ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

(Development Economics)

ANLAYSING THE IMPACTS OF PETROLEUM CONSUMPTION ON ECONOMIC GROWTH IN ETHIOPIA

BY: Alemnew Amslau

Advisor: Tewodros Negash (PHD)

A THESIS SUBMITTED TO THE DEPARTMENT OF ECONOMICS IN PARTIAL FULFILLEMNT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCINCE IN ECONOMICS (DEVELOPMENT ECONOMICS)

JAN, 2025

ADDIS ABABA, ETHIOPIA

DECLARATION

The brief overview of the investigation that will be provided and to verify the study's completion, titled “ANLAYSING THE IMPACTS OF PETROLEUM CONSUMPTION ON ECONOMIC GROWTH IN ETHIOPIA” is a dissertation of my own creation submitted in partial fulfilment of the requirements for the degree of Masters of Science in Development Economics that it satisfies the educational institution's academic necessities with guidelines and fulfils the study's committee of the accepted norms and results in terms of creativity and excellence.

By: Alemnew Amsalu Signature: _____ Date _____

Advisor: Dr. Tewodros N Signature: _____Date: _____

ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

This letter is to validate that the research paper titled "ANLAYISNG THE IMPACTS OF PETROLEUM CONSUMPTION ON ECONOMIC GROWTH IN ETHIOPIA" submitted in partial fulfilment of the requirements for the degree of Masters of Science in Development Economics conforms to the university's requirements and fulfils the minimum requirements in terms of inventiveness and reliability.

Internal Examiner: Dr. Jonse B_____ Signature_____: Date: _____

External Examiner: Dr. Mareshal N__ Signature: _____; Date: _____

Advisor Dr Tewoderose N Signature_____ Date:_____

ABSTRACT

Ethiopia, like any other emerging countries, has demonstrated poor economic performance. Although the fact that the country's current economic performance is highly remarkable, there are a number of challenges to sustain the present trend of economic growth. The main challenge is the availability and scarcity of energy sources. Energy is a driving force of development and plays a significant role in the country's economic growth and prosperity. Ethiopia's economy is heavily dependent on imported petroleum products. Petroleum is one of the most important commodities in social, political and economic challenges. The main objective of the study was to examine the impacts of petroleum consumption on economic growth. Specifically, it determined the short and long run relationship between petroleum consumption and economic growth. It also examined the impacts of petroleum price on economic growth, to analyzing and showing the trends of petroleum consumption and economic growth over the study period. It modified a growth model with GDP as the dependent variable and labour force, domestic capital investment and petroleum consumption and unit price of petroleum products as the independent variables to be estimated. An exploratory research design was used and research work followed a quanitative approach by using secondary source of data was used to collect information and Error Correction model was used to estimate.

First, the study determined the stationarity of the variables by using ADF and phillips-perron test and its result shows that all the variables are non-stationary at levels but stationary at first-difference. The Cointegration tests result indicated that the null hypothesis of no-cointegration was rejected at 5% level of significance. The estimation results of the long-run relationship revealed that the relationship between PC,AUPP and DCI with GDP was negative and statistically significant but LF was positive and not statistically significant. The estimated methods of the error-correction model shows that in the short run there was a positive and statistical insignificance impacts of lagged petroleum consumption on real GDP. The Granger causality test result shows there was unidirectional causal relationship between petroleum consumption to GDP.

Finally the result concluded that petroleum consumption has negative impacts on economic growth and the country is recommended that to derives or formulate policy implications from the results obtained regarding the implementations of the upstream projects of the petroleum and gas industry and to develop in alternative energy sources as substitutes of petroleum products.

KEY WORDS: Petroleum Consumption, Economic Growth, Ethiopia, 2025

ACKNOWLEDGMENTS

First and foremost, I would like to praise God in advance for providing me with the ability to pursue this research. Secondly, I want to express deep appreciation to my Advisor Dr.Tewodros N, for his helpful guidance, support, and encouragement during this project. My particular thanks go to my spouse, Ms. Samerawit Tsega, and my previous staff member, Dr. Getachew, for their time, encouragement, and motivation to keep working or complete this Master's Program paper. I'd want to thank the staff at the Petroleum and Energy Authority and Ethiopian Petroleum Supply Enterprise for taking the time to interview me and providing me with access to work-related documentation. I am very appreciative to all the responders in this study, who were quite cooperative in giving me

.

ACRONYMS AND ABBREVIATION

- ADB: African Development Bank
- ADF: Augmented Dickey-Fuller
- AGO: Automotive Gas Oil
- AIC: Akaike Information Criteria
- ARDL: Auto-regressive Distributive Lags Model
- AUPP; Average Unit Price of Petroleum Products
- CUSUM: Cumulative Sum
- CUSUMSQ: Cumulative Sum of Square
- DCI: Domestic Capital Investment
- DHT: Djibouti Horizons Terminal
- ECM: Error Correction Mechanism
- ECRGE: Ethiopia's Climate Resilient Green Economy
- EEA: Ethiopian Economic Association
- EPEA: Ethiopian Petroleum and Energy Authority
- EPRDF: Ethiopian People's Revolutionary Democratic Front
- EPC: Ethiopian Petroleum Corporation
- EPSE: Ethiopian Petroleum Supply Enterprise
- GDP: Gross Domestic Product
- GoE: Government of Ethiopia
- GTP: Growth and Transformation Plans
- H-D: Harrod-Domar
- HDT: Horizon Djibouti Terminal ‘
- HFO: Heavy Fuel Oil
- HGERA: Home-Grown Economic Reform Agenda,
- I(0): Integrated of Order Zero
- I(1): Integrated of Order One
- IMF: International Monetary Fund
- KPSS: Kwiatkowski Phillips Schmidt Shin
- LF: Labor Force
- LFO: Light Fuel Oil

- LM: Lagrangian Multiplier
- LPG: liquefied petroleum gas
- MGR: Motor Gas Regular
- MOME: Ministry of Mines and Energy
- MOTRR: Ministry of Trade and Regional Relation
- MOWE: Ministry of Water and Eneregy
- NBE: National Bank of Ethiopia
- OECD: Organization for Economic Cooperation and Development
- OLS: Ordinary Least Square
- PC: Petroleum Consumption
- PEA: Petroleum and Energy Authority
- SBIC: Schwarz Bayesian Information Criteria
- UECM: Unrestricted Error-Correction Model
- VAR: Vector-Auto-Regressive
- VECM: Vector Error-Correction Model
- WB: World Bank
- Δ: First Difference Operator

LIST OF TABELS

LIST OF FIGURES

Table of Contents

CHAPTER ONE

1.1. Background of the study

Ethiopia, the second most populous country in Africa, is still one of the poorest countries. Ethiopia's annual GDP growth rate was 5.6% in 2022 this indicates most of peoples received aid from abroad. However, in 2022, the real GDP growth cut down to 5.3% but stayed above East Africa's on average. According to the ADB, the GDP of Ethiopia is projected to grow 5.8% in 2023 and 6.2% in 2024. The sector to support this growth include Agricultural Products, tourism, Ethiotelecom's, manufacturing industry and Mining sectors. To facilitate this sector energy plays significant role and a key driver of the global economy, supporting agriculture, manufacturing and services across all countries. When non-renewable energy resources like petroleum oil, coal, and natural gas are to deplete within a country, it is significant to use renewable energy sources. Despite the focus on renewable energy sources such as wind, solar, hydrothermal and biofuel products continue to play an important role in all sectors of the global economy.

