ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE DYNAMICS RELATIONSHIP OF CARBON DIOXIDE, NITROUS DIOXIDE, SULFUR DIOXIDE EMISSIONS AND ECONOMIC GROWTH OF ETHIOPIA

BY

AWASH DAGNE AMHAYESUS

JUNE, 2019

ADDIS ABABA, ETHIOPIA

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As members of the Board of Examining of the final MSc thesis Open defense, we certify that we have read and evaluated the thesis prepared by:-Awash Dagne Amhayesus under the title "The Dynamics relationship of carbon dioxide, Nitrous dioxide, sulfur dioxide emissions and economic growth of Ethiopia" We recommend that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Development Economics.

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DECLARATION

I, declare that this thesis is my original work, prepared under the guidance of **Dr.Wondimagegne Chekol.** All sources that of material used for thesis have been dully acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

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St. Mary's University, Addis Ababa **JUNE, 2019**

ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a University advisor.

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Advisor Signature

St. Mary's University, Addis Ababa **JUNE, 2019**

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ABSTRACT

The core objective of this study is to asses Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2), Emissions and Economic growth of Ethiopia from 1990-2017. Quantitative research approach was used to show the studies that makes use of Statistical analysis. Secondary data were collected from the targeted sector World Bank data (WB) and international monetary fund IMF from 1990-2017 fiscal year. FGLS regression model used to identify the most important dynamic relationship of (CO_2), (NO_2), (SO_2) and *Economic growth of Ethiopia from 1990-2017.*

The finding of the study show that, the annual release of CO_2 emissions of Ethiopia from 1990-2017 (consumptions of modern energy like coal, frost, industries, transportations consumption) investigated worth average is 63712.3 m^2 ton which is dynamically positive contributed to 0.2% to Ethiopian economic growth. Whereas, the positive and significant relation between economic growth and CO_2 indicates, economic growth was inevitably increases carbon dioxide emissions in the country. Similarly, regression result towards annual emissions of SO_2 increased to 487.1 M^2 ton shows dynamic positive relationship with Ethiopian economic growth show 0.4% worth annually.

However, NO_2 is the highest which is showing annual increase in Ethiopia during with an emissions in average 4194.2 to 15894.7 metric ton next to carbon dioxide which is portrayed inverse dynamic relationship to Ethiopian economic growth at negative 0.6% per annual.

It suggested that Creating partnership between academia and implementing/ regulatory organizations to facilitate evidence-based decisions, Improving the awareness and participation of stakeholders like private sectors, non-government sectors and government sectors to get easy solutions. To minimize CO_2 emissions that comes from, economic growth and urbanizations in Ethiopia, cost effective, carbon free, and efficient utilization of renewable energy consumption based on the country comparative advantage that consider alternative use of resources are advisable like: -Hydro and Geothermal.

Key words, Carbon dioxide, Nitrogen dioxide, Sulfur dioxide Emission, Real GDP

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ACRONYMS

CIESIN: - Center for International Earth Science Information Network

CRGE: - Clean Renewable Green Energy

CRGE: - Climate Resilient Green Economy

EC: - Energy Consumption

EKC: - Environmental Kuznets Curve

FGD: - Flue Gas Desulphurization

GDP: - Growth Domestic Product

GHGs:-Green House Gases

GNP:-Gross National Product

GTP:-Growth and Transformation Plan

INDC:-Intended Nationally Determined Contribution

IMF: - International Monetary Fund

IPCC: - Intergovernmental Panel on Climate Change

LUCF: - Land-Use Change and Forestry

MOFED: - Ministry Of Finance and Economic Development

NAFTA: - North American Free Trade Agreement

OMI: - Ozone Monitoring Instrument

SPM: - Suspended Particulate Matter

TP: - Turning Point

UNEP: - United Nations educational planning

UNFCC:-United Nations Framework Convention on Climate Change

UNRISD:-United Nations Research Institute for Social Development

USAID: - United States of Agency International Development

UN: - United Nations

VOC: -Volatile Organic Carbon

WHO: - World Health Organization

CHAPTER ONE

INTRODUCTION

1.1. Back Grounds of the Study

Environmental emission from gas effect is continuously redact the economic growth as individual supers which is to produce such output combinations of physical, natural, social and human capital were used as input. There are different scales of global emissions per capital growth (such as; CO_2,NO_2,SO_2, CH_4), continental (SO_x, NO_x), regional (fly ash, photochemical smog), local (large particulates). As energy is a crucial resource for any economy growth since all production and consumption undertakings are directly connected to energy consumption, hence ensuring the basis for economic activity and social welfare; however, the use of fossil fuels as primary source of energy caused a noteworthy upsurge in the global emissions of several potentially harmful gases (Javid & Sharif, 2016).

Greenhouse gases (GHGs) absorb heat arriving from the sun and retain it in the atmosphere which entails the increase of earth surface temperature (Ozokcu & Ozdemir, 2017). Therefore, the matter of climate change driven by the increased quantity of GHGs polluting the atmosphere has depicted over the past two decades a major environmental concern caused by the phenomenon of global warming. However, the switch between renewable resources and fossil fuels is at the core of climate change mitigation strategy (Kumar et, al., 2015).

In December 1997, more than 160 nations met in Kyoto, Japan, to negotiate binding limitations on greenhouse gases for the developed nations in pursue realizing the Framework Convention on Climate Change of 1992. The outcome of this meeting was the Kyoto protocol which aim is to limit their greenhouse gas emissions relative to the levels emitted in 1990. The protocol was finally set in motion with Russia's ratification on February 16, 2005. This protocol was developed under the (UNFCCC, 2018).

While the next obvious question with regard to this protocol is that of the ability of it to actually reduce emissions from participating countries, the rightful answer is still unclear. The reason being is that emission in the world’s atmosphere is in fact actually increasing (UNEP, 2019).

Energy Agency (2010) showed that Global CO_2 emissions per capital increased by 0.4 Gt CO_2 between 2007 and 2008, which represented a growth rate of 1.5%. If this trend continues, the world will see increased levels of CO_2 released into the atmosphere by a whopping 15-20% in the next decade. However, according to the same report, SO_2 and NO_2 the culprits of this increasing trend by 4% and 7% in 2007-2016. A growth-decomposition (scale, technique and composition effect) covering 62 countries and seven manufacturing sectors over the 1990–2000 period shows that trade, through reallocations of activities across countries, has contributed to a 2–3% decrease in world SO_2 emissions. However, when compared to a constructed counterfactual no-trade benchmark, depending on the base year, trade would have contributed to a 3–10% increase in emissions. NO_2 emissions fell by 45% emissions per capital is risen in recent years (Ozokcu and Ozdemir, 2017).

It Due to increased utilization of existing coal plant with higher emissions per unit of output and of public electricity and heat production developed over time and estimates how they would have developed if improvements in emissions abatement, generation efficiency and fuel switching had not taken place.

But, it is not actually the developed countries whereby their commitment towards reducing the release of emission were obvious when current date showed that their total released emission was cut by approximately 2% within the same period (IEA,2010). Now, it's the developing countries that are releasing emissions more than ever with an average increase of approximately 6% per capital.

Energy Consumption, Emissions and Economic Growth in gases and particles from the combustion of fossil fuels and biofuels in Africa are expected to increase significantly in the near future due to the rapid growth of African cities and megacities. There is currently no regional emissions inventory that provides estimates of anthropogenic combustion for the African continent. This work provides a quantification of the evolution of African combustion emissions from 2005 to 2030, using a bottom-up method. This inventory predicts very large increases in black carbon, organic carbon, CO_2, NO_2, SO_2 and non-methane hydrocarbon emissions if no emission regulations are implemented in scenarios which involving certain fuels, specific to Africa in each activity sector and each region (western, eastern, northern and southern Africa), still the emissions is increased to 6-7%. The estimated trends in African emissions are consistent with emissions provided by global inventories, but they display a larger range of values. African combustion emissions contributed significantly to global emissions to economic growth by 2.3% per annual in 2010 Liousse et al, (2010). This contribution will increase more significantly by 2030: organic carbon emissions will for example make up 50% of the global emissions in 2030.

Energy Consumption, Carbon Dioxide Emissions on Economic Growth of Nigeria and motor oil are also a large source of pollutants in cities of sub-Saharan Africa such as Bamako (Mali) or Cotonou (Benin). Surprisingly high particulate emissions factors for such two wheeled vehicles were measured during AMMA campaign in Congou (Guinot et al 2014). And resulted in the development of a specific emission inventory for traffic emissions Assamoi and Liousse (2010).

Elevated levels of atmospheric pollutants were also observed during the POLCA program (Liousse and Galy-Lacaux, 2010) in Dakar (Senegal) and Bamako: the unexpectedly high aerosol and gas concentrations due to traffic and biofuel emissions in these cities have a demonstrated impact on human health through inflammatory diseases (Val et al., 2013).

In African, CO_2, SO_2 and NO_2 emissions are predicted to increase considerably ion the future. Future projections indicate an increase in the population density of developing countries, which will be much higher in Africa than in other parts of the world. The population of Africa could represent 40% of the world's population in 2100 (UN 2007). In addition, there is an explosive increase in the urban population in Africa, which could double from 2000 to 2030 (CIESIN, 2012) A rapid development of mining, oil and industrial activities is also expected across the whole continent. New megacities are expected along the Gulf of Aden with associated increases in traffic, energy and domestic emissions (Zhu et al., 2013).

Ethiopia's GHG profile is dominated by emissions from the agriculture sector, followed by land-use change and forestry (LUCF), and energy sector emissions. The agricultural activities that contribute the most to the sector's emissions are enteric fermentation (52%), manure left on pasture (37%), and burning of the savanna (4%).On other hand, Public electricity and heat production is the most important source of CO_2 emissions (around one-third of all CO_2 emissions) and is the largest and second largest source respectively of SO_2 and NO_2 emissions (the largest for the latter being transport) (FAOSTA, 2015). It can also increase environmental pressures the output of electricity and agricultural activities that contribute the most to the sector's emissions, still not accounting for a reduced demand.

The relationship between carbon dioxide emissions (CO_2), NO_2, SO_2 and economic growth (GDP) has been noticed growing attention in the recent energy economics literature ever afterward the crude oil prices had increased to double or ever more during the two energy crisis in the 1970s. However, many researchers have examined that relationship by using different approaches but the results were conflicting. Such controversy may due to the efficiency of applied statistical approaches or using different dataset. Hence, the current study ex-enhancing to evaluate the Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia.

1.2. Statements of the Problem

In Ethiopia, the agricultural sector absorbs 85 percent of the total employment and contributes 46.3 percent of gross domestic product. It is followed by the service sector which account for 10 percent of total employment and contributes 43 percent of gross domestic product, and the industry account 5 percent of employment and 10.7 of gross domestic product and in terms of population the country was the second populous country in Africa (World Bank, 2013). According to Ministry of Mines and Energy of Ethiopia on average per capita electricity consumption is 28KWH. Beside this, it shows the existence of great exploitable potential in natural Gas, coal, wind, solar, geothermal (MW) 5000-7000, hydro (MW) 45000 (MoFED. 2010). Ethiopian urban air pollutions are increasing through time to time and the pollutions has significance implications of human and environmental health in the country.

This implication comes from industries, transportations and country energy source including; NO_2 and SO_2 which is releasing from hydropower plantations combined GHG emissions to Climate Resilient Green Economy (CRGE) strategy contradict to economic growth from natural resource consumption and GHG emissions sets a goal to achieve carbon-neutral growth and middle-income status before 2025 (USAID,2018).

This shows that (Abera et, al., 2009; Endeg et, al., (2016), studies remarked that it suspects there is higher air pollutant emission from the total primary agricultural, forestry and energy supplies more than doubled from 1990 to 2012, with biofuels and waste accounting for 93% in 2012, followed by fossil fuels with 6%, and 1% from renewables.

