dickey–Fuller (ADF) Test

In conducting the DF test, it was assumed that the error term utwas uncorrelated. But in case the ut are correlated, Dickey and Fuller have developed a test, known as the augmented Dickey–Fuller (ADF) test**.** This test is conducted by "augmenting" the preceding three equations by adding the lagged values of the dependent variable Yt. (Pantula, 1989)

3.7.2. The Phillips–Perron (PP) Unit Root Tests

An important assumption of the DF test is that the error terms *ut* are independently and identically distributed. The ADF test adjusts the DF test to take care of possible serial correlation in the error terms by adding the lagged difference terms of the regress and. Phillips and Perron use nonparametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms. Since the asymptotic distribution of the PP test is the same as the ADF test statistic.(ibid)

3.8. Transforming non stationary time series

Now that we know the problems associated with non stationary time series, the practical question is what to do. To avoid the spurious regression problem that may arise from regressing a nonstationary time series on one or more nonstationary time series, we have to transform nonstationary time series to make them stationary. The transformation method depends on whether the time series are difference stationary (DSP) or trend stationary (TSP).

3.9. Cointegration

The concept of cointegration can be described as a systematic co-movement among the selected time series over the long-run. If two or more series are each non-stationary, but a linear combination of them is stationary then it can be said that the series are cointegrated.

3.9.1. Testing for Co integration When the Co integrating Vector Is Pre-specified

Let Yt denote an $(n\times1)$ vector of I(1) time series, let β denote an $(n\times1)$ pre specified cointegrating vector and let

$$ut = \beta\square Yt = \text{cointegrating residual}$$

The hypotheses to be tested are

$$Ho :ut = \beta\square Yt \sim I(1) \text{ (no cointegration)}$$

$$H1 :ut = \beta\square Yt \sim I(0) \text{ (cointegration)}$$

Any unit root test statistic may be used to evaluate the above hypotheses. The most popular choices are the ADF and PP statistics. Cointegration is found if the unit root test rejects the no-cointegration null.

The cointegration test has performed the existence of long–run equilibrium relationships among CO_2 emissions, energy consumption, economic growth and FDI. Johansen (1991) cointegration test is employed to examine whether the series are cointegrated. Johansen cointegration test uses trace and maximum eigen value tests to determine the number of cointegration relationships. The trace and maximum eigen value statistic indicate that there is a difference in significant level of each cointegration equation. The maximum eigen value test is carried out with separate tests on each eigen value and has the sharper alternative hypothesis.(Johansen ,1992)

3.9.2. The Johansen Trace and Maximal Eigenvalue Tests

To test whether the variables are cointegrated or not, one of the well-known tests is the Johansen trace test. The Johansen test is used to test for the existence of cointegration and is based on the estimation of the ECM by the maximum likelihood, under various assumptions about the trend or intercepting parameters, and the number *k* of cointegrating vectors, and then conducting likelihood ratio tests.

3.1.1.0. Granger causality test

This causality test is also can be used in explaining which comes first: chicken or egg. More specifically, the test can be used in testing whether the existence of egg causes the existence of chicken or vise versa.

The results: Egg causes the chicken and there is no evidence that chicken causes egg.

$$Y_t = \gamma_{yt-1+\beta xt-1+\varepsilon t}$$

If $\beta \neq 0$ then x Granger-causes y in the regression above. Generally, if x_{t-1} adds information to y_t in addition to that added by y_{t-1}, x "Granger causes" y. Granger causality of x on y is absent when $f(y_t|y_{t-1}, x_{t-1}, x_{t-2}, \cdots) = f(y_t|y_{t-1})$;

Lagged values of x add no additional information. Granger causality test in the term of vector error correction model (VECM) will reveal whether historical value of one variable might affect the current value of other variables. The Granger causality test in the term of VECM framework is described as follows:

$$\Delta Yt = \alpha_{10} + \alpha_{11}(Yt-1 - Xt-1) + \sigma_{11}\Delta Yt-p + \sigma_{12}\Delta Xt-p + \beta_1\Delta zt-p + \varepsilon t$$

$$\Delta Xt = \alpha_{20} + \alpha_{21}(Yt-1 - Xt-1) + \sigma_{21}\Delta Yt-p + \sigma_{22}\Delta Xt-p + \beta_2\Delta zt-p + \nu t \text{ ....(2)}$$

where $t = 1, \ldots, T$ denotes the time period, Δ represents change operator, Yt and Xt is a pair of endogenous variables, z is the vector of other variables; β1 and β2 are vectors of its parameters in each equation; εt, νt are two error terms; and $(Yt{-}1 - Xt{-}1)$ is the error correction term (ect).$\alpha_{11}$and α_{21} are the parameters that show the speed of adjustment to the long run equilibrium which might confirm the long-run relationship among variables. (Granger 1981)

3.1.1.1. Heterosedasticity

It means that the error terms are mutually uncorrelated, while the variance of εi may vary over the observations.