Ethiopian economy is based on agriculture and 80% of the country's people work in agriculture or related fields and reside in rural areas. Agriculture continues to be the most significant in economic activity and contributing to 42.9% of the country's GDP. In the earlier five years' agriculture was the greatest potential to reduce poverty and which is increased the contribution of GDP by 8.6% yearly. Although in the former fifteen years there has been a 152% rise in food production this is directly contributes to improved food security especially in rural regions and this is mostly depending on the availability of petroleum products consumption. The other economic sector is services sector accounts for 45.2 % of overall output, while the industry sector makes up 12.2 % of GDP contribution. Like all developing nations, Ethiopia has had unsatisfactory economic achievements in the past years. One of the most challenges for developing economic growth is availability and shortage of energy resources. Energy is an energetic power of growth and plays an important role in the country's economic growth. Reproducibility is a fundamental idea in manufacturing process economics. Certain inputs used in manufacturing procedures, like energy, cannot be replicated, but over time, other production variables like labor, capital, and natural resources can be replicated. Despite being one of the most valued and rare natural resources, oil components (crude oil, natural gas, refined petroleum products, and other liquids) are utilized as an energy source for more production or as a means of product consumption. energy is one of the most important issues in achieving long-term economic growth and the structural facilitators of realizing the three pillars of Ethiopian Home-Grown Economic Reform Agenda (EHGERA). In Ethiopia the consumption of energy becomes increasing and to use greater energy on the way to accomplishing strategic goals. The need for renewable energy resources has arisen due to

the rapid increase in energy demand and the supply of fossil fuels is running out and is unable to keep up with the demand (Apaydin, Gungor, and Taġdogan, 2019). The quantity and quality of energy used in an economy determines how far forward the economy and its socioeconomic development.

Courrently, countries around the world are on the track to moving towards validating the use of blading products and alternative and renewable energy to reduce envireomenetal pollution and petroleum price fluctuations. In these circumstances, exploring for alternate and renewable energy resources has become vital for nations in the production process of economic activities. Even though Ethiopia lucking for minerals and different types of resource of energy still there is a limitation of using this resource knowledgeably and wisely. Currently Ethiopia use as a source of energy are electricity, petroleum, biogas, charcoal, wind and geothermal as in economic activities but electricity, petroleum and charcoal are the most commonly used energy source as production process from rural area up to urban societies to use as day to day activity.

The Ethiopian government (GoE) has issued a 10-year growth plan based on its 2019 fiscal year Home-Grown Economic Reform Agenda (HGERA), which begins in 2020. The HGERA pillars are macro-financial reforms, institutional changes, and sectoral reforms, with the goal of establishing financial stability and recovering to a track of high growth and prosperity, ensuring quality of growth, improve productivity and competitiveness, undertake institutional transformation, ensure private sectors leadership in the economy, ensure equitable participation of women and young peoples and build climate resilient green economy. It additionally aims to substitute efficiency and introduce resistance in key successful qualifying sectors (energy, logistics, industry and telecom), improve the enterprise investment and address macroeconomic disproportions by putting into practice a series of proactive Growth and Transformation Plans (GTPs) in sub-Saharan African nations with the goal of turning them into middle-income nations by 2030. Enhancing the petroleum and oil gas business in the mining and production of petroleum for its role in developing countries' economy is one of these programs' fundamental principles. The petroleum and gas business are one of the main economic sectors that stimulates many other sectors, such as politics, manufacturing, transportation, building, trade, residential usage, and agricultural in irrigation production (Pinto & Slevin, 1987).

Petroleum is one of the most important commodities in the worlds Social, Political and economic issues and has a major impact on a nation’s economy as an engine of economic growth. In general, the Petroleum sector is more serviceable and important and it is not an exaggeration to say that petroleum has many benefits and is becoming a fundamental instrument for human's daily life economic activities.

Following the economic growth recorded in our country in the past years, the supply and consumption of petroleum has increased significantly and the number of investors joining the sector has also increased but so far, when it is low in line with the needs of the community and economic activity. Now day many foreign and local investors are joining to the investment of downstream of petroleum distribution in the country of Ethiopia. The companies are growth from 4 petroleum distributors companies in 1995 years to 50 in 2023 petroleum distributors companies.

In terms of its strategically important commodities and crucial role in the country's economic activity and higher usage of currency to import petroleum products from the foreign country and bring them into the country the government was decided that the marketing of fuel products should be governed by a different policy framework of marketing system and has been implemented for the past several years. Fuel marketing system is the basis of controlling marketing activities that governs the purchase and supply of fuel product, quality control, wholesale and retail marketing's, transportation, profit margin, licensing criteria of stake holders and the relationship between the actors of the transaction.

In addition to the above activities, the increasing of illegal black and contraband market, multi-faceted problems and ensure the access to the society by ensuring the transaction with appropriate business practice and the higher increments of petroleum subsidy the government of Ethiopia formulate policy of institution is fuel and fuel Products supply and distribution regulatory authority was established by Decree No. 1145/2019 and the authority mandates to control the above activities to make fuel supply and Distribution is fair. Since 2023fy the transaction of fuel in all the fuel stakeholders is done through electronically digital payment through Ethiotelecom's platform, tell birr after instructions from the coordination of PEA, Ethiotelecom's and transport and logistics minister to manage or control illegal black market and contraband of fuel trades and the transactions.

1.2. Profile of Petroleum in Ethiopia

Still now, Ethiopia use petroleum and oil products by buying them from abroad of Saudi Arabia, Rusia, U.A.E and Kuwait Government through Asabi Refining products and its imports are through the port of Djibouti and shipping in Djibouti Horizon Terminal (DHT). Until in the earlier 5 years MGR were imported into the country through two directions and terminals these are 15% was coming from Sudan and 85% was coming through Port of Djibouti while all other are entered through the port of Djibouti (June 2022, PEA), but in the recent years due to security problems all products are comes to Djibouti Horizon Terminal. This means that, like other imported goods, the port of Djibouti is servicing as the only and crucial port for the imports of petroleum products. Due to this in order to ensure reliable supply and smooth distribution the service capacity of the port of Djibouti especially the Horizon product loading terminal was increase the current demand of petroleum from our country, the type and amount of cargo that can be handled at the port, the capacity of the tanker / fuel depots built to receive and store the product and the equipment built to load products to vehicles, the capacity and data system service provided by the terminal are also increasing the efficiency of fuel supply and distribution.

The logistics and supply pressure of these fuel products getting high and is done entirely by the government through the Ethiopian Petroleum Supply Enterprise (EPSE) and Ethiopian transporter and distributer petroleum company agreements. In terms of Petroleum procurement and supply and distribution there is gap for occasional cargo disruptions due to lack of storage capacity, shortage of production and inconsistencies in the Djibouti Horizon. Among the widely used petroleum products in our country are gasoline, white diesel, kerosene, jet fuel, light and heavy black diesel, all of which are imported petroleum Products. From 2003 to 2023, the consumption of petroleum products is growing at a high rate. Accordingly, the annual Petroleum consumption of country, which was 1.2 million metric tons in 2003, has tripled and reached around 4.5 million metric tons in 2023 this shows high increment except in 2020fy due to the Covid-19 epidemic, especially Jet fuel, has shown a slight decrease to 3.8 million metric tons or 2.9 percent in 2020 it was lowered. As the economy has recovered from the effects of the Covid-19 epidemic and showed a growth of around 8.5% in 2021. Ethiopia presently uses one million litters of benzene, 6.5 million gallons of diesel, and two million litters of aviation fuel per day, which is likely to increase in the next years. However, the yearly kerosene usage is 260,000 metric tons, in comparison to the previous ten years, kerosene usage is dropping as the public replaces kerosene with electric stoves in cities and solar lights in rural areas.

1.3. Statement of the Problem

Ensuring greater access to sufficient, high-quality, dependable and reasonably priced energy (petroleum) will undoubtedly promote and sustain rapid economic growth. However, because the nation depends on imported crude oil and processed products, whose prices fluctuate, its supply of petroleum products is not secure. The current policy goals place a strong emphasis on the necessity of energy supply, availability, and affordability in order to promote environmentally friendly and sustainable socioeconomic development. Other tactics include developing and promoting alternative energy technologies to complement the conventional source and boosting competition in the petroleum subsector.