Further, Mekonnen and Tigist (2018) also improved the electric grid system consists almost entirely of renewable energy, nearly all from hydropower, with wind and geothermal. But, there is very limited study has been conducted on Gauss emissions in Ethiopia which is not relatively evaluate the dynamic relationship of CO_2, NO_2, SO_2 emissions and Ethiopia economy growth look like instead.

With the same contrarily idea Ethiopia agreed and signed an agreement to reduce emission of these gaseous pollutants. Kyoto protocol, Montreal protocol, Stockholm convention, Copenhagen Summit, South Africa Summit and Paris Agreement are some of the multilateral agreements that Ethiopia has taken the lead and signed at the forefront (Demis, 2012). Accordingly, Ethiopian environmental policy has been crafted to address the environmental issues including minimizing Emissions. The purpose of this study is to compile outdoor reports from 1990-2017 and emissions models to evaluate the Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia so as to generate policy information for decision makers to take strategic action.

1.3. Research Objective

1.3.1. General objective

The overall objective of the study is evaluating the Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia.

1.3.2. Specific Objective

1. To assess the annual trends of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions in Ethiopia.
2. To depict the dynamical relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia.
3. To examine the marginal abatement of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions towards the Growth of Ethiopian Economy?

1.4. Research Questions

The researcher forward the following research questions below:

1. What are the annual trends of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions in Ethiopia?
2. What is the dynamical relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia?
3. What is the magnitude of change in carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions on Ethiopian Economy Growth?

1.5. Significance of the study

This study produces:

1. If it detailed notifying the current study of long-term (27 years' data) in Ethiopian CO_2, NO_2 and SO_2 outlooks of country elastics of demand, supply and price projections by country GDP;

2. Studying an emission towards its marginal abatement to GDP and emission trend if it has implications towards trading systems analyses is important to show up the different Environmental configurations and trading rules is important by knowing the country emissions level;

3. If it is knowing the effect of Emission on GDP, it have advanced technology improvement scenarios and analyses of the impact of technological progress in the context of CO_2, NO_2 and SO_2 abatement policies.

1.6. Scope and Limitation of the study

The study delimited to annual portrayed data of CO_2, NO_2 and SO_2 and country real GDP from 1990 to 2017 which is based on the availability of country data. The study is evaluating the Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia which is not included SO_X, CO and NO_X due to in availability of national data.

1.7. Organization of the Paper

This thesis was divided in to five chapters. Chapter one constitutes background, statement of the problem, objectives, general objectives, specific objective, research Question, significance of the study and scope and limitations of the study. The second chapter presents literature review that provides theoretical and empirical framework to the research. The third chapter of this study was deals research methodology including the descriptions of the study, types and sources of data, sampling design, data collection and methods of data analysis. The fourth chapter is the main body of the research that comprises data analysis, interpretation and findings. Finally, the fifth chapter presents Conclusions and Recommendation based on the results of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Theoretical concept of Emissions and Economic Growth

Theoretical concept of Emissions (including noise, heat, and radiation) discharged into the atmosphere by residential, commercial, and industrial facilities Pollution discharged which is Measure of the average amount of a specific pollutant or material discharged into the atmosphere by a specific process, fuel, equipment, or source. It is expressed as number of pounds (or kilograms) of particulate per ton (or metric ton) of the material or fuel (USAID, 2018).

Regarding to economic growth which is increase in a country's productive capacity, as measured by comparing gross national product (GNP) in a year with the GNP in the previous year. Increase in the capital stock, advances in technology, and improvement in the quality and level of literacy are considered to be the principal causes of economic growth. In recent years, the idea of sustainable development has brought in additional factors such as environmentally sound processes that must be taken into account in growing an economy (Ozokcu &Ozdemir, 2017).

Seemly, there are three literature research strands which are interesting in the relationship between economic growth (GDP), energy consumption (EC) and environmental degradation, Emissions. But, some of them added other factors in the model such as; energy prices, capital, employment, foreign direct investment, industrial value added, agricultural value added and so on. The first strand is focusing on the relationship between GDP and environmental degradation which could be tested by environmental Kuznets curve (EKC) hypothesis. While the second strand is concentrating on causality relationship between Emissions and GDP. Finally, the third strand is exploring the relationship between GDP and emissions. The first strand of research is focusing on testing the EKC hypothesis. EKC is derived from original Kuznets Curve (KC) which is proposed by Simon Kuznets in 1955 (Benjaminson & Shenkute, 2012).

EKC illustrates that in early stages of GDP the environmental quality is improving until a certain level (peak/turning point), then that case is reversed beyond the turning point of emissions, as it declines when GDP increase. This strand of literature is started by Grossman and Krueger (1991) who have applied EKC in path-breaking study of the potential influence of North

American Free Trade Agreement (NAFTA) in the USA. The model includes SO_2, NO_2 dark matter, and suspended particulate matter (SPM).

Moreover, the second strand of literature is concentrating on causality relationship between EC and GDP. The findings are restricted within four hypotheses; Feedback hypothesis which illustrates bidirectional causality between EC and GDP, that means there is a significant effect of EC into GDP and vice versa. Growth hypothesis which describes unidirectional causality running from EC to GDP, it suggests that EC may have an important role into GDP. Conservation hypothesis which supports the existence of unidirectional causality running from GDP to Emissions, as GDP may have influence into Emissions. Neutrality hypothesis which emphasizes that there is no significant effect between Emission and GDP (Zhang et al., 2015). An early study of this strand is conducted by Kraft and Kraft (1978) in the USA. The findings support the existence of unidirectional causality running from GDP to Emissions.

Improvements in economic growth and welfare can affect the types of technological and financial opportunities used to avoid and manage environmental problems. In this situation, it is interesting to know whether economic growth and environmental preservation can coincide or not. In general, environmental goods and their quality are normally good; denoting that increased earnings from free trade would increase an individual's demand for higher environmental quality. In the early stage of economic development, a small portion of excess income is typically allocated for environmental problems, and thus, at this stage, the industrialization process is likely to be accompanied by environmental problems. When GDP per capita increases and exceeds a certain threshold, the level of pollution typically decreases. This combined effect can result in an inverted U-shaped relationship between GDP per capita and the level of pollution (Zaidi et al., 2016).

This inverted U-shaped relationship between GDP per capita and various indicators of pollution is referred to as the environmental Kuznets curve (EKC), which was introduced by Kuznets (1955). This hypothesis, which suggests a U-shaped or inverted U-shaped relationship between two variables, implies a non-linear relationship that is applicable to many areas. A number of studies have examined the environmental consequences of trade liberalization and economic growth in recent decades (Zaidi et al. (2016).

Furthermore, the climate change phenomenon, which has been an important research topic in recent years, has been considered to be one of the most important consequences of the global energy system and use.CO_2, NO_2 and SO_2 accounts for the largest portion of greenhouse gas emissions and is a major source of environmental problems. Thus, it is meaningful to examine the causal relationships between environmental pollution, trade liberalization, and economic growth (Eunho & Heshmati, 2010).

By applying EKC theory, previous studies have provided a better understanding of the environmental consequences of international trade and suggested that economic growth can improve the environment and that economic growth is necessary for maintaining or improving the quality of the environment. However, most of the previous studies have not taken into account the different levels of income across countries. In this regard this study is an attempt to remedy this limitation by focusing on comparing the relationships between CO_2, NO_2 and SO_2, trade liberalization and economic growth by accounting for level of development (Zaidi, etal., 2016).

2.2. Emission factors

Emission factors are from primary Agricultural, forestry and energy supplies and the different combinations of fuel/sector and usage/technology categories. The values of the EFs for BC and OC from motor gasoline and diesel oil were taken from developing country data of Junker and Liousse (2008). Note that traffic sector values reflect the fact that the total number of African vehicles includes a high proportion of old cars. Data on hard coal in the domestic sector, brown coal, fuel wood, vegetal waste and charcoal burning are also taken from Junker and Liousse (2008). EFs from hard coal in the industrial sector were set to 0.15 g kg^{-1}, 0.30 g kg^{-1} and 1.1 g kg^{-1}, respectively, for developed, semi-developed and developing countries, according to recent literature. EFs for two-wheeled vehicles are taken from Assamoi and Liousse (2010), based on both the literature and new measurements performed during the AMMA campaign in Congou (Guinot et al 2014).

Emissions from charcoal making and animal waste are taken from previous publications by Akagi et al (2011) remarked on the BC and OC EFs from coal in the power plant sector in developed countries are taken directly from diesel, motor gasoline, biofuel and brown coal were estimated from our EF values in the industrial sector and the ratios of power plant to industrial sectors (e.g. a ratio of 10 for liquid fuels, 7 for biofuel, 2.3for brown coal). The same method was applied for developing countries; CO_2, NO_2, SO_2 and NMHC. EF for CO, NO_2, SO_2 and NMHC species for developed countries were obtained from several publications.

Animal waste EFs have been assumed to be similar to the EF from charcoal making for the domestic sector. This assumption has been confirmed by Akagi et al (2011). CO, NOx and NMHC EFs for semi-developed and developing countries have been estimated from the values used for developed countries by applying the same methodology as for BC particles. SO_2 EFs were generally kept constant between developed, semi-developed and developing countries, except for motor gasoline and diesel.

In other hand, Public electricity and heat production is the most important source of CO_2 emissions (around one-third of all CO_2 emissions) and is the largest and second largest source respectively of SO_2 and NO_2 emissions (the largest for the latter being transport). There are generally four ways of reducing the environmental pressures from producing a given output of electricity and heat, i.e. not accounting for a reduced demand: Increasing the share of non-fossil fuels, as power production from renewable energy sources and nuclear produce no harmful emissions at the point of electricity production (with the exception of thermal renewables that involve combustion, such as certain types of biomass and wastes; and nuclear waste).

Increasing the efficiency with which electricity and heat is produced from fossil fuels. Advances in engineering technology and operational procedure have all resulted in improved efficiencies (EUEA, 2018). The use of combined heat and power increases efficiencies dramatically as much of the heat produced is used to provide useful energy services at other points of the system 3. Changing the mix of fossil fuels used for electricity and heat production. Coal, lignite and oil all naturally contain significant amounts of carbon, Sulphur, nitrogen, which react with oxygen during combustion to form the oxides that cause damage to the environment. Natural gas contains significantly less of these chemicals, thus a switch from coal or lignite to natural gas leads to an environmental improvement.

Introducing emissions abatement techniques in Flue gas desulphurization (FGD) can be fitted to reduce SO_2 emissions from the flue gases. There are a wide variety of FGD techniques, of which the most common are wet scrubbers. Wet scrubbers work by using a slurry or solution to absorb SO_2, producing an initially wet by-product. Frequently, limestone is used as the sorbent, generating gypsum as a by-product. Other techniques include spray dry scrubbing and regenerative processes which is FGD can achieve SO_2 removal of more than 90 % (Lamarque et al 2010).

2.3. Emissions of Carbon dioxide (CO_2)

Global carbon (C) emissions from fossil fuel use were 9.795 giga tone's (Gt) in 2014 (or 35.9 Gt CO_2 of carbon dioxide). Fossil fuel emissions were 0.6% above emissions in 2013 and 60% above emissions in 1990 (the reference year in the Kyoto Protocol). Based on a 2015 GDP forecast of 3.1% by the International Monetary Fund, the Global Carbon Project projects a 2015 decline of 0.6% in global emissions.