The Goldfeld–Quandt test

By narrowing our focus somewhat, we can obtain a more powerful test. Two tests that are relatively general are the Goldfeld–Quandt (1965) test and the Breusch–Pagan (1979) Lagrange multiplier test. For the Goldfeld–Quandt test, we assume that the observations can be divided into two groups in such a way that under the hypothesis of homoscedasticity, the disturbance variances would be the same in the two groups, whereas under the alternative, the disturbance variances would differ systematically.

3.1.1.2. Choosing Lag-Length

The ARDL method estimates (p+1)k number of regressions in order to obtain optimal lag length for each variable, where p is the maximum number of lag to be used and k is the number of variables in the equation. The model can be selected using the model selection criteria like Schwartz-Bayesian Criteria (SBC) and Akaike's Information Criteria (AIC). SBC is known as the parsimonious model: selecting the smallest possible lag length, whereas AIC is known for selecting the maximum relevant lag length.

Two additional criteria that are used to determine the appropriate lag length, and also seasonality, are the Akaike and Schwartz-Bayesian criteria. To apply these criteria calculate the following statistics for the system for each lag length (and with and without seasonal dummies).

$AIC = log\left|\Sigma\right| + 2g/n$

$SBC = log\left|\Sigma\right| + g\ log(n)=n$

Where $/\Sigma l$ is the determinant of the variance covariance matrix of the residuals of the system, g is the total number of parameters estimated in all equations and n is the number of observations.

Select the model with the lowest *AIC* or *SBC* value. The same sample period must be used for all models being compared.

3.1.1.3. Normality Tests

Jarque–Bera (JB) Test of Normality

The JB test of normality is an *asymptotic,* or large-sample, test. It is also based on the OLS residuals. This test first computes the skewness and kurtosis measures of the OLS residuals and uses the following test statistic:

JB = $n\ [s^2/6+(k\text{-}3)^2/24]$

where$n$ = sample size, S = skewness coefficient, and K = kurtosis coefficient.

For a normally distributed variable, S = 0 and K = 3. Therefore, the JB test of normality is a test of the joint hypothesis that S and K are 0 and 3 respectively. In that case the value of the JB statistic is expected to be 0.Under the null hypothesis that the residuals are normally distributed. If the computed *p* value of the JB statistic in an application is sufficiently low, which will happen if the value of the statistic is very different from 0, one can reject the hypothesis that the residuals are normally distributed. But if the *p* value is reasonably high, which will happen if the value of the statistic is close to zero, we do not reject the normality assumption

3.1.1.4. Stability tests

The stability of the model and the coefficients are checked through the CUSUM and CUSUM-Q, in which the CUSUM examine the stability of the long run and short run parameters, while the graphical presentation of the recursive coefficients is used to judge the stability of the coefficients.

3.1.1.5. Diagnostic tests

The model that has been used for testing the long-run relationship and coefficients is further tested with the diagnostic tests of Serial Autocorrelation, Hetroskedasticity and any model misspecifications.

3.1.1.6. Robustness check

To check the robustness of the obtained results from the above mentioned techniques, Co-integration and granger are used to analyse the long and short-run relationship among the variables these are the alternatives to test the relationship, and the significance in these results will justify and validate the results of our analysis.

Chapter four

4. Result and Discussion

4.1. Descriptive statistics

	CEPC	ECPC	FDI	RGDPPC	URB
Std. Dev.	0.260374	0.034777	2.004627	0.228633	0.646945
Skewness	-0.537605	0.091332	0.140547	0.974515	-0.241335
Kurtosis	2.508697	1.064752	1.623407	3.984857	2.029086
Jarque-Bera	2.212640	5.982706	3.125533	7.550376	1.861437
Probability	0.330774	0.050219	0.209556	0.022933	0.394270
Sum	108.4976	227.1929	127.9463	311.1969	173.0371
Sum Sq. Dev.	2.508397	0.044748	148.6856	1.934094	15.48591
Observations	38	38	38	38	38

Table1desciptive statistics

Table 1 presents the descriptive state of the initial data used for the analysis; the data is slightly skewed for cepc and urb while positively skewed for the rest of the two variables.