Prior to the beginning of industrialization and civilization energy was needed for household cooking and lighting and the majority of this energy came from fossil fuel and biomass. However, the amount of energy consumed and demanded rise significantly as industry, civilization and improvements in people's life styles changed in many regions of the world. Therefore, the use of contemporary energy sources like coal, oil, natural gas, electricity and solar power is growing in order to run countries with modern economies. According to estimates, the world could run out of coal in roughly 100 years, natural gas in 65 years, and petroleum in 50 years at the current rate of usage. Second, using fossil fuels extremely has a range of unfavorable effects on the environment including acid rain, air pollution and green house gas emissions, which worsen global warming. Thirdly, the price of petroleum is expected to rise even more radically as demand for it rises. Finally the impact of global crises, politically unstable circumstances, or market interruptions are leads to unsustainable economic growth. In order to minimize the possibility of a shortage of fossil fuels and the negative environmental impacts of burning fossil fuels excessively the use of biofuels in place of petroleum-derived fuels is thought to have several benefits. Firstly, burning biofuels avoids the release of excess greenhouse gases. Secondly, because they are derived from biofuel, unlike fossil fuels there is no risk of reduction. Lastly, because biofuels are biodegradable, spills will likely result in little to no environmental disaster. Currently, Ethiopia faces two major issues related to petroleum consumption; a high rate of environmental degradation and higher price expenditure for imported petroleum products which used for country’s export revenue. 82.7% of total energy consumption comes from fossil fuel with imported petroleum and electricity supply accounting for only 4.3% and 13% of the total requirement respectively. The demand of petroleum for country was increasing in year to year but the facility of distribution and supply of fuel products is not parallel are also problems. From the the increment of year to years petroleum price in the world as well as in Ethiopia and logistics market infrastructure problems impact on economic growth.

1.4 Objectives of the Study

1.4.1. General Objective

The paper aims to analyzing the impacts of Petroleum Consumption on Economic Growth in Ethiopia.

1.4.2. Specific Objective

The paper investigates the socio-economic, political and environmental impacts of long-term transitions and to provide more sustainable and economically possible alternatives. The thesis also explores the potential long-term usage of bioethanol as a renewable energy technology in Ethiopia, with the goal of reducing reliance on imported petroleum. The study attmepts to achieve the following objectives:

i. To investigate the granger causality relationship between economic growth and petroleum consumption.
ii. To determine the short and long run relationship between petroleum consumption and economic growth.
iii. To evaluate the economic impact of price of petroleum products on the economic development and national income.
iv. To analyzing and showing the trends of petroleum consumption and economic growth over the study period and forecast for future estimation.
v. Due to the increment of year to years petroleum price in the world as well as in Ethiopia and logistics market infrastructure problems impact on economic growth, to recommended country's starting petroleum production exploration, blading, refining and find other alternative renewable energy.
vi. To recommend policy of rules and regulations regarding the results obtained for petroleum consumption and economic growth and for encouraging the investment in renewable and alternative energy sources projects and concerning implementations of the upstream project of petroleum and gas industry while to reduce the economic impact of petroleum.

1.5. Research Leadership Questions

The study answers and guided by the following questions.

- ✓ Is there a long run causality association between petroleum consumption and RGDP?
- ✓ What is the impact of increasing global petroleum prices on its Economic activities?
- ✓ To what extent the government project management practiced of midstream and upstream petroleum production and others renewable resources?

1.6. Hypothesis of the study

- Petroleum consumption has a negative impact on economic growth in Ethiopia
- There is no a causal link between petroleum consumption and economic growth in Ethiopia, both in the long and short term.

1.7. Significnce of The Study

In Ethiopia, a lot of research published until now but on the title of the impacts of petroleum Consumption on economic growth is unusual in quantity and somewhat not address the consumption of petroleum. Due to this the study was helping to evaluate the relationship and interconnection between petroleum consumption and economic growth. It helps to provide inputs for policy makers to formulate necessary policy and Organizations for properly managing, tracking, and assessing the effective management of petroleum consumption to help the country move to a middle-income countries economy.

- To show the impacts of petroleum consumption on economic growth in case of increase in petroleum price.
- It is used as a reference for policy-makers, entrepreneurs, industrial sectors and researchers' farther investigations and studies undertaking on the same issue in the society as a whole.
- To forecast for future consumption of petroleum by showing the trends of petroleum consumption rate of the country and growing economic activity.
- To facilitate biofuel production of ethanol and biodiesel from the available resources by supporting the sugar factory industry and other molasses.
- To show what the interaction of the development of economic growth and petroleum demand in our country is like and investors into the sector of development petroleum mining, exploration, refining of oil and gas resources industries project.

1.8. Scope of the study

The geographical scope of the study is bounded by the quality and access and the stake holders are petroleum suppler, vehicle owner and transporter and government bodies are the main focusing targets . So, because of lack of data the study has been using only petroleum consumption of the energy resource and unable to use a long time period for the study. Due to this the study was limited to the period from 1992-2023FY which defines the growth model that includes GDP, petroleum consumption and other macroeconomic variables. The study period was determined based on the accessibility of data for the parameters utilized in the study. However, we are also assessing the main difficulties faced in Ethiopian petroleum oil and gas industry project implementation, as well as potential solutions for ensuring the effective execution of upstream and mid-stream oil and gas projects in Ethiopia.

1.9. Limitations of the Study

According to time and financial resource and inconsistency of data reported by different institutions and even by different departments in the same institution limitations have forced to limit the study to only for petroleum consumption of the Energy component. Due to a lack of previous studies in the area, data collection and analysis were challenging due to incomplete and missing information.

The thesis will serve as a starting point for further research on important topics, as there has been a lack of previous research in this area. The thesis focus only impacts of petroleum consumption and utilizing blended biofuel and other renewable energy reduces import bills, benefits the economy, and reduces carbon dioxide emissions, all of which have a substantial impact on the country's sustainable energy as transportation system rather than focusing on the lifecycle easements of renewable energy sources negative impacts and difficult.

1.10. Ethical Considerations

Ethical consideration is heaving when processing the investigation paper means, during data collecting, data entering, data peresentatin and interpretation of the findings of the process. The participants were made aware the goal of the study, and their informed acceptance was based on voluntary participation, professional integrity, duty to avoid harm, confidentiality, carefulness, documentation, objectiveness, openness, right to services, privacy issues and obtained results of communication.

1.11. Structure of the study

The paper is structured into five main sections. The initial section discusses with introduction of the paper, research questions, objectives , significance of the investigation, Hypothesis, scope and limitation of the study. The second section reviews relevant theoretical and empirical literatures related to petroleum consumption, followed by an overview of earlier investigations in the areas. The third chapter shows the research methodology and design, as well as the model selection used for the study, addressing issues such as data description and definition and model specifications. The fourth chapter examines presentation, analysis, and interpretation based on the obtained data, and the last chapter summarizes the key results, recommendations, and suggestions.

CHAPTER TWO

2.0. Literature Review

Renewable and clean energy is crucial for socio-economic and environmental development in worldwide. Those, proposing for renewable energy resources speciality for biofuel are an important indicator of a country's progress, especially in light of increasing energy consumption due to diminishing fossil fuel reserves, rising costs and its negative impacts on the environments. However, their socio-economic and environmental benefits have been questioned, leading to less interest in these options. To increase our understanding of the links and the potential implications of proposed policies, it is important to build on earlier studies by applying the most recent statistical methods to revise and enhance the set of data.