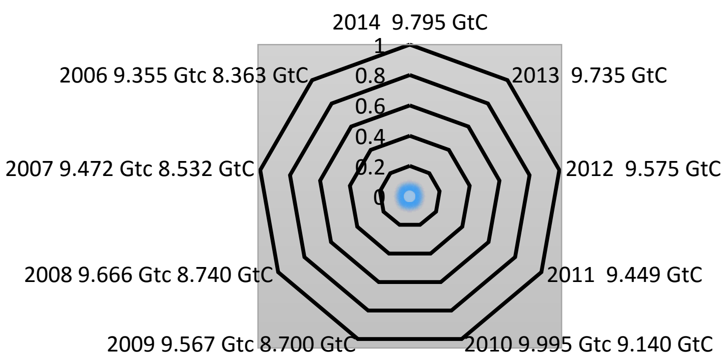

Figure 2.1. Annual Global Carbon Emissions

Source Data: - Global Carbon Project (Le Quéré et al. (2015).

**Convert carbon to carbon dioxide (CO2) by multiplying the numbers above by 3.67.*

1 giga tonne of carbon (GtC) = 1 billion tonnes of carbon

Fossil fuel emissions (including cement production) accounted for about 91% of total CO_2 emissions from human sources in 2014. This portion of emissions originates from coal (42%), oil (33%), gas (19%), cement (6%) and gas flaring (1%). Changes in land use are responsible for about 9% of all global CO_2 emissions. In 2013, the largest national contributions to the net growth in total global emissions in 2013 were China (58% of the growth), USA (20% of the growth), India (17% of the growth), and EU28 (a decrease by 11% of the growth). From 1870 to 2014, cumulative carbon emissions totaled about 545 GtC. Emissions were partitioned among the atmosphere (approx. 230 GtC or 42%), ocean (approx. 155 GtC or 28%) and the land (approx. 160 GtC or 29%). Countries that signed the UN Framework Convention on Climate Change adopted a target to stop the average global temperature from rising before it reaches 2°C above pre-industrial levels (Le Quéré et al. 2015).

The Fifth Assessment Report of the International Panel on Climate Change (IPCC, 2018) quantifies the global maximum CO_2 the world can still emit and also have a likely chance of keeping global average temperature rise below 2°C above pre-industrial temperatures. It reports that the goal is likely to be met if cumulative emissions (including the 535 GtC emitted by the end of 2013) do not exceed 1 trillion tonnes of carbon (PgC). A giga tonne of carbon (1 GtC) is the same as a petagram of carbon (1 PgC).If the accept the 2°C target, the world need to emit no more than 465 GtC by the time carbon emissions end. Many developing countries also support a reduction in the target to keep global average temperature increases below 1.5°C above pre-industrial levels.

Carbon dioxide (CO_2) is known as a greenhouse gas (GHG)—a gas that absorbs and emits thermal radiation, creating the 'greenhouse effect'. Along with other greenhouse gases, such as nitrous oxide and methane, CO_2 is important in sustaining a habitable temperature for the planet: if there were absolutely no GHGs, our planet would simply be too cold. It has been estimated that without these gases, the average surface temperature of the Earth would be about -18 degrees Celsius.

Since the Industrial Revolution, however, energy-driven consumption of fossil fuels has led to a rapid increase in CO_2 emissions, disrupting the global carbon cycle and leading to a planetary warming impact. Global warming and a changing climate have a range of potential ecological, physical and health impacts, including extreme weather events (such as floods, droughts, storms, and heat waves); sea-level rise; altered crop growth; and disrupted water systems. The most extensive source of analysis on the potential impacts of climatic change can be found in the 5th Intergovernmental Panel on Climate Change (IPCC) report; this presents full coverage of all impacts in its chapter on Impacts, Adaptation, and Vulnerability. In light of this evidence, UN member parties have set a target of limiting average warming to 2 degrees Celsius above pre-industrial temperatures. This entry provides a historical to present day perspective of how CO_2

emissions have evolved, how emissions are distributed, and the key factors that both drive these trends and hold the key to mitigating climate change (UN, 2010).

To set the scene, let's briefly look at how the planet has warmed particularly since the Industrial Revolution. In the chart below the x-axis shows the time spanning 1850 to 2017. On the y-axis, we see the global average temperature rise above or below the 1961-1990 baseline temperature. This means that we use the average temperature over the 1961-1990 periods as a baseline against which yearly changes in temperature are measured. The red line represents the average annual temperature trend through time, with upper and lower confidence intervals (the possible upper and lower range) shown in light grey.

We see that over the last few decades, temperatures have risen sharply at the global level-to approximately 0.8 degrees Celsius higher than our 1961-1990 baselines. When extended back to 1850, we see that temperatures then were a further 0.4 degrees colder than they were in our 1961-1990 baseline. Overall, if we look at the total temperature increase since pre-industrial times, this therefore amounts to approximately 1.2 degrees Celsius. We have now surpassed the one-degree mark, an important marker as it brings us more than halfway to the global limit of keeping warming below two degrees Celsius (Daworten et, al.,2016).

The interactive chart below you can also view these trends by hemisphere (North and South), as well as the tropics (defined as 30 degrees above and below the equator). Here we see that the median temperature increase in the North Hemisphere is higher, at closer to 1.4 degrees Celsius since 1850, and less in the Southern Hemisphere (closer to 0.8 degrees Celsius). Evidence suggests that this distribution is strongly related to ocean circulation patterns (notably the North Atlantic Oscillation) which has resulted in greater warming in the northern hemisphere Hannah and Max, 2017.

2.4. Nitrous dioxide (NO_2) emissions

NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment. Nitrogen Dioxide (NO_2) is one of a group of gases called nitrogen oxides (NO_x). While all of these gases are harmful to human health and the environment, NO_2 is of greater concern. Many chemical species of nitrogen oxides (NO_x) exist, but the air pollutant species of most interest from the point of view of human health is nitrogen dioxide (NO_2). Nitrogen dioxide is soluble in water, reddish-brown in color, and a strong oxidant (WAGNER, 1970).

Nitrogen dioxide is an important atmospheric trace gas, not only because of its health effects but also because (a) it absorbs visible solar radiation and contributes to impaired atmospheric visibility; (b) as an absorber of visible radiation it could have a potential direct role in global climate change if its concentrations were to become high enough; (c) it is, along with nitric oxide (NO), a chief regulator of the oxidizing capacity of the free troposphere by controlling the build-up and fate of radical species, including hydroxyl radicals; and (d) it plays a critical role in determining ozone (O_3) concentrations in the troposphere because the photolysis of nitrogen dioxide is the only key initiator of the photochemical formation of ozone, whether in polluted or unpolluted atmospheres (WAGNER, 1970).

Sources on a global scale, emissions of nitrogen oxides from natural sources far outweigh those generated by human activities. Natural sources include intrusion of stratospheric nitrogen oxides, bacterial and volcanic action, and lightning. Because natural emissions are distributed over the entire surface of the earth, however, the resulting background atmospheric concentrations are very small. The major source of anthropogenic emissions of nitrogen oxides into the atmosphere is the combustion of fossil fuels in stationary sources (heating, power generation) and in motor vehicles (internal combustion engines).

In most ambient situations, nitric oxide is emitted and transformed into nitrogen dioxide in the atmosphere. Oxidation of nitric oxide by atmospheric oxidants such as ozone occurs rapidly, even at the low levels of reactants present in the atmosphere. Altshuller calculated that 50% conversion of nitric oxide would take less than 1 minute at a nitric oxide concentration of 120 $\mu g/m^3$ (0.1 ppm) in the presence of an ozone concentration of 200 $\mu g/m^3$ (0.1 ppm). Consequently, this reaction is regarded as the most important route for nitrogen dioxide production in the atmosphere (HAYDON, 1967).

Other contributions of nitrogen dioxide to the atmosphere come from specific no combustion industrial processes, such as the manufacture of nitric acid, the use of explosives and welding. Indoor sources include tobacco smoking and the use of gas-fired appliances and oil stoves. Differences in the nitrogen oxide (nitric oxide and nitrogen dioxide) emissions of various countries are due mainly to differences in the consumption of fossil fuels. Worldwide emissions of nitrogen oxides in the early 1980s were estimated at approximately 150 × 1012 g/year.

Occurrence in air Maximum 30-minute or 1-hour average and maximum 24-hour average outdoor nitrogen dioxide concentrations of up to 940 $\mu g/m^3$ (0.5 ppm) and 400 $\mu g/m^3$ (0.21 ppm), respectively, have been reported. Annual mean concentrations in urban areas throughout the world are generally in the range 20–90 $\mu g/m^3$ (0.01–0.05 ppm) (1, 4–6). Urban outdoor levels vary according to the time of day, the season of the year and meteorological factors. Typical daily patterns comprise a low background level on which are superimposed one or two peaks of higher levels that correspond to rush-hour traffic emissions of nitrogen oxides. Hourly average nitrogen dioxide concentrations near very busy roads often exceed 940 $\mu g/m^3$ (0.5 ppm).

Maximum hourly concentrations in the United Kingdom are generally of the order of 470–750 $\mu g/m^3$ (0.25–0.4 ppm). From 1988 to 1990, highest 1-hour averages in the United States ranged from 75 to 1015 $\mu g/m^3$ (0.04–0.54 ppm). Thus, the maximal hourly mean value may be several times the annual. Long-term monitoring activities during the 1960s and 1970s indicated an increase in concentrations of nitrogen oxides in many urban areas throughout the world (Delworth, et, al., 2016).

Recent reports from the United States, however, show a decrease in nationwide nitrogen dioxide concentrations, resulting from a decrease in nitrogen oxides emissions, from 1981 to 1990. Whether nitrogen dioxide concentrations are increasing in urban areas in other parts of the world is unknown, although it is known that, at least in the United States, concentrations are highly correlated with population level and population levels worldwide continue to grow. Nevertheless, indoor sources, such as cooking with gas or cigarette smoking, may be the main contributors to individual exposure (WHO, 2018).

Owing to the widespread use of unvented combustion appliances, nitrogen dioxide concentrations in homes may exceed considerably those found outdoors. The average concentration over a period of several days may exceed 200 $\mu g/m^3$ (0.1 ppm) when unvented gas stoves are used for supplementary heating or clothes drying, or when kerosene heaters are used; typically, means are lower (1, 12–14). Maximum brief (minutes to 1-hour) concentrations in kitchens are in the range 230–2055 $\mu g/m^3$ (0.12–1.09 ppm) during cooking. The highest 15-

minute concentration recorded for a home with an unvented gas space heater was 2716 µg/m^3 (1.44 ppm) (smith, 2004).

Generally, concentrations in excess of 1880 µg/m^3 (1 ppm) are necessary during acute controlled exposures to induce changes in pulmonary function in healthy adults (WHO, 2018). Because these concentrations almost never occur in ambient air, concern about the effects of nitrogen dioxide has been focused on people with pre-existing lung disease.

There have been numerous studies of people with asthma, chronic obstructive pulmonary disease, or chronic bronchitis showing that exposure to low levels of nitrogen dioxide can cause small decrements in forced vital capacity and forced expiratory volume in 1 second (WHO, 2018) or increases in airway resistance. Pulmonary function responses have been shown in three studies of asthmatics exposed to 560 µg/m^3 (0.30 ppm) while performing mild to moderate exercise. These results are not always consistent with other studies of asthmatics exposed to the same or higher nitrogen dioxide concentrations. Cut emissions from coal, NO_2 pollution is still a chronic problem. It's also an important factor in why the country is still plagued by serious particle pollution; NO_x forms small particles in the atmosphere contributing to the formation of ozone and particulates.

Meanwhile in Europe, the lignite-fired power plants in Germany's industrial region near Cologne stand out, alongside clusters of coal plants in Poland. The data also sheds a light on the under-reported pollution hotspots in the Middle East and North Africa, a region home to very high oil consumption and poor emission standards. Desert dust is a well-known source of particle pollution in the region, but the satellite data reveals that oil-fired power plants, refineries and transport are key sources too. The map also points to the impact of emissions regulations in some places. While there are plenty of coal plants in the US, NO_2 concentrations near plants in India, South Africa, Australia and Indonesia stand out much more. In these countries, there has been a failure to enforce meaningful pollution standards, or to implement them. It's not hard to spot the megacities on the map, where transport is the main source of emissions (Delworth, etal.., 2016).