4.2. Econometrics analysis

4.2.1. The Unit root test

	ADF test		Philips perron		Decision
Variables Variables	Intercept only	Intercept and trend	Intercept only	Intercept and trend	Order of integration
	ADF statistics	ADF statistics	Philips Statistics	Philips perron statistics	
Cepc	-1.791335	-4.322977*	-1.740795	-4.408388*	I(0)
Ecpc	-1.140396	-2.209360	-1.129942	-2.209360	
D(ecpc)	-6.000486*	-5.911106*	-6.012659*	-5.917570*	I(1)
Rgdppc	1.090130	0.045011	1.090130	0.867792	
D(rgdppc)	-4.266531*	-5.205282*	-4.300428*	-5.055553*	I(1)
Fdi	-0.455229	-3.321801	-0.732354	-3.238506	
D(fdi)	-8.345144*	-8.506070*	-8.693988*	-9.041993*	I(1)
Urbg	-2.346622	-2.292473	-1.758690	-1.819719	
D(urb	-3.619107*	-3.533732*	-3.577454*	-3.477829*	I(1)

Table 2 unit root test

We take the first difference of the variables and see if they become stationary. I(1) and I(0) denotes stationarity at first difference and at level respectively. The ADF and PP stationarity tests were carried out. We can also determine the order of integration of the variables in the process. In order to ensure the no variable is integrate of order higher than one.

Looking at the results of ADF and PP tests conducted on the first difference of the variables, the null hypothesis of unit root test is strongly rejected for carbon dioxide emission in both ADF and PP statistics in the case of intercept and trend. On the other hand the null hypothesis of unit root test is not rejected in the case of other variables at conventional statistical levels in both unit root tests. Hence we can conclude that all the variables become stationary at their first difference and hence are I (1) and except carbon dioxide emission which is I(0). The results obtained are reported in Table 2. Based on these tests statistic, it is found that there is a mixture of I(1)and I(0) of underlying regressors and therefore, the ARDL testing could be proceeded.

4.2.2 Co-Integration Test

4.2.2.1 Lag Length Selection Criteria

The order of lags in the ARDL model is selected by either the Akaike information criteria (AIC) or the Schwarz criteria (SC). The optimal lags on variables were selected by Akaike information criteria and turned out to be the ARDL(3,0,2,0,2) .

The Johansen co-integration test result is very sensitive to the number of lags included for the endogenous variables in the estimation of the ARDL. This necessitates the determination of an optimal lag order prior to the test of co-integration.

4.2.3. Granger causality

It is performed to examine the presence of bidirectional causality in the sense of Granger. it is presented below

Null Hypothesis:	F-Statistic	Prob.
ECPC does not Granger Cause CEPC	3 .65392	0.0506
CEPC does not Granger Cause FDI	3.73983	0.0223
RGDPPC does not Granger Cause CEPC	0.93854	0.4352
ECPC does not Granger Cause FDI	2.95387	0.0496
RGDPPC does not Granger Cause ECPC	7.23372	0.0010
ECPC does not Granger Cause RGDPPC	4.34211	0.0124
RGDPPC does not Granger Cause FDI	3.06553	0.0442
FDI does not Granger Cause RGDPPC	3.16102	0.0401

Table 3 granger causality test

From the above table there is unidirectional causality between FDI and CO_2 emission in which the causuality is running from CO_2 emission to FDI. There is bidirectional causality relationship running from Energy consumption to RGDPPC in Ethiopia. Any measure of energy consumption could adversely affect the economic growth of a country mean that a reduction in energy consumption leads to a significant direct impact on economic growth of a country. There is also granger causality between FDI and RGDPPC.

4.2.4. Bound test

To investigate the presence of long-run relationships among the variables, testing of the bound procedure is used.

Table 4 Bound test result

F statistics	Lag	Significance Level	Bound critical value	
			I0	I1
5.467876	3	1%	4.4	5.72
		5%	3.47	4.57
		10%	3.03	4.06

The calculated F-statistic from bound test of ARDL model, reported in Table 5 is higher than the upper bound critical values at five per cent level of significance. This implies that the null hypothesis of no co-integration can be rejected and therefore there is evidence to support the long run relationship among the variables.

The calculated F-statistics is 5.467876 while upper critical bound at significance level 5% is 4.57. This implies that there is long run relationship among carbon dioxide emission energy consumption economic growth and FDI in Ethiopia.