2.1. Definition and concepts of Petroleum

Petroleum is an old name for crude oil, composed of two Latin words: petra (rock or stone) + oleum (oil). The Oil obtained from dead plants and bodies buried in the earth for millions of years is called petroleum". petroleum chemistry in brief is a combination of carbon and hydrogen (C + H). “Petroleum” also means crude oil, natural petroleum gas, any liquid or gas produced from crude oil, natural petroleum gas, coal, peat or crude oil and natural petroleum gas products and condensate. "Petroleum products" means the pure or appropriately mixed petroleum products obtained from the refining or processing of natural crude oil and petroleum gas, bio-fuel or synthetic fuel within the appropriate temperature.

2.2. Petroleum products meaning and benefits

The petroleum industry has three sub-sectors these are upstream, midstream and downstream segments. **Upstream section** involves the process of exploration, development and production of crude oil and natural gas. **Midstream section** is the transportation and storage refining of crude oil or natural gas into consumable petroleum products. **Downstream** section refers to the conversion of crude oil and natural gas into thousands of finished products or refined products are made available to the consumers through supply and distribution to registered petroleum retail stations (Sylvester, Shima, Rani, & Shaikh, 2011).Crude oil it is a compound of carbon and hydrogen found naturally in the earth's crust and contains small amounts of oxygen and nitrogen and metallic minerals. Crude oil/petroleum/ enters a refinery and is refined into different types of fuel Products at different temperatures the refining process is called **fractional distillation.** The following are Petroleum products obtained by refining crude oil that benefits of fuel to the consumer.

A, **Motor and aviation gasoline**: - Motor fuel is the fuel used for cars/vehicles with gasoline engines and small airplanes. It is known for its volatility and good ignition characteristics. These two characteristics contribute significantly to the car's power and acceleration which helps the fuel to ignite more easily when cold without engine knocking. Refined gasoline boils in the range of 30-225C^0 and its hydrometer ranges from 0.700 – 0.760.

B, White jet fuel /Kerosene/: - This oil is mainly used in domestic fuel for burning, cleaning, heating and producing insecticide, light lamp, herbicide and also useful in cooking and power jet engines. White Kerosene Oil can be easily stored for several years and its hydrometer ranges from 0.750 – 0.810.

C, Diesel/Naphtha/ fuels: - Diesel is the type of fuel used for high density engines. The main use of diesel is for trucks, buses, taxis, ships, boilers for power generation. Because of high compression engines are self-igniting and heat is what ignites the fuel, it does not need a spark plug. The main characteristic of diesel fuel is ignition quality, which is known as cetane number. Diesel fuel boils between 150-370 C^0 its hydrometer ranges from 0.800 – 0.860.

D, Jet fuel/: - Jet fuel is mostly a mixture of paraffin, kerosene, naphthenic and to a lesser extent olefins and aromatic hydrocarbons. Jet fuel has good combustion and high energy content. Jet fuel is the fuel used for commercial aircraft and military aircraft with turbine engines.

E, Lubricating Oils (lubricants, waxes, asphalt): - Lubricant is a substance which is used to control (more often to reduce) friction and wear of the surfaces in a contact of the bodies in relative motion. Depending on its nature, lubricants are also used to eliminate heat and wear debris, supply additives into the contact, transmit power, protect seal, protect chains and other components reliably against wear and corrosion.

F, Heavy and Light Black Diesel (HFO and LFO)

i) **Light fuel Oil (LFO):** Crude oil condensate is mainly utilized in the generation of energy in residential and smaller industrial liquid-fuel consuming machinery. It is bright in colour and has an average density of 0.82 to 0.86.

ii) **Heavy fuel Oil (HFO):** is a residual fuel incurred during the distillation of crude oil. It is used to generate motion and/or heat that have a particularly high viscosity and density. Heavy fuel oil is mainly used as a marine fuel.

2.3. Conceptual Framework

2.3.1. Background of Petroleum and Oil Gas Industry

The petroleum and oil gas industries are significant contributors to the world's economic growth. According to the Worldwide Energy Agency, global consumption of energy is predicted to increase by 1.5% per year until 2030 (Inkpen & Moffett, 2023). The need for energy is expected to increase by 60% in 2030 in comparison to the Century Year 2000. Considering substantial effort on renewable sources of energy, the use of fossil fuels, such as petroleum, natural gas, and coal are decline and predicted to supply biofuel products to meet the majority of the world's expanding energy requirements by 2030. However, the oil and gas industry are unique, and just a few sectors create significant petroleum oil to satisfy the requirements of the population. The modern oil and gas industry began in 1859, when Colonel Edwin Drake (Inkpen & Moffett, 2023) discovered the first petroleum in Pennsylvania.

Petroleum oil and gas project administration practices are comparable to those used in other mega projects. Mega projects are massive, challenging projects which typically spend as much as a billion dollars and require many years to conceive, implement and include several public and private participants, are fundamental and benefit millions of citizens (Flyvbjerg, 2017).

The petroleum oil and gas company are also known for huge expenditures, big interactions and advanced administrative duties. The scope and extent of these projects necessitate special consideration during the project administration procedure (Adedeji and Samuel, 2022). Investigators determined five significant phases in the oil and gas implementation process. These phases are imaginative, practicality, comprehensive layout, equipment purchasing, and construction/start-up. Alvarado and Wagner (2002) established seven project implementation phases. These are Engineering and Technology, shipping, manufacturing, installation and link up, transportation, certification and establishment and finally maintenance and operation.

In the global economy, petroleum oil and gas projects face obstacles by a number of factors, particularly when in their implementation timing. These are include overtaking expenditures and time, lack of resources and qualified workers, regulatory incompetence and inappropriate laws and regulations, inadequate scheduling and strategy, insufficient advancement command and scope of work, unsuccessful project procedure evaluation and oversight, and adjustments project scope, delayed reactions from accountable authorities, product purchasing, project communication administration, manpower and project time administration, mechanical engineering, handling project integration, management of project quality and project managing risks.

In the African context, scientists have explored the factors that cause to project failures in a variety of companies. A study conducted (Ika, 2014) identified certain of the elements that impact project achievement or failure. Several African countries address problems such as a favourable atmosphere, insufficient availability of materials, a lack of educated labour, nepotism, safety issues, and ineffective policy formulation and execution. Furthermore, barriers highlighted by petroleum oil and gas companies which are impeding the expansion and development of the petroleum sector in Africa include political involvement, ambiguity and delays in enacting laws, energy policies, and regulations, which are the primary reasons why projects do not achieve.

Ethiopia's petroleum and natural gas company remains in its earliest phases, with the first well dug in the 1950s by Sinclair while operating in the Ogden Basin (Purcell, 2014). From the 1970s, different companies have gone to Ethiopia seeking for hydrocarbon deposits. Tenneco was the first company to find petroleum in the 1970s, followed by Russian Mining Company in the 1980s. In the 1990s, the Ethiopian government founded Calub Gas Share Co. with a loan from the World Bank to explore for its newly discovered gas. However, the Calub Gas Company was dissolved few seasons later (The World Bank, 2016). PETRONAS, a subsidiary of the Malaysian National Oil Company, agreed on a Petroleum Production Sharing Contract with the Ethiopian government in June 2007 for the purpose of investigating petroleum and natural gas in the Ogden Basin (The World Bank, 2016). Following four years of inquiry operations across the country, PETRONAS discontinued the contract because of not sufficient observable products, finical management, security and technical issues and some others companies in different time periods are agreed in Ethiopia in the production and operation petroleum products these are POLY-GCL Petroleum Investment Limited, South West Energy (HK) Ltd, New Age, Delonx, Falcon Petroleum and Tallow Oil company’s but now these are eliminated or blocking their projects implementing of the petroleum and oil gas exploration productions due to varies reasons. This might be due to the fact that the country's petroleum industry is still in its childhood and the sector is highly politicized. Exploration were taking place in a variety of locations in the previously of decades, which includes in the areas of the Ogden Basin in the southeast region of Ethiopia, Afar in the Northeast Ethiopia, Southern Rift Basin, the Gambela Basin, the Mekele Basin, Metema Basin, the Abay Basin in North western and Main Ethiopian Rift Basin regions (Ministry of Mines, Petroleum and Natural Gas, accessed on April 17th, 2019), but these company are now terminated or dropped its agreement due to financial, lack of skilled manpower, management, security, political and technical issues. As a result, the country's petroleum sector has not been effective at obtaining significant international companies.