From Santiago to Seoul, via London and Paris, the map reveals the toll that cars and trucks exact on air quality. One way to measure the impact of transport on air quality is to compare pollution levels during weekdays and weekends, when there is usually less traffic. In the bigger cities, this comparison shows dramatic drop-offs in pollution, such as in Seoul, South Korea.

2.5. Sulfur dioxide (SO_2) Emissions

Historical reconstructions of sulfur dioxide emissions are necessary to access the past influence of sulfur dioxide on the earth system and as base-year information for future projections. This paper presents a new estimate of global and country-level sulfur dioxide anthropogenic emissions over the 1850–2005 period. This work represents a substantial update of previous with newer data and improved methodologies, and was the basis for the sulfur emissions in Lamarque et al. (2010).

The emissions reconstruction presented here accounts for regional differences in the pace and extent of emission control programs, has annual resolution, includes all anthropogenic sources, and provides global coverage. Fuel-based and activity-based (Eyring et al., 2010) estimates of shipping emissions were reconciled for recent decades and then extrapolated to 1850. A global mass balance for sulfur in crude oil was calculated as an independent estimate of petroleum emissions.

Finally, a regional and global uncertainty analysis was conducted. Anthropogenic emissions have resulted in greatly increased sulfur deposition and atmospheric sulfate loadings near most industrialized areas. Sulfuric acid deposition can be detrimental to ecosystems, harming aquatic animals and plants, and damaging to a wide range of terrestrial plant life. Sulfur dioxide forms sulfate aerosols that have a significant effect on global and regional climate. Sulfate aerosols reflect sunlight into space and also act as condensation nuclei, which tend to make clouds more reflective and change their lifetimes, causing a net cooling work (Smith et al., 2004).

It changes Brought by sulfate aerosols may be second only to that caused by carbon dioxide, albeit in the opposite direction. Sulfur is ubiquitous in the biosphere and often occurs in relatively high concentrations in fossil fuels, with coal and crude oil deposits commonly containing 1–2% sulfur by weight. The widespread combustion of fossil fuels has, therefore, greatly increased sulfur emissions into the atmosphere, with the anthropogenic component now substantially greater than natural emissions on a global basis (Smith et al., 2001).

Sulfur dioxide SO_2 impact human health, ecosystems, agriculture, and global and regional climate. A new annual estimate of anthropogenic global and regional sulfur dioxide emissions has been constructed spanning the period 1850– 2005 using a bottom-up mass balance method, calibrated to country-level inventory data. Global emissions peaked in the early 1970s and decreased until 2000, with an increase in recent years due to increased emissions in China, international shipping, and developing countries in general. An uncertainty analysis was conducted including both random and systemic uncertainties. The overall global uncertainty in sulfur dioxide emissions is relatively small, but regional uncertainties ranged up to 30%. The largest contributors to uncertainty at present are emissions from China and international shipping. Emissions were distributed on a 0.5◦ grid by sector for use in coordinated climate model experiments (Forster et al., 2007).

2.6. Global Gas Emissions and Economic Growth

The long term trend of economic output shows continuous increment over time. This leads rising level of employment, income, and promote both private and public investment in vast sectors. Natural capital includes raw materials extract from the earth, carbon, sulfur and nitrogen sequestration services provided by soil and forest. Its unique elements are some have finite limits, irreversible change, its impact extends across many generations, due to critical threshold sudden and dramatic change may occurs. So, it needs to be used sustainably and efficiently in order to secure growth in the long run. In some way energy consumption and carbon dioxide emission were increased in the world so roughly the last 200 years. This rise in energy consumption is primarily from increased fossil fuel consumption demand (Green Energy act, 2009).

Literature comparing national ambient air quality standards (AAQSs) globally is scattered and sparse. Twenty-four hour AAQSs for particulate matter <10 μm in aerodynamic diameter (PM10) and sulfur dioxide (SO_2) in 96 countries were identified through literature review, an international survey, and querying an international legal database. Eighty-three percent, of the 96 countries with information on the presence or absence of AAQSs, have 24h AAQSs for either PM10 or SO_2. Slightly more countries have 24-h AAQSs for SO_2 (76 countries) than PM10 (69 countries). The average 24-h AAQSs for PM10 and SO2 are 95 $\mu g/m^3$ (95% confidence interval (CI]), 82–108 $\mu g/m^3$, n= 68) and 182 $\mu g/m^3$ (95% CI, 158–205 $\mu g/m^3$, n=73). The population-weighted average AAQS for PM10 is 98 and 155 $\mu g/m^3$ for SO2. The average AAQS for both PM10 and SO_2 are substantially higher than the recommended World Health Organization Air

Quality Guideline (WHO AQG) value. Several countries have promulgated AAQSs at the WHO AQG value for PM10, but none for SO_2 (Candace & Kirk, 2010).

CO_2 was cumulatively emitted due to human activities including deforestation. Scientific literature suggests that limiting average global temperature rise to 2 °C above pre-industrial levels – the target internationally adopted in UN climate negotiations – is possible if cumulative emissions in the 2000–2050 period do not exceed 1,000 to 1,500 billion tones CO_2. NO_2 also has a detrimental effect on biodiversity, inhibiting plant growth. In the UK, it's been estimated that (pdf) 63% of the most sensitive wildlife habitats have been affected by excessive nitrogen deposits. If the current global increase in CO_2 emissions continues, cumulative emissions will surpass this total within the next two decades (Jos et al., 2012)

2.7. Gas Emissions and Economic growth in Ethiopia

According to accomplish transition from a subsistence economy to an agro-industrial economy during 1930–1990 Ethiopia needed an infrastructure to exploit resources, a material base to improve living conditions, and better health, education, communications and other services. Though, fail to achieve as planed target due to the administrative and technical capabilities to implement a national development plan, staffing problems because they neglected to identify the resources and to establish the organizational structures necessary to facilitate large scale economic development (Alemayehu, 2005).

According to Ethiopian economic update II Over the past decade, Ethiopia has achieved high economic growth, averaging 10.7 percent per year. The economy continued to expand at a rapid pace of 8.5 percent in 2011/12 and rank the country 12th fastest growing

While, in Africa including Ethiopia the economy still dominated by agriculture and energy consumption pattern dominated by primary energy source (EIA, 2012). According to Netherlands environmental assessment agency: - since, 2000, an estimated total of 420 billion tones.

Abera et, al., (2009) studied on Sources of variation for indoor nitrogen dioxide in rural residences of Ethiopia, from total of 17,215 air samples were fully analyzed during the study period. Wood and crop were principal source of household energy. Biomass fuel characteristics were strongly related to indoor NO_2 concentration in one-way analysis of variance. There was variation in repeated measurements of indoor NO_2 over time. In a linear mixed model regression analysis, highland setting, wet season, cooking, use of fire events at least twice a day, frequency of cooked food items, and interaction between ecology and season were predictors of indoor NO_2 concentration. The volume of the housing unit and the presence of kitchen showed little relevance in the level of NO_2 concentration. Agro-ecology, season, purpose of fire events, frequency of fire activities, frequency of cooking and physical conditions of housing are predictors of NO_2 concentration. Improved kitchen conditions and ventilation are highly recommended.

Standardized Ethiopian calculating SO_2 emissions from fuel combustion have been available for many years. The amount of SO_2 emitted is directly related to the Sulphur content of the fossil fuels consumed in the country, and the desulphurization techniques used, if any. Data on emissions from fuel combustion are considered 13.6% (Abera et, al., 2009).

The Ethiopia flux of sulfur dioxide (SO_2) emitted by passive volcanic degassing is a key parameter that constrains the fluxes of other volcanic gases (including carbon dioxide, CO_2) and toxic trace metals (e.g., Afar Soda AShi poison gas). It is also a required input for atmospheric chemistry and climate models, since it impacts the troposphere burden of sulfate aerosol, a major climate-forcing species. Despite its significance, an inventory of passive volcanic degassing is very difficult to produce, due largely to the patchy spatial and temporal coverage of ground-based SO_2 measurements. We report here the first volcanic SO_2 emissions inventory derived from global, coincident satellite measurements, made by the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite in 2005–2015. The OMI measurements permit estimation of SO_2 emissions from over one exploded creator and two Active volcanoes, including *Berehale, Ertale and Manusaa* Afar regional state of Ethiopia. On average over the past decade, the volcanic SO_2 sources consistently detected from space have discharged a total of ~63 kt/day SO_2 during passive degassing, or $\sim 23 \pm 2$ Tg/yr. We find that ~30% of the sources show significant decadal trends in SO_2 emissions, with positive trends observed at multiple volcanoes in Ethiopian Afar region.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design

Quantitative research approach was used since it helps to conduct systematic empirical study of observable phenomena via statistical or mathematical techniques (Kothari, 2004). The objective of quantitative research is to develop and employ mathematical models, theories and hypotheses pertaining to phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. Quantitative research is generally made using scientific methods, which can include: The generation of theories, the development of instruments and methods for measurement variables, Collection of empirical data and analysis of data.

In this study, this approach enabled to evaluating the Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions and economic growth of Ethiopia taking to evaluate evidence from years 1990 to 2017. Thus, this enabled to test the theory in the context of Ethiopia.

3.2. Sample and Sampling Technique

The researcher needs to have a large sample size in order to get more accurate results and have a high likelihood of detecting a true result. Thus the research used Purposive sampling method.

3.3. Data Source Instrument

To comply with the research objectives, the researcher focused on secondary data, which was be obtained from publications of World Bank and statistical data base of International Monetary Fund (IMF).From 1990-2017 fiscal year.

And this is because the advantage of using secondary data includes the higher quality data compared with primary data collected by researchers themselves; the feasibility to conduct panel evidence, which is the case in this study; and the permanence of data, which means secondary data generally provide a source of data that is both permanent and available in a form that may be checked relatively easily by others.

3.4. Method of Data Analysis

Whatever a good quality of data one have, it could give no meaning unless appropriate method of analysis is used. Accordingly, with the secondary data both descriptive and econometrics method of analysis will be made to falsify the hypothesis which states that the coefficient of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) is zero. The theoretical considerations and the empirical the model specifications of this study was Cross-sectional time-series FGLS regression. The aim of test is to see whether the coincident δ equals zero, which would imply that process is non-stationary (Pantula, 1989)

3.4.1. Model specifications

In the long-rum steady state, Gas Emission desired capital stock (process root δt^*) is assumed to be proportional to expected output:

$(Yt\ e)\ (1)\ \delta\ t^* = a\ (\beta t\ e\beta)$

Because of difficultly in identifying theoretically correct specification and obtaining the necessary and reliable data in Ethiopia, this paper does not attempt to build and estimate using logit model of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) in Ethiopia. Due to this fact, rather it is more of exploratory data analysis.

Nevertheless, the findings of this analysis may give supportive idea for those who tries to build a full – scale fundamental relationship between carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) and economic growth of Ethiopia and macroeconomic variables in this county, which can then be used to develop appropriate caravel of emissions behavior.

Macroeconomic variables assumed influence the gap between actual investment to desired investment included in the empirical analysis are: - Δcarbon dioxide (CO_2), ΔNitrous dioxide (NO_2), ΔSulfur Dioxide (SO_2) and from economic growth of Ethiopia; real per capita GDP - growth rate, consumer price index government budget deficit and Dummy variable to capture structural change.

DGE/ GDP = f (P, $InCO_2$, $InNO_2$, $InSO_2$, In CPI, LnGBD (-1), D). Which is:

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right)$$

Where

Real GDP =Growth rate of real gross product is defined by PI/GDP = the ratio of private sector investment to GDP + the percentage change in consumer price index-lagged ratio of government budget deficit to GDP.