The next stage of the procedure would be to estimate the coefficients of the long-run relations and the associated error correction model (ECM) using the ARDL approach.

4.2.5. The Johansen Co-integration Test Result

The presence and the number of such co-integrating relationships are checked using the trace and the maximum eigen value methods.

H0=There is no co integration among the variables.

H1=There is cointegration among variables.

Hypothesized No. of CE(s)	Eigen value	Trace statistics		Max-eigen statistics	
		t-statistics	Critical value	t-statistics	Critical value
None *	0.596855	70.04737	69.81889	32.70451	33.87687
At most 1	0.380745	37.34286	47.85613	17.25259	27.58434
At most 2	0.289960	20.09026	29.79707	12.32762	21.13162
At most 3	0.193966	7.762646	15.49471	7.7626646	14.26460
At most 4	2.45e-08	8.80e-07	3.841466	8.80e-07	3.841466

Table 5 Johansen co-integration test result

We can see from the above table that the trace test and maximum eigen suggests that there are one co-integrating equations at the 0.05 level. Since the objective this paper is to investigate the dynamic relationship between CO_2 emission energy consumption economic growth and foreign direct investment only one co-integrated equation is estimated.

4.2.6. Estimated long run model

The next stage of the procedure would be to estimate the coefficients of the long-run relations and the associated error correction model (ECM) using the ARDL approach.

Variable	**Ecpc**	**Rgdppc**	**FDI**	**Urb**	**Constant**
coefficent	1.066633 (1.813030)	-0.015196 (0.173447)	0.122914 (0.037951)	0.173696 **(**0.059052)	-10.281560
t-stat	**[0.588315]**	**[-0.087609]**	**[3.238800*]**	**[2.941428*]**	

Table 6 long run model result

We can write the long run equilibrium equation as follows

Cepc=10.284560-1.06666338ecpc+0.015196rgdppc-0.122914fdi-0.1736964urb

Here RGDPPC and FDI play insignifant role in CO_2 emission of Ethiopia. This result does not contradict to Endeg tekalign (2014) found the insignificance of CO_2 emission in explaining economic growth in the long run. From the above result urbanization and FDI play a significant impact on CO_2 emission of Ethiopia. A 1% increase in FDI leads to approximately 0.12% increase in CO_2 emission per capita, all things being equal. As can be seen from the above result, FDI is significant indicating that it does have a major impact on carbon dioxide emission in the long run. The coefficients of energy consumption, real GDP per capita were also found to be statistically insignificant. And further economic growth in Ethiopia does not lead carbon dioxide emission to the environment due to insignificance of economic growth in explaining CO_2 emission in the long run. But here urbanization found to be statistically significant in explaining co_2 emission and have impact on carbon dioxide emission.

4.2.7. Estimated Short run error correction model

Dependent variable CEPC

ARDL(3,0,2,0,2) based on AIC

Variable	coefficient	std.erorr	t-statistics	Prob.
D(CEPC(-1))	0.311756	0.235651	1.322957	0.1989
D(CEPC(-2))	0.499634	0.213978	2.334979*	0.0286
D(ECPC)	0.939385	1.600751	0.586840	0.5630
D(FDI)	0.028557	0.035698	0.799942	0.4319
D(FDI(-1))	-0.075446	0.041116	-1.834930	0.0795
D(RGDPPC)	-0.013383	0.154210	-0.086783	0.9316
D(URB)	0.212301	0.131600	1.613233	0.1203
D(URB(-1))	-0.200121	0.120040	-1.667125	0.1091
ECM(-1)	-0.880701	0.287072	-3.067880**	0.0054
ECM = CEPC - (1.0666*ECPC + 0.1229*FDI -0.0152*RGDPPC + 0.1737 *URB - 10.2816)				

R-squared	0.767354	Mean dependent var	-2.827394
Adjusted R-squared	0.656089	S.D. dependent var	0.245802
S.E. of regression	0.144148	Akaike info criterion	-0.770090
Sum squared resid	0.477910	Schwarz criterion	-0.236828
Log likelihood	25.47657	Hannan-Quinn criter.	-0.586008
F-statistic	6.896608	Durbin-Watson stat	2.408756
Prob(F-statistic)	0.000052		

Table 7 short run coefficient

The coefficient of error correction term represents the speed of adjustment of this variable back to its long- run value following a shock. Here the coefficient of error correcting term for the equation is negative and significant tells that there is adjustment towards long run steady state mean that there is long run causality running from Energy consumption, Real GDP per capita, FDI and urbanization to CO_2 emission. The error correction term of -0.880701 shows that about 88% percent of the deviation of the actual CO_2 emission from its equilibrium is eliminated every year and hence full adjustment would require a period of less than two years.