2.3.2. Consumption and Marketing of Petroleum Products

The Demand and marketing for regulatory petroleum-based products, which include Automotive Gas Oil, Kerosene, and regular motor gas fuels made from petroleum, has risen in recent years, with the exception of the latter half of 2020/21fy, which was disrupted by COVID-19 pandemic and Northern part of internal conflict. Even though, more capital required for investment more investors joining to the investment of petroleum companies and retiles dialer stations. Up to writing this paper in Ethiopia there are above 50 registered petroleum-marketing companies and almost 1500 registered retail fuel stations (Ethiopian Petroleum and Energy Authority Report, 2023). These companies' market, offer for sale, and transport petroleum products such as diesel, kerosene, gasoline (petrol), lubricants, liquefied petroleum gas (LPG), jet fuel, HFO, and LFO. Importing petroleum goods through the EPSE provides availability to all petroleum-based goods at an identical price, ensuring competitiveness in the petroleum sector. The sector has become competitive in recent years. However, in comparison to other African countries, it is still insufficient to serve more than 126 million people and 1.4 million registered vehicles. Despite the fact that a large portion of the population lives in rural areas, the majority of these gas stations are in cities. To make the company more desirable to investors, the Ministry of Trade and Regional Relation (MOTRR) is formulating another ruling, which suggests to modify the profit margins of distributive companies and dialers. These are now the company and dialers have been gained and modify a profit margin from 0.23 cents/litters to 0.88 cents/litter in all petroleum products.

Tabel 2. 1. shows the fuel retile marketing stations in others African countries.

Country's	Number of Fuel Retail Stations	Sealing Price per Litter
Ethiopia	1500	31.74
Uganda	3200	60.56
Kenya	2160	65.49
Egypt	3560	70.45
Tanzania	2170	82.25
Sudan	1150	55.65
Nigeria	5827	45.53
South Africa	5000	62.65

As we see from the above table the retail fuel stations in Ethiopian is not enough to survive 126 million peoples as to compared with others African counters and this is also indicating that the growth rate of Ethiopia is still undermine.

2.4. Theoretical Literature

The petroleum and oil gas industry are one of the world's most important and largest sectors of economy, driving politics, manufacturing, logistics, enterprises, trade, communities, and farming and irrigation (Pinto & Slevin, 1987). Petroleum has been utilized for waterproofing, construction, and lamps since prehistoric times. The petroleum and oil gas industry include any operations such as drilling, exploitation, distillation, transportation, and commercialization of petroleum and gas-related goods in the following three major sectors: upstream, downstream, and midstream (Sylvester, Shima, Rani, & Shaikh, 2011).

Petroleum and oil gas became in demand resources in modern times as methods for obtaining and refining fossil fuels advanced and demands driven by technology rose. Throughout the 19th and 20th centuries, the United States and Russia emerged as the two dominant nations in the petroleum oil sector, occasionally joined by Canada, Mexico, Iran, Trinidad, Saudi Arabia, and Venezuela.

George Henry Bissell and a group of entrepreneurs was created Pennsylvania Rock Oil Company in 1855 to find an improved replacement for asphalt-derived kerosene. They engaged Edwin Drake, who on August 27, 1859, at Oil Creek in Titusville, Pennsylvania, built the first drilled petroleum effectively, which is widely regarded as the beginning of the modern petroleum revolution. The Standard Petroleum Company, founded by John D. Rockefeller in 1870 and eventually monopolizing more than 80% of the petroleum products market swiftly surpassed the newly renamed Seneca Petrol Company.

The petroleum and natural gas industries shifted to heating and cooking services, whereas the petroleum sector found a market in the newly created car transportation segment. In 1909, regulations regarding antitrust forced Modern Petroleum Company into 34 firms; however, by the 1940s, three among these companies, together with four other foreign companies, expanded to become the industry leaders and acquired the moniker "seven Sisters". These include Seneca Oil Company (1858), Anglo-Persian Oil Company (1909), Turkish Petroleum Company (1910), Gulf Oil (1901), Texaco (1901), Standard Oil Company (1870), and Royal Dutch Shell (1907).

As nations that exported petroleum became more mindful of their natural assets and ready in capturing the benefits of the petroleum industry's assets, large businesses were forced to strike arrangements in order to continue extracting oil. Following World War II, a fifty-fifty profit-sharing system was established, but oil-exporting nations quickly began reorganizing corporations with the goal to gain greater authority over earnings. Petroleum supply and pricing were in an unsatisfactory equilibrium for both oil supplying and oil importer nations, frequently disrupted by politics and conflicts, resulting in a series of petroleum shocks and worries in the second half of the 21st century.

2.4.1. Relationship between petroleum consumption and GDP

Many scholars around the world have conducted extensive research on the relationship between energy consumption and economic growth. Unfortunately, the actual findings are varying among countries, as is the technique and methods used. However, there aren't many researches looking into the relationship between petroleum use and GDP. As a result, academics have proposed a variety of testable hypotheses with relationship-related policy consequences.

The first theory is hold as petroleum consumption is necessary for economic growth, since energy is both a direct and indirect input in the production process, supplementing labour and capital inputs (Wanjiku Eunice Wambui,2 Dr. Omondi S. Gor, 3 Dr. P.O. Machyo, 2021)(Ebbon, 1996; Toman & Jamelkova, 2003). In this case, a unidirectional Granger causality between petroleum consumption and GDP indicates that the country's economy is petroleum-dependent, and that policies encourage energy consumption should be implemented to stimulate economic growth, as insufficient energy facilities may limit economic growth.

The second hypothesis, known as the "Conservation" hypothesis, states that policies aimed at reducing petroleum consumption and waste, such as greenhouse gas reductions, efficiency improvement measures, and demand administration regulations, may have no negative impact on real GDP (Mehra, 2006). The "conservation" concept is supported if an increase in GDP causes a rise in petroleum consumption. However, it is feasible that a developing economy hampered by political, infrastructure, or resource mismanagement causes inefficiency and a drop-in demand for products and services, including petroleum use. If this is the case, an increase in GDP may reduce petroleum usage.

According to the third "impartiality" theory, petroleum consumption is a negligible component of real GDP and so should have no substantial impact on economic growth (Asafu-Adaye, 2000; Jumbe, 2004). In this case, energy conservation initiatives may not have an unfavourable effect on real GDP. The absence of Granger causation between energy consumption and real GDP supports the "impartiality" argument.

The fourth hypothesis implies a bidirectional relationship between energy consumption and economic growth. The feedback hypothesis argues that energy consumption and real GDP are inextricably linked and may complement one another. In this case, increases (declines) in energy consumption correspond to gains or decreases in real GDP, and vice versa. In this case, the "feedback" theory is supported by evidence of bidirectional granger causality between energy use and real GDP.

The other Standard economic growth theories have identified labour, capital, and technological innovation as drivers of economic growth and development. Energy consumption, access, coverage, and use all have a significant impact on economic growth potential, particularly in developing nations (Stern et al., 2019). The key topics to consider are service quality (infrastructure development) and sustainability (the use of renewable energy sources). Increased petroleum consumption and use are critical for technological growth because they allow for greater economies of scale in production.