CPI = the percentage change in consumer price index.

BDI/ GDP (-1) = lagged ratio of government budget deficit to GDP.

D = Dummy variable to capture structural change (D= 0 for the period 1990 – 2017, and

D= 1 for the remaining period)

To avoid non-stationary and spurious results, analyzing the nature of each variable about their distribution (normal or skewed) and its trend (stationary or non-stationary) is the first task in econometric regression which is Cross-sectional time-series FGLS regression by taking time series to Single lag OLS.

To this affect, first, the ratio rather than the level is preferred for each variable. Believing that this does not avoid the spurious result particularly due to serial correlation of macroeconomic variables, for most of the variables that are expected to suffer from non-stationary, real ratios or growth rates will be used.

These variables are real per capita GDP growth rate, real foreign reserve and real exchange rates real credit availability. All the variables were tested for normal distribution. It was found that all variables were almost normally distributed results.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Summary of Descriptive Statistics

There has been a growing evidence of the link between dynamic Relations Ship of CO_2, NO_2, SO_2 Emission and economic growth in Ethiopia. But when it is viewed at the effect of CO_2, NO_2, SO_2 Emission on the economic growth of a country, there has been a debate on the relationship between them. In some countries there was evidence of the crowding out effect of privet investment on a country, while there has been the crowding in evidence taken 28 years' annual data from countries. But for sure, a complementary relationship CO_2, NO_2, SO_2 Emission and growth of Ethiopia could have preferred for better economic growth. This study found out the existence of the crowding out the effectiveness of privet investment on economic growth in the Ethiopia The study also evaluates the macroeconomic determinants of private investment in Ethiopia for the last four and half decades (1990-2017) in long run perspective by means of a regression analysis based on the co-integration of variable relevance.

4.2. Carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) Emissions from 1990-2017 in Ethiopia.

Table 1 : Descriptive summary of summarize InSO2, InCO2, InNO2 with LnGDP

Variable	Obs	Mean	Std. Dev.	Min	Max
InSO2	28	487.1607	312.2715	142.3	1419.2
InCO2	28	63712.35	16006.73	43594.2	90641.8
InNO2	28	15894.76	4194.268	10577.2	23273.9
LnGDP	28	6.634643	3.383714	2.24	12.31

*****Source from researcher Environmental data, 2019**

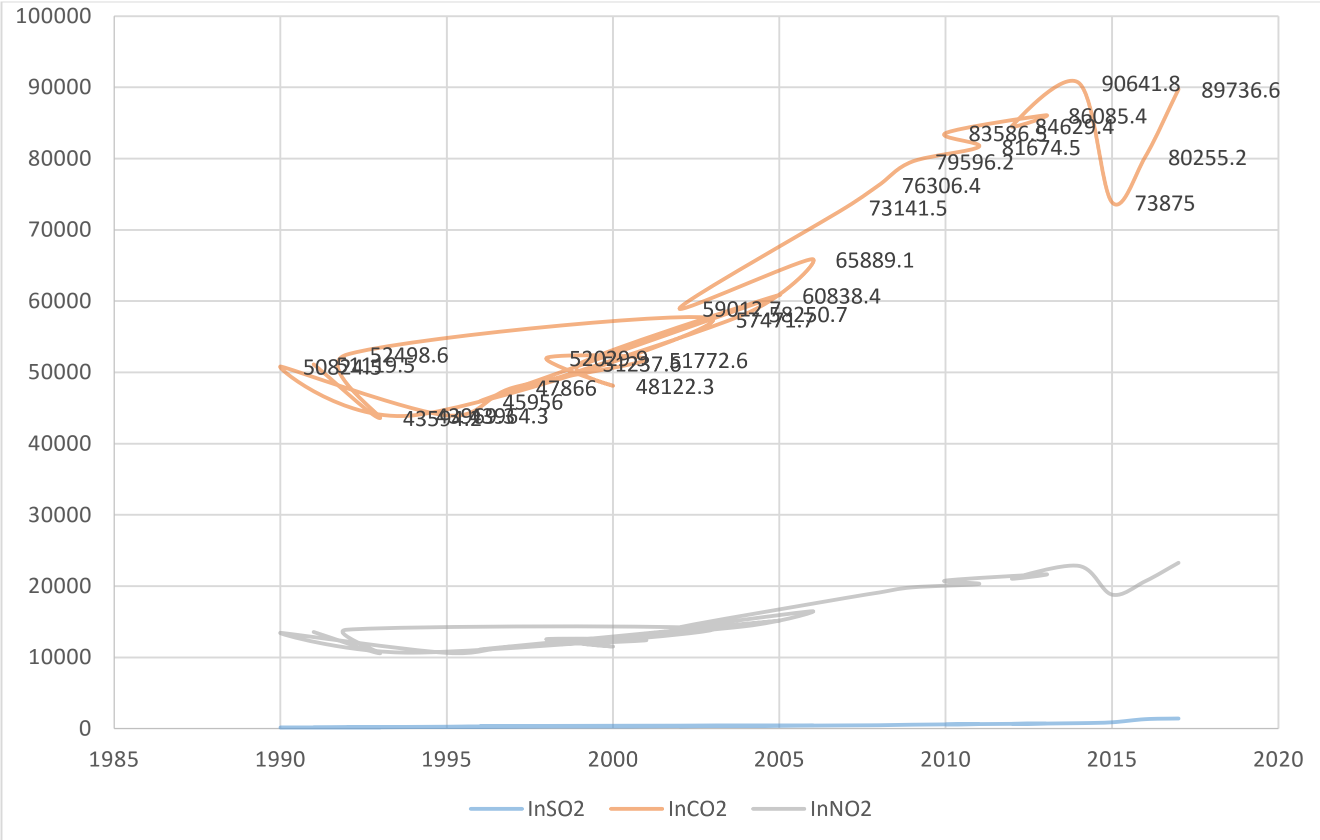

Figure 4.1. : Cumulative time Serious Of Carbon Dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide, (SO_2) Emissions from 1990-2017 in Ethiopia.

*****Source from researcher Environmental data, 2019**

From above Cumulative time series Figure 2.7.result, regarding to Trends of Carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) Emissions from 1990-2017 in Ethiopia. Ethiopia has become an economic powerhouse with an ever increasing trajectory of economic growth. It has also become the largest emitter of CO_2 emissions in the Ethiopia, and as more and more of the 100million population enter the labor market and increase consumption in average country real GDP is growth by 6.6 % which is CO_2 emissions will only increase. As previously explained, policy-makers can counteract this increase by creating a framework to encourage more efficient production methods, requiring less energy.

This could be an adoption of new technology or development of human capital and a continued shift into transportations forestry burning and knowledge based manufacturing increase CO_2 emissions directly by moving to cleaner, albeit more expensive energy sources such as solar power and cleaner coal, as it has been doing. There are many studies calculating regional level CO_2 emissions, in Ethiopia and worldwide. Many of these studies employ the IPCC (2006) guidelines and emission factors (EFs) as a default, however some studies expand upon this and calculate new EFs. One study that utilize different EFs is Shan et al., (2016) and USAID, 2018 who then calculate provincial level CO_2 emissions using energy consumption data and apparent emission factors. Research has shown that the fiscal federalist system employed by the Ethiopia government has led to economic slow growth, and this study has shown that further increasing the role of government in production would also decrease CO_2 emissions.

NO2 is the highest relief which is showing annual increase in average 15894.76 ± 4194.268 metric ton next to carbon dioxide which is portrayed in average mean difference of63712.35 ± 16006.73 metric tons per year. Abera et,al.,(2009) studied on Sources of variation for indoor nitrogen dioxide in rural residences of Ethiopia, from total of 17,215 air samples were fully analyzed during the study period. Wood and crop were principal source of household energy. Biomass fuel characteristics were strongly related to indoor NO_2 concentration in one-way analysis of variance. There was variation in repeated measurements of indoor NO_2 over time which is the analysis, highland setting, wet season, cooking, use of fire events at least twice a day, frequency of cooked food items, and interaction between ecology and season were predictors of indoor NO_2 concentration.

The volume of the housing unit and the presence of kitchen showed little relevance in the level of NO_2 concentration. Agro-ecology, season, purpose of fire events, frequency of fire activities, frequency of cooking and physical conditions of housing are predictors of NO_2 concentration. Improved kitchen conditions and ventilation are highly recommended.

In other hand SO_2 is indicated in average mean difference of 487.1607± 312.2715 metric ton which is register lower that CO_2 and NO_2 in average year difference from 1990 to 2017.Standardized Ethiopian calculating SO_2 emissions from fuel combustion have been available for many years. The amount of SO_2 emitted is directly related to the Sulphur content of the fossil fuels consumed in the country, and the desulphurization techniques used, if any. Data on emissions from fuel combustion are considered 13.6% (Abera et, al., 2009).

The Ethiopia flux of sulfur dioxide (SO_2) emitted by passive volcanic degassing is a key parameter that constrains the fluxes of other volcanic gases (including carbon dioxide, CO_2) and toxic trace metals (e.g., Afar Soda AShi poison gas). It is also a required input for atmospheric chemistry and climate models, since it impacts the tropospheric burden of sulfate aerosol, a major climate-forcing species. Despite its significance, an inventory of passive volcanic degassing is very difficult to produce, due largely to the patchy spatial and temporal coverage of ground-based SO_2 measurements.

4.2.1 Summary of Descriptive statistics

Table 2 : Summarize InSO2 InCO2 InNO2 InCPI, InGE, LnGDP, INF

Variable	Obs	Mean	Std. Dev.	Min	Max
InSO2	28	487.1607	312.2715	142.3	1419.2
InCO2	28	63712.35	16006.73	43594.2	90641.8
InNO2	28	15894.76	4194.268	10577.2	23273.9
InCPI	28	170.2	78.72359	75.8	490.3
InGE	28	1982.179	1946.804	416.4	8597.1
LnGDP	28	6.634643	3.383714	2.24	12.31
INF	28	9.25	5.571256	1.3	22.5

****Source from researcher Environmental data, 2019**

***** ***NB, GE: Government expenditure, GDP: gross domestic product, INF: inflations CPI; consumer price index***

From above table 2 descriptive data, average Consumer price index mean difference is indicated to 170.2 million birr per annual anal government expenditure is shows to average mean difference of 1982.179 million Et birr and inflations rate is increasing 5.5% per annual with 28 years in Ethiopia.