4.2.8. Diagnostic Tests

4.2.8.1. Post estimation diagnostics.

We have also tested for autocorrelation, normality and heteroscedasticity. The LM test for serial correlation indicates that this model is free from serial correlation and White test for heteroscedasticity shows that the model does not have hetroscedasticity problem which is a good sign of this model. In addition the Jarque-Bera test shows that residuals of this model is normally distributed that is desirable.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.713286	Prob. F(1,29)	0.4053
Obs*R-squared	0.888208	Prob. Chi-Square(1)	0.3460

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.548027	Prob. F(6,30)	0.7675
Obs*R-squared	3.654813	Prob. Chi-Square(6)	0.7233
Scaled explained SS	2.089720	Prob. Chi-Square(6)	0.9113

Normality test

P -value---0.42458

Ramsey RESET Test: Model Misspecification

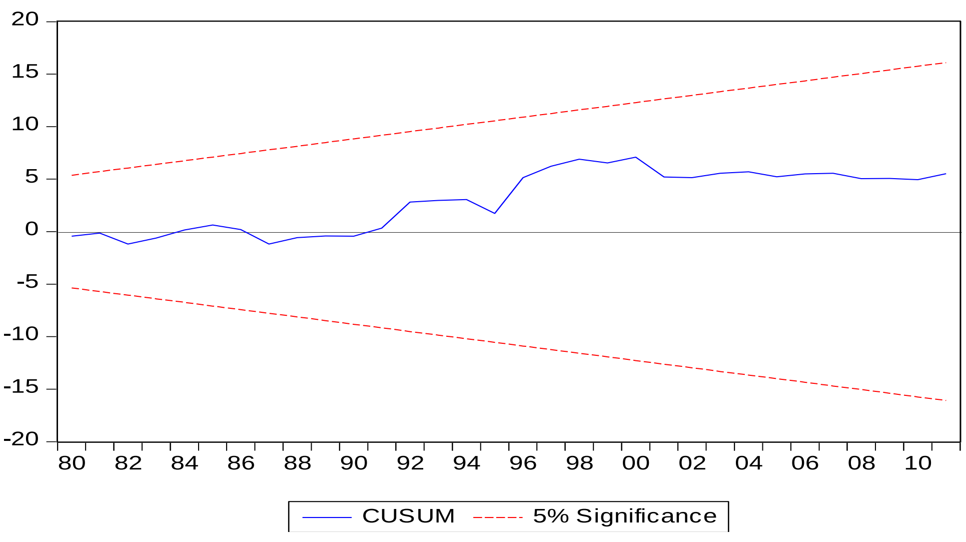
Omitted Variables: Squares of fitted values			
	Value	Df	Probability
t-statistic	0.828546	19	0.4176
F-statistic	0.686488	(1, 19)	0.4176

Table 8 post estimation diagnostics result

4.2.9. Stability Test

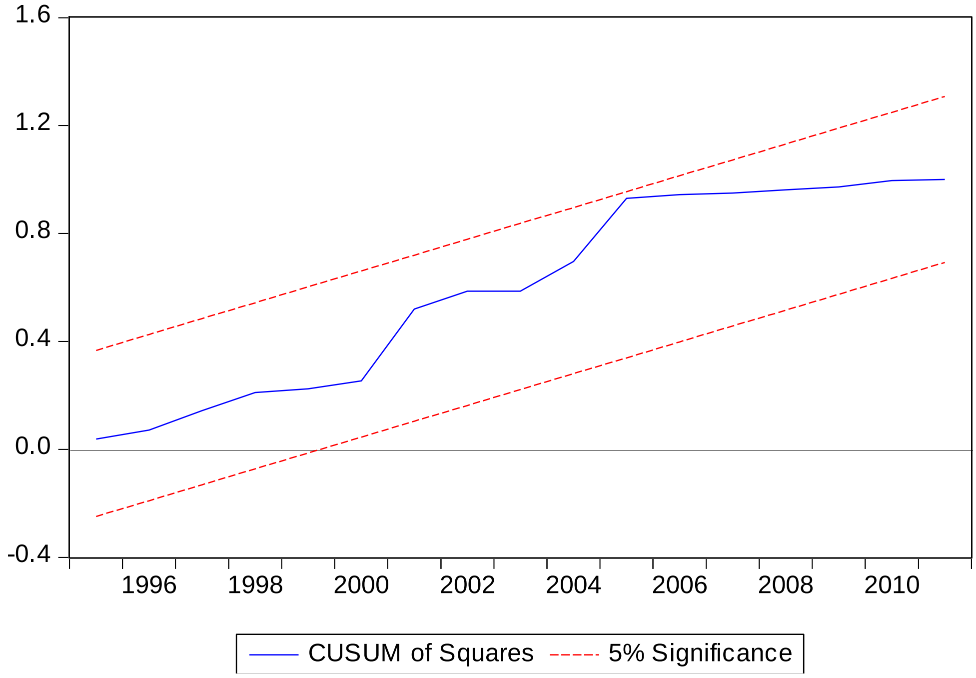
It is clear from the figures that parameters are stable; both sum of the residuals and sum of the squared residuals are moving inside the boundaries. The straight lines represent critical bounds at 5% significance level.