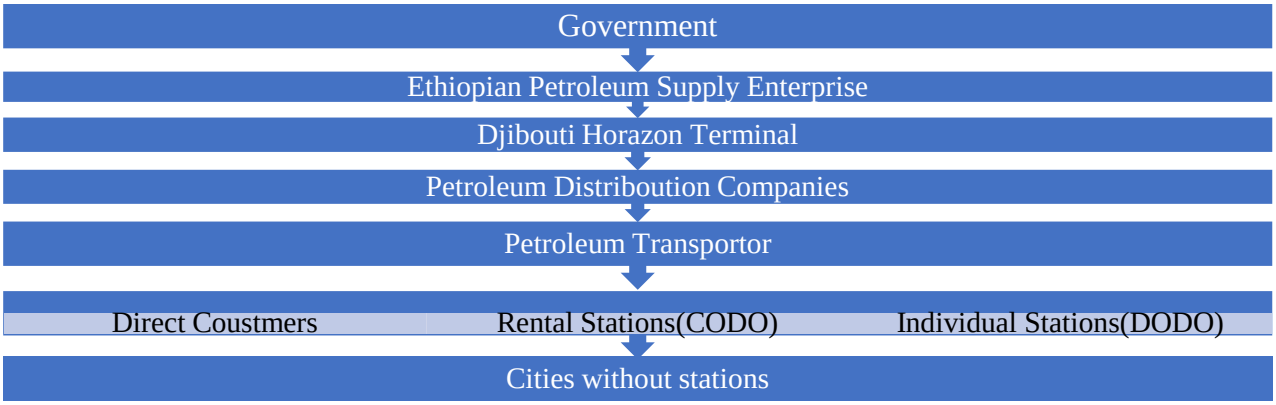
2.4.2. Petroleum Marketing Policy Framework

Petroleum is a major source of energy that is marketed with wholesale and retail prices customized by the government. This oil marketing policy has been implemented in our country for more than half a century, but due to lack of control, monitoring and support system that can be said to be strong considering its age, it is still a sector where many problems are reflected. The government wanted to make fuel trading governed by a different policy framework because fuel is a source of energy that is bought entirely from abroad this is paid more foreign currency for the national income. Following the increments of world petroleum prices, the country's economic activity is having a great impact, and it is necessary to look at the petroleum trading at different time periods. The majority of Ethiopia's petroleum distributor businesses are controlled by the Ethiopian Petroleum Corporation (EPC), which also controlled and operated the country's only refining products in Assab prior to June 1991. Transport to the interior demand areas is primarily handled by the National Transport Corporation and individual truckers. Since 1996, four oil companies have been responsible for the distribution and marketing of petroleum products, these are Agip, Total, Mobil and Shell, who operate depots, tank trucks, and filling stations around the country. However, as of the date of this research, around 50 company have invested in the importation and distribution of petroleum products that are refined.

In Ethiopia, petroleum logistics management system plays an important role to the countries transportation and distribution of petroleum. According to investigations, supply and logistics in this industry are still in early stages, and they are one of the most restricting constraints to the sector's growth. The main factors include the distance from the source of petroleum to the port, the insufficent status of Djibouti's port, the lack of a comfortable route, security issues, a lack of credit usage, a lack of state backing up, a lack of consumer demand facts, and a lack of the latest technological advances. As a result, the country periodically experiences fuel scarcity.

The structure of the supply chain is shown below.

Figure 2. 1 shows the petroleum Marketing policy structure of Ethiopian policy



2.4.3. The oil marketing system policy in the period of King and the Derg:

An agreement between the government and oil distribution companies to purchase fuel products from DHT and distribute them at the retail outlets built in the country. Before the signing of the Distribution Agreement in November 1967, there was four foreign oil companies that directly imported and distributed refined oil, namely Total, Shell, Agip and Mobil. Although there is no information about when these oil companies started working before this agreement and how they were working, it is said that Total Company was buying and distributing refined fuel from the foreign market and importing it. In the year According to the agreement made in 1967 a government company established for the purpose of importing crude oil through the Ethiopian Oil Refinery Association and information indicates that after the crude oil was refined the above companies were distributing it to consumers at wholesale and retail prices settled by the government.

After -mentioned agreement was in force for 12 years, it was revised and signed again in April 1979 during the Derg regime. At this time, a government organization called Ethiopian Oil Corporation was made to manage Asab Oil Refinery. The agreement is also known as Restatement of Distribution Agreement. The content is similar to the original agreement, where an attempt has been made to make the procedures more clear. It has been learned that the four foreign oil companies mentioned above have been distributing oil for several years until 1996 .

2.4.4. Oil marketing policy and practice in the EHAD era:

After the fall of the Dreg government some changes have been made in the fuel marketing sector as a result of some policy adjustments made by the EHAD government. Among these the instruction given by the Cabinet of Ministers regarding the fuel price reform procedure as of September 1996, which is still undergoing some reforms is mentioned. Apart from this, the distribution agreement that was made with the government has been left and fuel distribution companies have signed direct purchase in EPSE and sale contracts with fuel importing companies and are now distributing fuel in fuel bulk to consumers. Because the foreign purchase or import of fuel is done entirely by the government (EPSE), is not enough compared to the country's fuel demand and some users and distributors are complained and due to basic purpose of the Ethiopian energy sector strategy (1994) is to enable improved access to reliable and affordable modern energy supply using efficient and cleaner energy technology in an environmentally sustainable way, to promote the country's long-term social and economic development. But know the previous 1994 policy has been reviewing and has planned to present it to the government for approval. The approval policy covers the evolution and introduction of various technologies such as electric rail, electric cars, hybrid autos and flexi-fuel vehicles. Shifting to these technologies will lessen independent on oil imports and reduce the country’s carbon footprint. Unlike

the 1994 strategy, the current draft energy policy (2015) has paid more attention to the evolution and development of electric power infrastructure connections, not only as a source of foreign currency, but also as an important factor in the irrigation of agricultural products, distribution of power at all and region's geopolitical stability.

2.4.5. Oil marketing policy and practice in the Prosperity era:

After the fall of the EHAD government, some changes have been made in the fuel marketing sector as a result of some policy Administration adjustments made by the FDRGE. Among these, the instruction given by the Cabinet of Ministers set the institution and there is structure to manage, monitoring and evaluating quality of products, elimination of fuel credit sales and initiation of hand-to-hand sales, improving and implementing pricing and profit margin procedures, adjusting that reflect the global price of oil sales that are being sold at a loss, To support the expansion of investment in gas stations, establishing a marketing system in cities that do not have petroleum stations, regulate the fair distribution and logistics of fuel between companies, regions, stations and developing electronics marketing platform, establishment of tell birr system for those who buy fuel directly from companies.

Throughout a decade, Ethiopia had just ten functioning petroleum suppliers. That is already history, with the number nearly four times to decade and 42 companies and 1200 stations was in November 2021, but now to reach 50 companies and over 1500 fuel stations by 2023. Furthermore, the shareholder structure of these organizations has shifted dramatically. While petroleum suppliers developed decades ago were mostly owned by foreigners or big companies, they have been replaced by those who owned by Ethiopians and the government to attract local companies. Companies have been required to build their own storage facilities with a minimum capacity of five million litters of fuel, in addition to having at least five fuel stations reduced to only half a million litters and two stations, which should grow to six in five years. The depot size requirement shrunk after the enterprise increased its own reserve capacity.

Tabel 2. 2. Shows number of petroleum distribution companies in Ethiopia

Year	Foreign Company	Local Company	Total Companies	Petroleum Retile Stations
Until 1992	4	-	4	68
1993-2013	3	4	7	160
2014-2021	6	21	27	860
2023 up to now	5	47	52	1500

Source: - Ethiopian Petroleum and Energy Authority

2.5. Empirical Review

Research on the link between petroleum consumption and economic growth has been widely explored, although results vary among countries and methodologies. In Ethiopia, the consumption of petroleum products becomes increase in the last five years and its imported price also increase. The insufficiency supply and increasing price of petroleum products combined with environmental pollution cause, the country has resulted in increased the efforts of to find other alternative energy resources and biofuel productions. The instability of global fuel price causes variability for both biofuel and feedstock's price uncertainty influence the feasibility of biofuel investments. As a result, the one of the objectives is promoting the production of biofuel products i.e. bioethanol and biodiesel is profitable and used to minimize the impacts of fossil fuel petroleum consumption of the country.