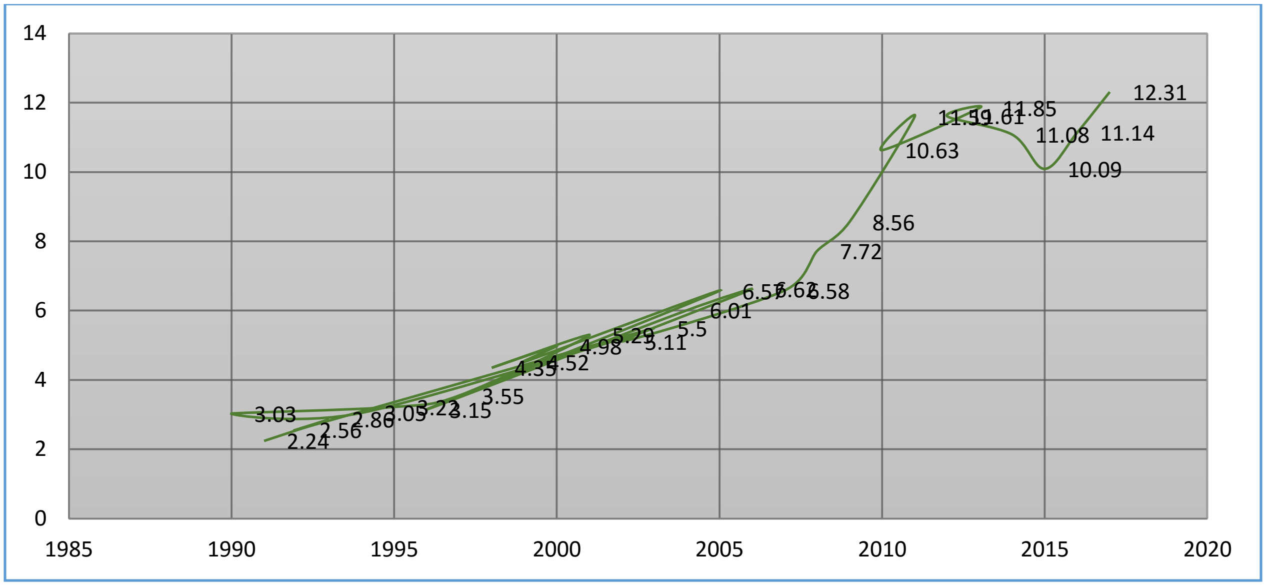

Figure 4.2. Annual Real GDP growth in Ethiopia

*****Source from researcher Environmental data, 2019**

From above Figure 2.8 : result portrayed from annual mean average increment Real GDP being 6.7% per year which is the lagged country (Real RGDP) Rate of Economic Growth in real Domestic Gross Product variable is shows less average growth rate.

This indicates that past levels of economic growth in Ethiopia from 1990-2017 inform current levels, implying that to Government expenditure and IFR is the most macroeconomic inflectional for country economic growth retardations by 2.5 to 14.5% in Ethiopia showing on the Figure 2.8 above which proportionally in continuous level or no GDP fluctuations shows.

The Data Online outlines the following details of how the GDP on the provincial level is constructed, and what Gas's emissions in the variables present in the data contain. Country Gas's emission disruptions to structure of GDP has been classified according to the historical sequence of development. Primary gases emission refers to extraction of natural resources after mutilations; secondary industry involves processing of primary products; and tertiary industry provides services of various kinds for production and consumption which is end outcome.

4.3. Estimation Result using Time series properties '1990-2017'

Test of stationery

Table 3 : Unit root test with trend and intercept term

	ADF	
Variables	**Levels**	**Differences**
InSO2 |	-3.243	-3.732*
$InCO_2$ |	-3.263	-3.815*
$InNO_2$ |	-3.332	-3.6345*
InCPI |	-3.584	-4.230*
InGE |	-2.346	-4.212*
LnGDP |	-2.520	-4.112*
INF |	-3.332	-3.443*
	(critical value at 5%= -3.600)	

implies the null hypothesis of non- stationery can be rejected at 5% level of significance.

*****Source from researcher Environmental data, 2019**

The unit root test implies that the null hypothesis of non-stationery cannot be rejected at ***5***% level of significance for all the variables at level. However, for the difference we can *safely* reject the null hypothesis of non-stationary at 5% level of significance.

The unit root test above shows that all the variables used in the model are found to be non-stationary at their level values.

owndataCO_2, SO_2, NO_2 emissions 1990 up to 2017 ethiopia.xlsx", sheet ("Sheet1") fi

Co-integration Test

Table 4: Unit root test with trend on residuals

ADF (test statistic -5.553)
(critical value at 5%= -3.600)

*****Source from researcher Environmental data, 2019**

Therefore, the variables in the model are co-integrated using the Engle Granger (1987) approach. The co-integration test suggests the existence of long run equilibrium and hence the formulation of ECM will be possible. (Guajarati D, 2003). The single equation ECM is estimated below.

Test of specification error

Ramsey RESET test is applied using powers of the fitted values of $\Delta lnCO_2$, NO_2, SO_2

Ho: model has no omitted variables

H1= model has omitted variables

F (3, 17) = 2.09

critical F (3, 17) at 10%=2.44

Prob > F = 0.1390

Since critical F (3, 17) at 10%=2.44 > F (3, 17) = 2.09

we do not reject the null hypothesis in favor of the alternative hypothesis, thus there are no omitted variables in the model implying that the Variable is correctly specified.

White test

qui reg CO_2, SO_2, NO_2

estat imtest, white

White's test for Ho: homoskedasticity against

Ha: unrestricted heteroskedasticity

$chi^2(5) = 23.77$ Prob > $chi^2 = 0.0002$

Table 5: Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	23.77	5	0.0002
Skewness	3.77	2	0.1518
Kurtosis	2.29	1	0.1302
Total	29.83	8	0.0002

***Same conclusion, we reject the null hypothesis

*****Source from researcher Environmental data, 2019**

According to Brook, (2008) indicated that if the P-values of these test statistics are considerably in excess of 0.05, then the test give conclusion that there is no evidence for the presence of hetro-scedasticity. It is clear evident that the errors are homoscedastic.

Therefore, based on this statistic we fail to reject the null hypothesis that is indicated as there is no Heteroscedasticity for the models.

Multicollinearity

Table 6: Correlations matrix (obs=28)

	LnGDP	$InSO_2$	$InCO_2$	$InNO_2$	InCPI	InGE	INF
LnGDP	1.0000						
InSO2	0.8476	1.0000					
InCO2	0.9540	0.7864	1.0000				
InNO2	0.9384	0.7959	0.9954	1.0000			
InCPI	0.7172	0.9354	0.6498	0.6616	1.0000		
InGE	0.7633	0.9770	0.7093	0.7278	0.9427	1.0000	
INF	0.8644	0.9600	0.7755	0.7770	0.8662	0.9165	1.0000

*****Source from researcher Environmental data, 2019**

The correlation matrix shown in Table 6 indicates that the country privet investment effectiveness indicators are highly correlated among themselves with the country economic growth index calculated. In view of this, the stepwise regression approach was used. The individual country privet investment variables and the combined to ecumenical growth index were introduced into the model one at a time, resulting in nine estimated models. Also, variance inflation factors (VIF) analysis was conducted.

The results (available on demand) show that the presence of multi collinearity is minimal in each of the models estimated. Multi collinearity is deemed to be high if VIF is greater than five (as a common rule of thumb) and according to Kutner, Nachtsheim, and Neter (2004 Kutner, M., Nachtsheim, C., & Neter, J. (2004). VIF of 10 should be the cut off.

4.4. The Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) Emission and Economic growth of Ethiopia.

4.4.1. Regression Results (dependent variable— CO_2, NO_2, SO_2)

4.4.1.1. Coefficient of Determination LR chi2 (8) and adjusted R^2

It is also explaining the level of the explanatory power. If R-squared = 0 (no explanatory power) This means that none of the change in the dependent variable can be measured by the change in the independent variables. The estimated equation is useless.

If LR chi^2= 1 (full explanatory power)

This means 100% of the change in the dependent variable can be explained by the change in the independent variables. But, the adjusted R-squared is a modified version of R-squared that has been adjusted for the number of predictors in the model.

Table 7: Regression results (dependent variable—CO_2, SO_2, NO_2 emissions)

Ordered Least Square regression				Number of obs	=	28
				LR chi2(6)	=	98.70
				Prob > chi²	**=**	**0.0000**
Log likelihood = -43.949368				Pseudo R2	=	0.5290

LnGDP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
InSO2	.0094981	.016794	0.57	0.572	-.0234176	.0424139
InCO2	.0021895	.0005592	3.92	0.000	.0010935	.0032856
InNO2	-.0062355	.001916	-3.25	0.001	-.0099908	-.0024802
InCPI	.0859771	.0505314	1.70	0.089	-.0130625	.1850168
InGE	-.0031522	.0017141	-1.84	0.066	-.0065117	.0002073
INF	.4368954	.2796527	1.56	0.118	-.1112138	.9850046

*****Source from researcher financial data, 2019**

In this section, the above presented long run relationship between the dependent variable and explanatory/determinant variables is briefly described and interpreted in light of theoretical underpinnings and contextual realities of Ethiopia. The secondary data collected were classified and tabulated after which the multiple regression technique was used to estimate the respective relationships.

Researcher was used Ordinary Least Square basic assumptions and conducting unit root test, regression analysis is conducted The Dynamics relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) and Economic growth of Ethiopia. The regression analysis is undertaken with non-stationary variables and differenced variables, to control for non-stationary variable estimation problem. The regression result is presented. The coefficient of the lagged dependent (Real GDP) Rate of Economic Growth in real to Domestic Gross Product variable is positive and is at least 5% significant which is model is fitted. This indicates that past levels of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) in Ethiopia from

1990-2017 inform current levels, implying that to economic growth shows that it follows 52.9% of partial adjustment process.

Discussion

From the study confident result regarding to (GRDC) Growth rate of domestic capital found the likelihood rations of 0.5290unit changing in economic growth at significance level of 5% value. past levels of carbon dioxide (CO_2), Sulfur Dioxide (SO_2) is found to be positive and statistically significant at 1% which means that when every time the country ‘s economic growth which is Growth rate of consumer price index is increase by 0.08 unit explained the level of economic growth in the sector also increase, though it is statistically significant.

However, McKinnon (1973) and Shaw (1973) suggest that there could be a positive relationship between consumer price index and the Growth rate of domestic capital. Because, a higher Growth rate of domestic capital would increase as a result, and equilibrium consumer price index would be higher. This hypothesis, known as the McKinnon and Shaw hypothesis is based on the assumption that the quantity of financial resources is the main constraint on consumer price index rather than the cost of financial resources (Khan & Khan, 2007).

According to the early neoclassical approach, Growth rate of domestic capital differentials are the main reason for firms to become a multinational company. From this standpoint, capital moves from a country where the return on capital is low to a place where the return on capital is high. This approach is based on perfect competition and capital movement free of risk assumptions (Harris, 2000) (cited in Seruvatu & Jayaraman, 2001) identified that the neoclassical consumer price index theory influenced by the growth rate of real GDP in a positive manner. This is also known as the “accelerator effect.”

From regressions result which is Starting from past levels of carbon dioxide (CO_2) shows appositive relations ship to GDP indicated that in likelihood of coefficient variance to economic growth by (0.002) unit ratio which is distributed test of Walden test result of (Z=3.92)which was statically 5% significance. Which is carbon dioxide (CO_2) is shows 0.02% of accelerator effect to Ethiopian economic growth.

It shows that, the contributions of Ethiopia to CO_2 emissions from the consumptions of modern energy like coal consumption in different sectors were eminent. Whereas, the positive and significant relation between economic growth and CO_2 indicates, economic growth was inevitably increases carbon dioxide emissions in the country. Similar study by Endeg et, al., (2016) Energy Consumption, Carbon Dioxide Emissions and Economic Growth in Ethiopia shows significant and positive sign of Urbanization with CO_2 emissions shows an increment in urban population increases CO_2 emission to the environment. And, there is causality from energy consumption to economic growth and urbanization. As well as, from economic growth and urbanizations to carbon dioxide emissions.

In general, the response is the governmental policies of managing CO_2 emissions and air quality in urban areas and city authorities' effort in urban planning towards an environmentally friendly and sustainable development of cities. In response to the awareness of the negative effects of air pollution on the social and economic development, the Ethiopian government has issued a system of policies relevant to air quality management.

Regression result towards SO_2 indicted positive relationship worth to Real GDP in likelihood coefficient interval of (0.0094) at radically distributions test of Z=0.57) which was no significance relationship to Economic growth. This means that SO_2 has shown 0.004% statically effect to Ethiopian economic growth.

Challenges in Ethiopia include emissions from vehicles, indiscriminate waste burning at landfills and within households, emissions from the industrial SO_2 complexes increase which is country legislation specific to air pollution is very old and only covers industrial sources. An update of the legislation would be useful and should include control measures for vehicular sources, prohibition of uncontrolled waste burning, control of agricultural fires, address the issue of trans boundary air pollution, control of other contributing sources, and specify fuel and emission standards.