Figure 4 Plot of cumulative sum of recursive residuals

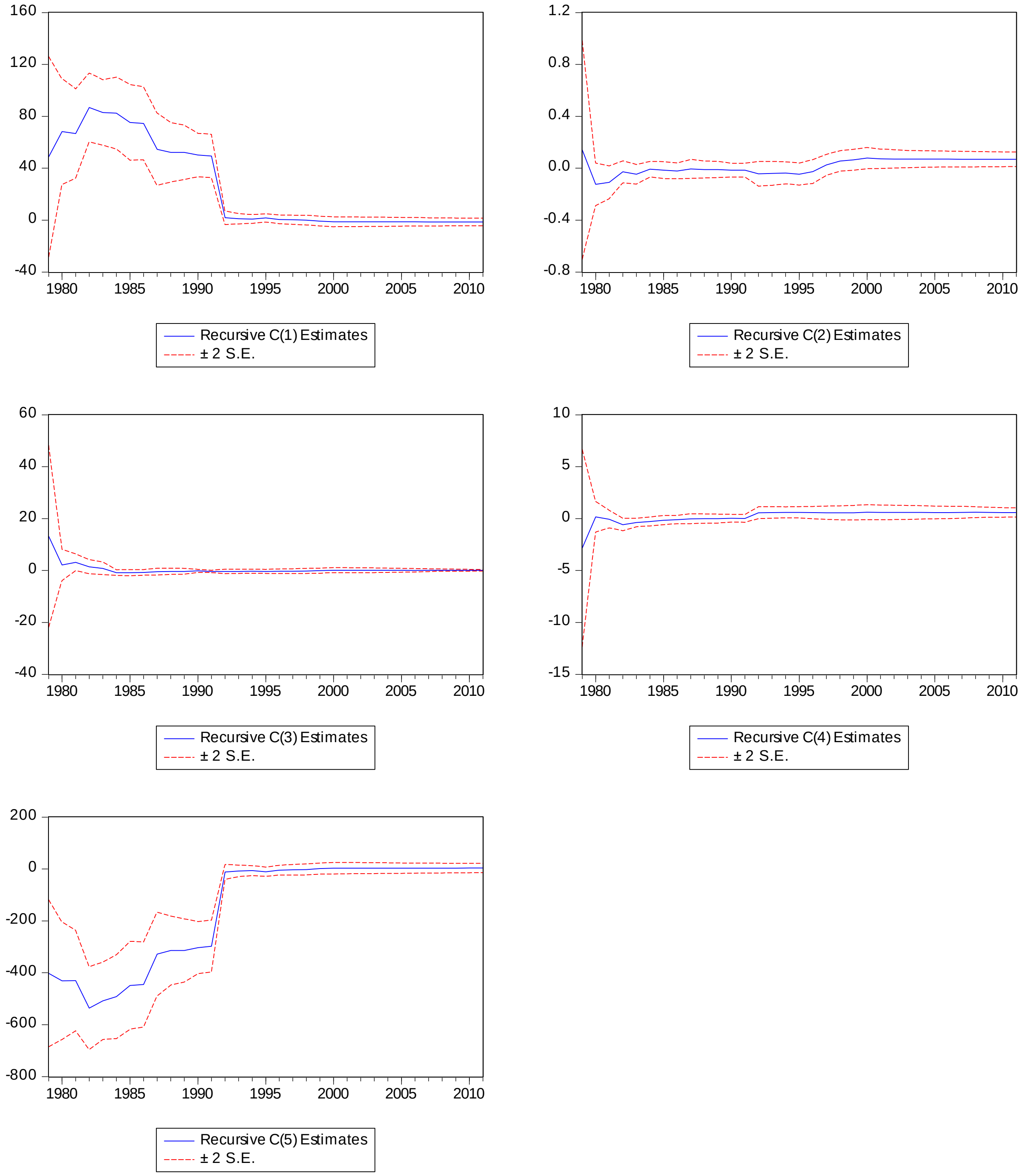


As it is clear from Fig. 4, the plot of the CUSUM is within the boundaries and hence these statistics confirm the stability of the long run coefficients of regressors.