(Gebremeskel and Tesfaye 2008), Ethiopia has an overall land surface of 1.2 million Sq.KM and is expected to have a predicted probable surface of around 25 million hectares of agricultural land appropriate for biofuel feedstock manufacturing. Ethiopia is viewed as one of the most suitable nations in Africa for tapping renewable sources of energy because of its geogeraphical location. The results show that bioethanol production (from molasses) can be very profitable in Ethiopia and the biofuel industry can be seen as a way out of poverty. Although most registered companies had the intention of following large-scale commercial development especially those companies registered to grow energy crops for biodiesel production, these only two of the sugar factories Finchaa and Metehara currently produce bioethanol. The government's biofuel strategy to encourage domestic biofuels production, with an objective of reducing the dependence on high- cost fossil fuel is also a manifestation of this endeavor (MoME 2007). Even though rising world prices of fossil fuel, there are no biofuels investment activities in Ethiopia with a focus on bioethanol and biodiesel production. Besides, Ethiopia boarded on a 5% blend of bioethanol production in transport fuel in 2008, which was raised to 10% a few years later. Although Ethiopia's Climate Resilient Green Economy (ECRGE) strategy expects a 5% biodiesel blend in transportation fuel and rising electrical power production from renewable sources of energy from domestic and Ethiopian goods by 2030, (FDRE 2011), biodiesel blending in transport fuel has not yet started in Ethiopia. As part of Ethiopia's first national Growth and Transformation Plan (GTP I), the country was to produce 181,604 cubic meters of bioethanol from sugar by products (molasses) by the end of the GTP I period 2010/11-2014/15 (MoFED 2015). Furthermore, the development of bioethanol facilities in conjunction with current and incoming sugar factories was envisaged; however, this has yet to materialize, owing to the fact that the projected ten new sugar plants under construction are not yet operational due to a variety of causes. Nevertheless, the

opportunities and challenges presented by rising biofuel production have sparked extensive policy debate (Searchinger et al. 2008; Azar 2011), which is still ongoing.

Many empirical researches on the petroleum consumption-CO2 emissions nexus in Ethiopia have not previously been done. Furthermore, none of these researches sought to investigate the possibility of mediating/moderating roles of other factors on the environmental consequences associated with increased energy consumption or to assess the effects of economic expansion on CO2 emissions. Grossman and Krueger (1991) established the environmental Kuznets curve theory, which proposed that the effects of economic expansion on environmental quality are non-linear and represent an inverted U-shape.

Researchers and academics on this topic are to identify the gaps in the preceding relevant works. The energy sources petroleum was employed to test this relationship. The findings of the co-integration technique suggest that the current period's petroleum usage and economic growth are positively correlated. Apart from fossil fuels, whose correlation was positive, there, was an adverse association found between lag levels of petroleum use and economic development.

Adegbemi, Olalekan, Babatunde (2013) looked into the connection between Nigeria's economic growth and energy use from 1975 to 2010. Ordinary least squares and co-integration methods were used to evaluate secondary time-series data and the outcome demonstrates that in the long term all energy consumption away from coal consumption moved similarly with economic development. The empirical findings show that Nigeria's economic growth is significantly and favorably correlated with the use of petroleum, electricity, and coal energy. However, although being favorable, Gas consumption has little impact on economic growth. Coal's influence was negative but large, therefore now is the time to enhance its use for the country's benefit

Narayan et al. (2017) discovered that between 1985 and 2013, the wealthier states of India observed a prevalence of the feedback hypothesis between real GDP growth and petroleum consumption in both the short and long run. Akinlo (2021) provides data to support the cointegration of petroleum consumption and economic growth, with causality running only from economic growth to petroleum consumption in Nigeria from 1981 to 2015. Throughout 1981 and 2019, the price of petroleum oil affected the amount of its consumption, which in turn affected the level of economic growth in Nigeria; Adebisi et al. (2023) demonstrated that petrol and diesel prices have a negative and considerable impact on the production output in Nigeria. However, previous to this analysis, Anfofum (2018) analyzed annual data from 1970 to 2016. The analysis demonstrates a long-run and dynamic link for all factors excluding commercial oil consumption and oil price variables, which have no short-term impact on

Nigeria's GDP. Furthermore, capital and labor were found to have a greater impact on output growth than energy use. Oil prices have a negative long-run influence on real GDP while having a positive short-term impact. Independent studies on the relationship between petroleum energy consumption and economic growth in countries other than Nigeria (Kenya, South Africa, Pakistan, and India) were also conducted, although with divergent results. Wanjiku (2011) studies the relationship between Kenya's petroleum use and economic growth from 1980 to 2009. The results showed that the series were co-integrated; petroleum use has a positive short-run impact on real GDP. The long-run model shows positive production elasticity in relation to petroleum consumption.

Ziramba (2015) examines the long-term and causal links between oil consumption and economic growth in South Africa from 1970 to 2008. The findings support unidirectional causality from oil consumption to economic growth. In India, Habib (2019) looks at the relationship between petroleum use and economic growth from 1980 to 2014. The study found that petroleum consumption had a long-term significant impact on India's economic growth. In the short run, there was also a unidirectional causal relationship between petroleum consumption and economic development. In conclusion, the empirical findings described in the reviews on petroleum energy versus economic growth were not homogeneous.

Masih and Masih (1996, 1997, and 1998) used the Johansen methodology to examine energy use and economic growth using several Asian economies. In Masih and Masih (1996), they found a long run energy income relationship for India, Pakistan and Indonesia but no long run relationship for Malaysia, Singapore and the Philippines. Masih and Masih (1997) used income, energy consumption and energy prices for Korea for the period 1955 to 1991 and for Taiwan for the period 1952 to 1992. They found bidirectional causality. On the other hand, Masih and Masih (1998) found a relationship but no evidence of directions for Thailand and Sri Lanka. Reddy and Yanagida (1998) considered energy consumption and economic activities in Fiji and concluded that total energy use in the commercial sector was sharply reduced as a result of structural changes in the economy and an increase in the efficiency of energy use.

Using gross domestic product and energy consumption with co-integration and Granger causality, Cheng (1999) for India used data for the period 1952 to 1995, Cheng and Wong (2001) for Singapore used data for the period 1975 to 1995; Aqeel and Butt (2001) for Pakistan used data for the period 1955 to 1996 and applied the technique of co-integration and Hsiao's version of Granger causality. They found that economic growth Granger causes energy consumption in their respective studies. Hwang and Gum (1992) found bidirectional causality while Cheng and Lee (1997) found no long run relationship for Taiwan. On the other hand, Yang (2000) used different types of energy consumption;

oil, gas, coal and power to test for the causal link with gross domestic product in Taiwan. Using data for the periods 1954 to 1997, he found t unidirectional causality from economic growth to coal consumption and concluded that different forms of energy exhibited different direction of causality.

Glasure (2002) employed a five variable Vector Error Correction Methodology to study causality between economic growth and energy consumption in Korea. Government expenditure was used as a proxy for government activity, money supply was used as proxy for monetary policy and oil prices were included as important factor explaining the causality using data for the period 1961 to 1990. Structural breaks of two oil price spikes were further included as dummies in the model. He found bidirectional causality and the oil price was found to have the biggest impact on energy growth and energy consumption.