In Ethiopia has already got a network of air pollutant monitoring stations, which monitors key air pollutants. At present only PM10 and SO_2 are pollutants which do not always comply with monthly standards. In relation to 24 hours WHO guidelines of 50 $\mu g/m^3$ for PM10 and 20 $\mu g/m^3$ for SO_2, the respective Ethiopia standards are relatively high. Botswana's other air quality objectives are comparable to those of the WHO and the US EPA developed to protect human health (USAID, 2018).

The expansion of World Banks' SIM-AIR model to include control measures for the industrial processes used in the copper belt could also be beneficial. Ethiopia could also benefit from the development of an action plan for improving air quality, a quantification of the impacts of air pollution due to and implementation of control measures in the smelters of SO_2 per capital.

Result from NO_2 emissions is indicated in negative relations ship with Real GDP in likelihood coefficient interval of (-.00623) at radically distributions test of Z=-3.25) which has significance relationship to Economic growth. In most ambient situations, nitric oxide is emitted and transformed into nitrogen dioxide in the atmosphere. In other side, breathing air with a high NO_2 concentration can irritate airways in the human respiratory system.

Oxidation of nitric oxide by atmospheric oxidants such as ozone occurs rapidly, even at the low levels of reactants present in the atmosphere. Altshuller calculated that 50% conversion of nitric oxide would take less than 1 minute at a nitric oxide concentration of 120 $\mu g/m^3$ (0.1 ppm) in the presence of an ozone concentration of 200 $\mu g/m^3$ (0.1 ppm). Consequently, this reaction is regarded as the most important route for nitrogen dioxide production to Economy growth supported by (USAID, 2018)

Other contributions of nitrogen dioxide to the atmosphere come from specific no combustion industrial processes, such as the manufacture of nitric acid, the use of explosives and welding. Indoor sources include tobacco smoking and the use of gas-fired appliances and oil stoves. Differences in the nitrogen oxide (nitric oxide and nitrogen dioxide) emissions of various countries are due mainly to differences in the consumption of fossil fuels. Worldwide emissions of nitrogen oxides in the early 1980s were estimated at approximately 150 × 1012 g/year.

Occurrence in air Maximum 30-minute or 1-hour average and maximum 24-hour average outdoor nitrogen dioxide concentrations of up to 940 $\mu g/m^3$ (0.5 ppm) and 400 $\mu g/m^3$ (0.21 ppm), respectively, have been reported. Annual mean concentrations in urban areas throughout the world are generally in the range 20–90 $\mu g/m^3$ (0.01–0.05 ppm) (1, 4–6). Urban outdoor levels vary according to the time of day, the season of the year and meteorological factors. Typical daily patterns comprise a low background level on which are superimposed one or two peaks of higher levels that correspond to rush-hour traffic emissions of nitrogen oxides. Hourly average nitrogen dioxide concentrations near very busy roads often exceed 940 $\mu g/m^3$ (0.5 ppm) (7).

Maximum hourly concentrations in the United Kingdom are generally of the order of 470–750 μg/m^3 (0.25–0.4 ppm) from 1970-2016 indicated an increase in concentrations of nitrogen oxides is shows a variations of 0.076% to country economy in many urban areas throughout the world (Delworth, et,al., 2016).

Recent reports from the United States, however, show a decrease in nationwide nitrogen dioxide concentrations, resulting from a decrease in nitrogen oxides emissions, from 1981 to 1990change in0.04 United States economic concentrations are highly correlated with population level and population levels worldwide continue to grow. Nevertheless, indoor sources, such as cooking with gas or cigarette smoking, may be the main contributors to individual exposure (WHO, 2018).

It finally Climate according to USAID (2018) Change Mitigation Targets and Plans in its INDC, Ethiopia pledges to cap its 2030 GHG emissions at 145 $MtNO_2$, which equates to a 64% (255 $MtNO_2e$) reduction from projected business as usual emission levels in 2030. The reduction includes 90 $MtCO_2e$ from agriculture, 130 $MtCO_2e$ from forestry, 20 $MtCO_2e$ from industry, 10 $MtSO_2e$ from transport, and 5 $MtCO_2e$ from buildings.

The INDC is in line with Ethiopia's CRGE, Ethiopia's strategy for addressing mitigation objectives and climate change adaptation, whose implementation would decrease per capita emissions by 64%.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The research was designed with the objectives of to assessing the annual trend and the dynamic relationship of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) emissions towards the Growth of Ethiopian Economy. In this title of, the Dynamics Relationship of Carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) Emissions and economic growth, from 1990-2017 in Ethiopia. This research were used on Secondary data, which was to obtained from publications of World Bank (WB) and statistical data base of International Monetary Fund (IMF). From 1990-2017 fiscal year. To analyze the result and used the following key variables, Carbon dioxide (Co_2), Nitrous dioxide (No_2), Sulfur dioxide (So_2), Consumer price index, (CPI), Government expenditure (GE), inflation (inf),and the Dependent variable is Economic Growth (Real GDP) of the country.

The regression result is discussed. The coefficient of the lagged dependent (Real GDP) Rate of Economic Growth in real to Domestic Gross Product variable is positive and is at least 5% significant which is model is fitted. This indicates that past levels of carbon dioxide (CO_2), Nitrous dioxide (NO_2), Sulfur Dioxide (SO_2) in Ethiopia from 1990-2017 inform current levels, implying that to economic growth shows that it follows 52.9% of partial adjustment process.

From regressions result which is Starting from past levels of carbon dioxide (CO_2) shows appositive relations ship to GDP indicated that in likelihood of coefficient variance to economic growth by (0.002) unit ratio which is distributed test of Walden test result of (t= 3.92) which was statically 5% significance. Which is carbon dioxide (CO_2) is shows 0.02% of accelerator effect to Ethiopian economic growth.

SO_2 indicted positive relationship worth to Real GDP in likelihood coefficient interval of (0.0094) at radically distributions test of (Z=0.57) which was significance relationship to Economic growth. This means that SO_2 has shown 0.004% statically effect to Ethiopian economic growth.

NO_2 emissions is indicated in negative relations ship with Real GDP in likelihood coefficient interval of (-.00623) at radically distributions test of Z=-3.25) which has significance relationship to Economic growth.

5.2. Recommendations

Some implication for this study were found to be relevant, to make balancing the emission and economic growth in the country. To bring sustainable development or economic growth in the country to considering environmental issues has play a vital role to sustain the economic growth.

In the economic activities expanding environmental healthy practices which needs cooperation and integration work by various stack holders, especially the industry/manufacturing sectors, researchers and political leaders. To control the emission and to keep the environment from pollution which require knowledge, skill, attitudinal and behavioral change and management to balance the economic growth and emission. Therefore the researcher and the government of the country need to continuously keep in touch with this issues for further research to address the issues and need to resolve the problem/threats.

1. The result of this study indicated that So_2 has a positive and significant influence in the economic growth of the country so to keep the balance the government should import a low sulfur content fuel from abroad, reducing import of higher sulfur containing diesel and number of trucks that commonly uses diesel advisable.

2. It was found that Co_2 has appositive and significant relationship to economic growth of the country, so to bring healthy environmental economic practices it needs creating partnership between academia and implementing /regulatory organizations to facilitate evidence-based decisions, Improving the awareness and participation of stakeholders like private sectors, non-government sectors and government sectors to get easy solutions for the carbon emission threats and problems.

3. Government need to set Serious rules and regulation on Country emission by implementing those the rules set and the regulation.

Generally the Government give attention on those emitting industry Like, Cement industry, Tobacco industry, Steel industry, Textile industry, to minimize their emit on environment. And also give deep training to those Owners of the industry to minimize emission.

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APENDEX I

```
. import excel "C:\Users\Awash\Desktop\2019\May\Emission Data CO2, NO2 AND SO2\emission\do
file\Book2.xlsx", sheet ("Sheet1") first row clear.
. two way (tsline year) (tsline year) (tsrline year LnGDP), ytitle(GDP) ttitle(1990 -2017) by(,
title(order leas scatter CO2,SO2,NO2 EMISSIONS TO ECONOMIC GOWTH)) by(2019
> egend(on)) by(InSO2 InCO2 InNO2, total missing)
```

ADF

Variables	Levels	Differences
InSO2 |	-3.243	-3.732*
InCO2 |	-3.263	-3.815*
InNO2 |	-3.332	-3.6345*
InCPI |	-3.584	-4.230*
InGE |	-2.346	-4.212*
LnGDP |	-2.520	-4.112*
INF |	-3.332	-3.443*

(critical value at 5%= -3.600)

*implies the null hypothesis of non- stationery can be rejected at 5% level of significance.

own data CO2,NO2,SO2 emissions 1990 up to 2017 ethiopia.xlsx", sheet("Sheet1") fi

Co-integration Test

Table 4: Unit root test with trend on residuals

ADF (test statistic -5.553)

(critical value at 5%= -3.600)

Ho: model has no omitted variables

H1= model has omitted variables

F (3, 17) = 2.09

critical F (3, 17) at 10%=2.44

Prob > F = 0.1390

Since critical F (3, 17) at 10%=2.44 > F (3, 17) = 2.09

White test

```
qui reg CO2, SO2, NO2
estat imtest, white
```

White’s test for Ho: homoskedasticity against

Ha: unrestricted heteroskedasticity

chi2(5) = 23.77 Prob > chi^2 = 0.0002

Source	chi^2	df	p
Heteroskedasticity	23.77	5	0.0002
Skewness	3.77	2	0.1518
Kurtosis	2.29	1	0.1302
Total	29.83	8	0.0002

Table 6: Correlations matrix (obs=28)

	LnGDP	InSO2	InCO2	InNO2	InCPI	InGE	INF
LnGDP	1.0000						
InSO2	0.8476	1.0000					
InCO2	0.9540	0.7864	1.0000				
InNO2	0.9384	0.7959	0.9954	1.0000			
InCPI	0.7172	0.9354	0.6498	0.6616	1.0000		
InGE	0.7633	0.9770	0.7093	0.7278	0.9427	1.0000	
INF	0.8644	0.9600	0.7755	0.7770	0.8662	0.9165	1.0000

. xtgls LnGDP InSO2 InCO2 InCPI InCPI InGE INF, panels(iid) corr(independent)

note: InCPI omitted because of collinearity

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares

Panels: homoscedastic

Correlation: no autocorrelation

Estimated covariance's =	1	Number of obs =	28
Estimated autocorrelations =	0	Number of groups =	28
Estimated coefficients =	6	Time periods =	1
		Wald chi2(5) =	604.97
Log likelihood =	-29.6973	Prob > chi2 =	0.0000