Figure 5 CUMSUM of squares



Also from figure 6, we can judge the stability of the coefficients; it is clearly evident that the individual coefficients of the model are also stable and are within the boundary of the critical limits.



Figure,6 recursive coefficient curves

4.1.1.0. Impulse response

Impulse-response analysis employed the response to Cholesky one standard deviation innovations. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. An impulse response function traces the effect of a onetime shock to one of the innovations on current and future values of the endogenous variables.

The responses of per capita carbon emissions to per capita energy are positive but the responses of per capita carbon emissions to per capita energy consumption are positive during eight years and then it responses is negative . The responses of per capita carbon emissions to FDI are positive.

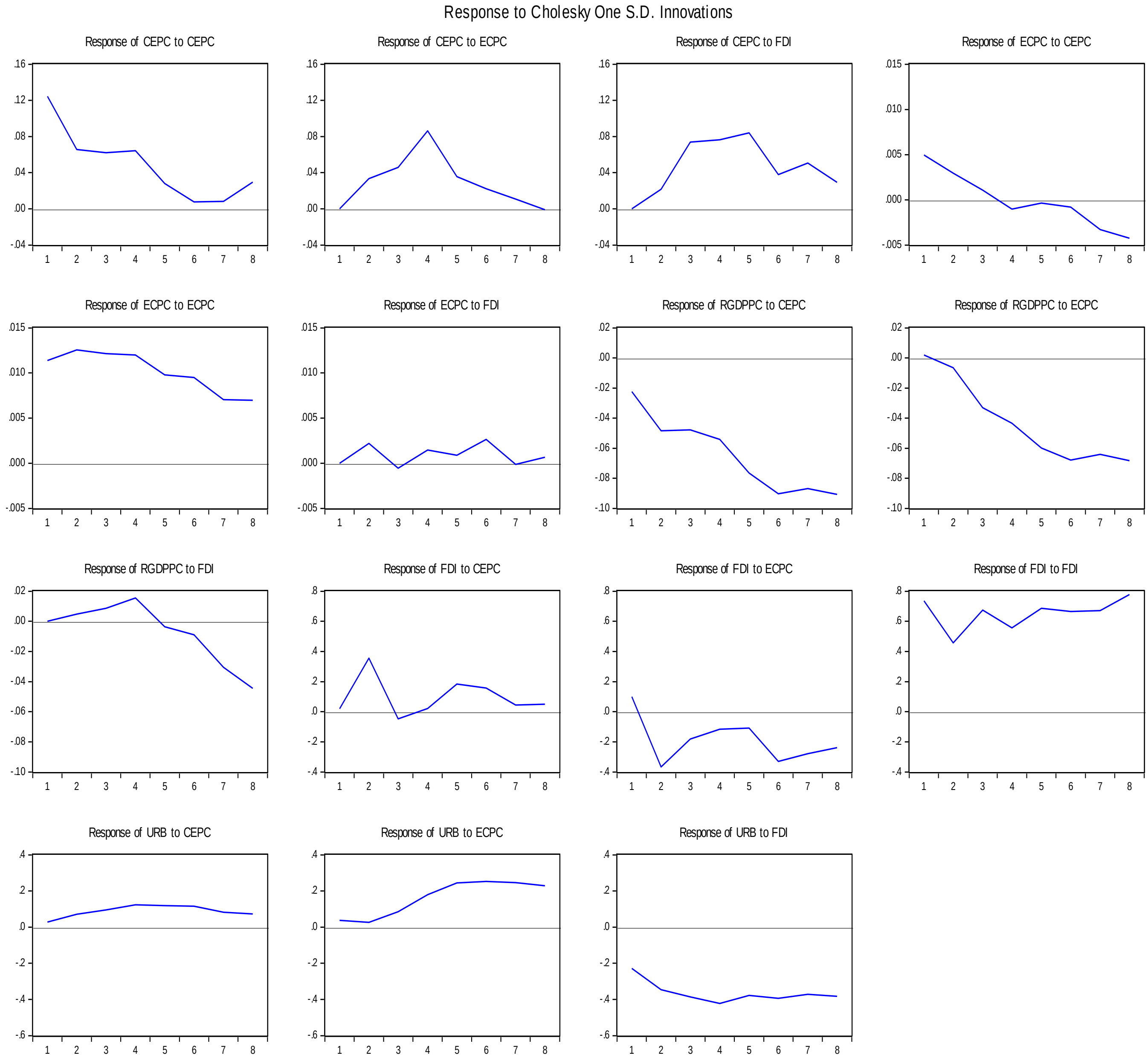


Figure 7 impulse response

Chapter five

5. Conclusion and policy implication

5.1. Conclusion

This study aimed to examine the dynamic relationship between CO_2 emission, energy consumption, economic growth and foreign direct investment in Ethiopia using ARDL system. Under this objective this paper tries to answer the following specific objectives the nexus between CO_2 emission and FDI and the trends of CO_2 emission in Ethiopia and examine the existence of causality between the variables in order to give policy implication.

The unit root test result shows that few variable are non stationary at level but they become stationary of few variables after first differencing I(1) and the rest is I(0).

Johansen cointegratin test of cointegration show that there is one cointegration equation between CO_2 emission, energy consumption, economic growth and FDI. The cointegration result shows that there is long run association among the above variables in case of Ethiopia.

It is found that the error correction terms (ECM(-1) is statistically significant . This indicates that there exists a long-run relationship among the variables (-0.88%) which shows the speed of adjustment towards equilibrium and suggests a rapid speed of convergence to equilibrium.

It is found that CO_2 emissions, energy consumption, economic growth, foreign direct investment and urbanization are cointegrated. This implies that the explanatory variables such as energy consumption, economic growth and foreign direct investment are allying with CO_2 emission level.

From causality result shows that there is unidirectional causality between energy consumption, FDI and CO_2 emission in which the causality is running from CO_2 emission to

FDI which implies that the relatively lower environmental standards has attracted FDI. There is bidirectional causality between real GDP per capita and energy consumption. The bidirectional causality between real GDP per capita and energy consumption implies that these variables are jointly determined and affect each other simultaneously whereas; there is no causality between $CO_2$and economic growth and CO_2 to urbanization in the short run in Ethiopia. Economic growth in Ethiopia is insignificant in explaining CO_2 emission, ensuring that economic growth in Ethiopia can be achieved without degrading the quality of the environment. So, in long run we do not have to be concerned about the environmental pollution coming from higher economic growth.

The pair wise Granger causality test between foreign direct investment and carbon dioxide emission suggested that Granger causality runs one-way from carbon dioxide emission to FDI. FDI inflows are found significant, it reduce the level of emission. Any further FDI inflow is not a problem for CO_2 emission in Ethiopia rather it is a benefit so as to reduce the level of emission in Ethiopia.

The CUSUM and CUSUMSQ tests results suggest the policy changes considering the explanatory variables of CO_2 emissions equation will not bring in distortion in the level of CO_2 emissions in Ethiopia.

FDI has significant effect on CO_2 emissions; however, from this result we are able to directly support the pollution haven.

An impulse response function traces the effect of a onetime shock to one of the innovations on current and future values of the endogenous variables. The responses of per capita carbon emissions to per capita energy are positive but the responses of per capita carbon emissions to per capita energy consumption are positive during eight years and then it responses is negative . The responses of per capita carbon emissions to FDI are positive.

5.2. Policy implication

In order to reduce CO_2 emission Ethiopia should implement strategies of increasing the level investment in an area of energy infrastructure and the proclamation should be inclined on energy conservation policies to increase of energy efficiency level and in order to reduce the wastage of energy use. The government should expand and diversify the existing energy use and a need for creating awareness to control the level of emission.

Government should improve investment more on energy efficiency infrastructure such as to transform public transportation facilities to be energy efficient one so as to reduce CO_2 emission. More attention is made on Investment on clean energy and need for proper utilization of resources.

The implementation of more severe laws that require the usage of energy efficient technologies and supplying them at affordable price such as hydro and geo thermal energies should reduce CO_2 emission level.

In the above result FDI have significant role in the carbon dioxide emission of Ethiopia .so it is better to attract FDI inflow in Ethiopia.

The creation of a fund for environmental improvement in this country might be a possible policy action that will ensure better environmental conditions in the region.

We suggest future research to employ firm-level data on FDI inflows so that a direct test could be made between the pollution haven and pollution halo hypotheses.

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