LnGDP	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]

```
-------------+----------------------------------------------------------------
       InSO2 |   .0030313   .0038349     0.79   0.429     -.004485    .0105475
       InCO2 |   .0001445   .0000159     9.09   0.000     .0001134    .0001756
       InCPI |   .0021833   .0055831     0.39   0.696    -.0087595    .0131261
       InCPI |          0  (omitted)
        InGE |  -.0006805    .000391    -1.74   0.082    -.0014469    .0000859
         INF |   .2311515    .095101     2.43   0.015     .0447569    .4175461
       _cons |  -5.208931   .8805624    -5.92   0.000    -6.934802   -3.483061
------------------------------------------------------------------------------


Complementary log-log regression                Number of obs      =        28

                                                Wald chi²(0)       =         .
Log likelihood =          0                     Prob > chi²        =         .
------------------------------------------------------------------------------
       LnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       InSO2 |  -9.18e-16          .        .       .            .           .
       InCO2 |  -1.75e-17          .        .       .            .           .
       InNO2 |   9.97e-17          .        .       .            .           .
       InCPI |   1.44e-15          .        .       .            .           .
        InGE |   5.49e-17          .        .       .            .           .
         INF |   1.09e-14          .        .       .            .           .
       _cons |    4.94006          .        .       .            .           .
------------------------------------------------------------------------------
convergence not achieved
r(430);

. varlmar
varlmar only works with estimates from var or svar
r(198);

. xtologit LnGDP InSO2 InCO2 InNO2 InNO2 InCPI InGE LnGDP INF
invalid path specification;
```

```
LnGDP may not predict itself

r(198);


. ologit LnGDP InSO2 InCO2 InNO2 InCPI InGE INF


Iteration 0:   log likelihood = -93.301726

Iteration 1:   log likelihood = -75.550744

Iteration 2:   log likelihood = -69.279792

Iteration 3:   log likelihood =  -54.56841

Iteration 4:   log likelihood = -45.361862

Iteration 5:   log likelihood = -44.045471

Iteration 6:   log likelihood = -43.952562

Iteration 7:   log likelihood = -43.949581

Iteration 8:   log likelihood = -43.949368

Iteration 9:   log likelihood = -43.949368


Ordered Least square  regression                 Number of obs   =         28

                                                  LR chi2(6)      =      98.70

                                                  Prob > chi2     =     0.0000

Log likelihood = -43.949368                       Pseudo R2       =     0.5290

       LnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]

-------------+----------------------------------------------------------------

       InSO2 |   .0094981    .016794     0.57   0.572    -.0234176    .0424139

       InCO2 |   .0021895   .0005592     3.92   0.000     .0010935    .0032856

       InNO2 |  -.0062355    .001916    -3.25   0.001    -.0099908   -.0024802

       InCPI |   .0859771   .0505314     1.70   0.089    -.0130625    .1850168

        InGE |  -.0031522   .0017141    -1.84   0.066    -.0065117    .0002073

         INF |   .4368954   .2796527     1.56   0.118    -.1112138    .9850046

-------------+----------------------------------------------------------------

       /cut1 |   36.57659   8.258372                      20.39048     52.7627

       /cut2 |   37.65757   8.219536                      21.54757    53.76756

       /cut3 |   38.55547   8.270866                      22.34488    54.76607

       /cut4 |   40.12518   8.651727                       23.1681    57.08225

       /cut5 |    42.9342   9.468116                      24.37703    61.49136

       /cut6 |   44.67835   9.792584                      25.48524    63.87146
```

```
      /cut7 |   46.15036   10.05272                      26.44739    65.85332
      /cut8 |   47.73233   10.35015                       27.4464    68.01825
      /cut9 |   48.91764   10.56085                      28.21876    69.61652
     /cut10 |   50.02334   10.74229                      28.96883    71.07784
     /cut11 |   51.67481   11.12965                      29.86111    73.48852
     /cut12 |   53.61345   11.53988                       30.9957    76.23119
     /cut13 |   55.03872   11.77998                      31.95039    78.12706
     /cut14 |    56.1283   11.91215                      32.78092    79.47567
     /cut15 |   57.27527   12.06797                      33.62248    80.92807
     /cut16 |    59.3968   12.53206                      34.83442    83.95918
     /cut17 |   60.99374   12.75942                      35.98573    86.00175
     /cut18 |   63.10424   13.21858                      37.19631    89.01217
     /cut19 |   66.79159   13.99902                      39.35402    94.22917
     /cut20 |   69.47642   14.49729                      41.06225    97.89059
     /cut21 |   71.02508   14.73408                      42.14681    99.90335
     /cut22 |   72.03205   14.81298                      42.99914    101.0649
     /cut23 |   72.68712   14.82997                      43.62092    101.7533
     /cut24 |   73.21123   14.83372                      44.13767    102.2848
     /cut25 |   73.86489   14.85621                      44.74725    102.9825
     /cut26 |   74.83224   14.89524                      45.63812    104.0264
     /cut27 |   82.38924   32.81544                      18.07217    146.7063

. arch LnGDP InSO2 InCO2 InNO2 InCPI InGE INF, arch(1/1)
Number of gaps in sample:  27   (gap count includes panel changes)
(note: conditioning reset at each gap)
(setting optimization to BHHH)
Iteration 0:   log likelihood = -25.367579  (not concave)
Iteration 1:   log likelihood = -25.367579  (not concave)
Iteration 2:   log likelihood = -25.367579  (not concave)
Iteration 3:   log likelihood = -25.367579  (not concave)
Iteration 4:   log likelihood = -25.367579  (not concave)
(switching optimization to BFGS)
Iteration 5:   log likelihood = -25.367579
```

```
ARCH family regression

Sample: 1990 - 2017, but with gaps                Number of obs   =        28
Distribution: Gaussian                            Wald chi²(6)    =    676.36
Log likelihood = -25.36758                        Prob > chi²     =    0.0000

------------------------------------------------------------------------------
             |                 OPG
       LnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
LnGDP        |
       InSO2 |   .0020721   .0057128     0.36   0.717    -.0091247    .0132689
       InCO2 |   .0004176   .0001171     3.56   0.000      .000188    .0006472
       InNO2 |  -.0010516   .0004229    -2.49   0.013    -.0018804   -.0002228
       InCPI |  -.0002108   .0176504    -0.01   0.990    -.0348051    .0343834
        InGE |  -.0002542   .0005191    -0.49   0.624    -.0012715    .0007632
         INF |   .1821879   .1591291     1.14   0.252    -.1296993    .4940751
       _cons |  -5.410536   2.241532    -2.41   0.016    -9.803857   -1.017215
-------------+----------------------------------------------------------------
ARCH         |
        arch |
         L1. |  -1.19e-06          .        .       .            .           .
             |
       _cons |   .3584706   .1281308     2.80   0.005     .1073387    .6096024

. arch LnGDP InSO2 InCO2 InNO2 InCPI InGE INF, arch(1/1) tarch(1/1)

Number of gaps in sample:  27   (gap count includes panel changes)
(note: conditioning reset at each gap)
(setting optimization to BHHH)
Iteration 0:   log likelihood = -25.367579  (not concave)
Iteration 1:   log likelihood = -25.367579  (not concave)
Iteration 2:   log likelihood = -25.367579  (not concave)
Iteration 3:   log likelihood = -25.367579  (not concave)
```

```
Iteration 4:   log likelihood = -25.367579  (not concave)
(switching optimization to BFGS)
Iteration 5:   log likelihood = -25.367579

ARCH family regression

Sample: 1990 - 2017, but with gaps                Number of obs   =        28
Distribution: Gaussian                            Wald chi²(6)    =    676.36
Log likelihood = -25.36758                        Prob > chi²     =    0.0000

------------------------------------------------------------------------------
             |                 OPG
       LnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       LnGDP |
       InSO2 |   .0020721   .0057128     0.36   0.717    -.0091247     .013269
       InCO2 |   .0004176   .0001171     3.56   0.000      .000188    .0006472
       InNO2 |  -.0010516   .0004229    -2.49   0.013    -.0018804   -.0002228
       InCPI |  -.0002108   .0176508    -0.01   0.990    -.0348058    .0343841
        InGE |  -.0002542   .0005191    -0.49   0.624    -.0012715    .0007632
         INF |   .1821879    .159132     1.14   0.252    -.1297051    .4940809
       _cons |  -5.410536   2.241559    -2.41   0.016    -9.803911    -1.01716
-------------+----------------------------------------------------------------
        ARCH |
        arch |
         L1. |  -4.70e-07          .        .       .            .           .
       tarch |
         L1. |  -4.70e-07          .        .       .            .           .
             |
       _cons |   .3584708   .1281312     2.80   0.005     .1073383    .6096033
. arch LnGDP InSO2 InCO2 InNO2 InCPI InGE INF, parch(1/1)

Number of gaps in sample:  27   (gap count includes panel changes)
(note: conditioning reset at each gap)
(setting optimization to BHHH)
```

```
Iteration 0:   log likelihood = -25.367579  (not concave)

Iteration 1:   log likelihood = -25.367579  (not concave)

Iteration 2:   log likelihood = -25.367579  (not concave)

Iteration 3:   log likelihood = -25.367579  (not concave)

Iteration 4:   log likelihood = -25.367579  (not concave)

(switching optimization to BFGS)

Iteration 5:   log likelihood = -25.367579


ARCH family regression


Sample: 1990 - 2017, but with gaps                Number of obs   =        28

Distribution: Gaussian                            Wald chi2(6)    =    676.36

Log likelihood = -25.36758                        Prob > chi2     =    0.0000

             |                 OPG

       LnGDP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]

                   LnGDP        |

       InSO2 |   .0020721   .0057128     0.36   0.717    -.0091247     .013269

       InCO2 |   .0004176   .0001171     3.56   0.000      .000188    .0006472

       InNO2 |  -.0010516   .0004229    -2.49   0.013    -.0018804   -.0002228

       InCPI |  -.0002108   .0176508    -0.01   0.990    -.0348058    .0343841

        InGE |  -.0002542   .0005191    -0.49   0.624    -.0012715    .0007632

         INF |   .1821879    .159132     1.14   0.252    -.1297051    .4940809

       _cons |  -5.410536   2.241559    -2.41   0.016    -9.803911    -1.01716

        ARCH|

       parch |

         L1. |  -4.71e-07          .        .       .            .           .

             |

       _cons |   .3584708   .1281312     2.80   0.005     .1073383    .6096033

                   POWER        |

       power |   1.999999          .        .       .            .           .
```

APENDIX II

Year	InSO2	InCO2	InNO2	InCPI	InGE	LnGDP	INF
1990	142.3	50824.5	13440.7	107.1	661.6	3.03	1.3
1991	198.8	51119.5	13561.1	97.1	416.4	2.24	3.4
1992	187.2	52498.6	13883.5	87.2	473	2.56	3.4
1993	183.8	43594.2	10577.2	75.8	463.6	2.86	4.8
1994	213.1	43969.3	10659.5	108.9	625.4	3.05	4.9
1995	270.2	43964.3	10629.5	126.5	715	3.22	5
1996	353.8	45956	11103.4	159.5	1273.6	3.15	5
1997	343.8	47866	11532	144.9	850.6	3.55	5.6
1998	283.1	52029.9	12561.4	125.8	1180.1	4.35	5.6
1999	322.5	51237.6	12292.1	145.7	1253.8	4.52	7.2
2000	305.8	48122.3	11521.3	147	1202.1	4.98	7.2
2001	377.4	51772.6	12410.8	167.6	992.8	5.29	7.3
2002	337.7	59012.7	14205.1	135	1534.5	5.11	7.3
2003	365	57471.7	13983.1	159.4	535.5	5.5	7.8
2004	383.2	58250.7	14386	158.2	1286.4	6.01	7.8
2005	442.3	60838.4	15151.3	177	1265	6.57	8.2
2006	457.7	65889.1	16475.4	149.1	1329.9	6.62	8.8
2007	450.7	73141.5	18341.9	161	1666	6.58	8.8
2008	474.1	76306.4	19104.2	165.1	1756.4	7.72	9.1
2009	549.9	79596.2	19829.9	173.9	1860	8.56	9.1
2010	603.7	83586.5	20777.2	183.1	2453.6	10.63	11.8
2011	634.5	81674.5	20303.1	186.3	2438.9	11.59	12.7
2012	663.8	84629.4	21059	189.1	2824.6	11.61	13.1
2013	703	86085.4	21656.4	186.9	2689.3	11.85	13.1
2014	763.5	90641.8	22838.4	197.5	3709.8	11.08	13.6
2015	886	73875	18808.5	248.4	4093.8	10.09	22.3
2016	1324.4	80255.2	20687.5	312.2	7352.2	11.14	22.3
2017	1419.2	89736.6	23273.9	490.3	8597.1	12.31	22.5