Soytas and Sari (2003) tested the time series properties of energy consumption and gross domestic product. They reexamined the causality relationship between the two series in the top ten emerging markets—excluding China due to lack of data and G-7 countries. They found bidirectional causality for Argentina and causality running from gross domestic product to energy consumption in Italy and Korea and from energy consumption to gross domestic product in Turkey, France, Germany and Japan. This implies that energy conservation may harm economic growth in the last four countries.

Oh and Lee (2004) also studied South Korea but shifted the data set ten years ahead to consider the period 1970-1999. They considered energy, labour and capital to be important production factors for generating gross domestic product. They used a Vector Error Correction methodology and found bi-directional causation.

There are not many studies which investigate oil consumption and GNP interaction. Zou and Chau (2005) found no cointegration between oil consumption and GDP, in China for the period of 1953-2002. Due to liberalization of China's economy in 1984, they separate these periods into 1953-1984 and 1985-2002. They found cointegration relationship between oil consumption and GDP. In 1953-1984 periods, they found no causality between oil consumption and GDP in the short run; conversely, they found bidirectional causality in the long run. In 1985-2002 period; in short run they found unidirectional causality from oil consumption to GDP; however, in the long run there was bidirectional causality as in 1953-1984 period.

2.6. Overview of Literature

Investigating how petroleum consumption impacts on economic growth is crucial for developing energy resource and environmental policies. This study of literature review aims to summarize pervious research based on the link between petroleum consumption and economic growth and further related research papers to date of know. Since Kraft and Kraft's (1978) pioneering work, numerous studies have found unidirectional, bidirectional or no causality, depending on the country and methodological analyzed. Furthermore in certain countries, the outcomes are varying over time, making it difficult to draw perfect conclusions. Jumbe(2004) and Ghali and El-Sakka (2004) with regard to several empirical contributions, found evidence of a bidirectional relationship between Malawi and Canada respectively.

The study's findings vary depending on the variables examined and the analytical technique employed to evaluate causality, despite disparities in structural and economic policies among countries are happen. Initially, the causal relationship was assessed using the Granger (1969) test technique. The techniques assume that data series are stationary at first difference and there is co integration relationship between variables. Granger (1986) and (1988) argue that these tests do not capture long-term relationships between variables, limiting their ability to uncover them. As a result, empirical findings on causal links using these tests are often disagreeing. This study was used the bounds test co-integration approach to analyze the relationship between petroleum consumption and GDP for a single country, which is now considered the most appropriate method for investigating causality due to its ability to overcome previous problems in Ethiopia.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Data collection methods

As you know, two types of data collection methods have been used to conduct the study depending on the finding of objectives and source of data, these are primary and secondary data collecting method is used to obtain data. Primary data collection methods include questionnaire, phone contact surveys, formal and informal interviews, experiments and observations with various actors and experts which allow researchers to gather specialized and precise information. However, in economics, several study papers mostly used secondary macroeconomic time series data in their analyses, with data sourced mostly from the Literature review, conducted during the phases of thesis formulation, which include: the theoretical background information presentation, Reports, journals, strategy documents, newspaper articles, workshop papers, books, research papers, online sites, policy documents, and proclamations pertinent to the study were all studied, both electronically and in print. The literature review was used to develop the study on existing experiences because the topic of study for Ethiopia is new

3.1.1 Sources of Data

Many econometric analysis rely on the availability and accuracy of data were collected from different sources. The study was commanly used secondary macroeconomic time series data spanning for 31(1992/93 to 2022/23FY), to address the impacts of petroleum consumption on the Ethiopian economy. The era is chosen depending on the accessibility and accuracy of appropriate data for research and findings. The volume and Price of imported petroleum products were collected from EPSE and EPEA , RGDP and domestic capital investment from NBE, Labor Force from CSA and others relevant data was collected from Statistical data base of World Economic Outlook databases and Ethiopian Economic Association (EEA) and statistical data base of IMF, WB, AFDB. The analysis also relies on data collected from suggestions, conversations, and surveys from experts and stakeholders over the past two years regarding institutional field supervision activity throughout the country. It is also based on an analysis of previous reports filed to the Ministry of Water and Energy, PEA, and other researchers' background, journals, ppublished articles or papers newspapers, magazines and periodical research papers, educational materials, institutional annual reports done in the country and related websites.

3.2. Research Design

The analysis was done using an explanatory research design of trend studies, which showed the patterns and described the problem and the implications of petroleum consumption on economic growth in greater detail, as well as creating practical hypotheses from empirical output of results. This design enables to showing the cause of underlying problem and reasons for implementation of petroleum and oil gas projects and develop others alternative renewable energy resource use in Ethiopia to minimized the government expenditure and subsidy. The research approach was employed quantitative research of time series data throughout the use of petroleum consumption, unit price of petroleum products, Labor Force, Domestic Capital investment and RGDP data.

3.3. Variable description

The meanings of all variables were dependent and the explanatory variables that are included in the model are sated and expressed as below:

Petroleum consumption (PC): This is the annual year volume quantity of petroleum products consumed (in metric tonnes) over a certain time period.

Average Unit Price Petroleum Products (AUPP): AUPP is the Average Unit Price of petroleum product which is the settled by the government in the exchange of purchasing and selling of Petroleum that are ups and down in given period of seasons based on world curd oil price change. It is updated by government on each, monthly, quarterly and annually. Which is obtained by the sum of unit price of each petroleum products divided by number of products type (AGO, MGR, Jet Fuel, Kerosene, LFO and HFO) with in corresponding year.

Real GDP (Y): is known as the yearly quantity of actual gross domestic product (GDP) divided by the overall work force/labour/ of human population, which is regarded as being the most accurate measure of economic development that reflects an economy's standard of life.

Labour force (LF): In this research, the labour force is expressed by the entire population working age of 15 to 64 years. Population is calculated using the actual description, which includes every citizen irrespective of legal nationality or citizenship (WB, 2020). Although the labour force's level of performance is significant in output, GDP and labour force are expected to be positively related. However, if it can't be utilized effectively and is not as profitable, it may become a burden on economic growth due to a high rate of unemployed.

Domestic Capital Investment (DCI): The act of investing in a country's own companies and products instead of foreign ones. It can be a key component of a country's GDP, and is used to measure a nation's economic activity. Capital is defined as the total expenditure as a proportion of GDP. Logically capital expressed as gross domestic capital accumulation (total expenditure) as a proportion of GDP is predicted to have a beneficial effect in actual economic growth rates.

3.4. Model specification

3.4.1 Theoretical Model Specification

The study's theoretical model is based on the Cobb-Douglas production function model for economic growth equation, which has been updated to account for the impact of petroleum consumption on economic growth in Ethiopia. According to Solow's growth model, economic growth is driven by capital accumulation, labour force enlargement and technological advancements that increase productivity. Solow's model describes the production function as follows:

$Y_t = F(LF_t, DCI_t, At)$ …… (3.1)

Where Yt= is economic growth, DCI= Domestic Capital Investment, LF=Labor force and A= technology change.

However, the general production function model links economic growth (measured by output or RGDP) to a collection of economic variables, with an implicit causal relationship between these variables and economic growth. This approach assumes that output is determined by a Cobb-Douglas production function of the form:

$Y_t = A_t LF_t^a DCI_t^p$ …….. (3.2)

Where Y_t is aggregate output (GDP), A is production efficiency at time t, LF is labour force, and DCI is the country's investment capital. A modified Cobb-Douglas production function can be used to investigate the link between petroleum use and economic growth. The modified production function can be written as follows.

$Y_t = A_t LF_t^a DCI_t^p PC_t^q AUPP_t^r$ ... ... (3.3)

Where Y_t is aggregate output (GDP), A_t is efficiency of production at time t, LF_t is labor force at time t, DCI_t is Domestic Capital of the investment, PC_t is petroleum consumption, $AUPP_t$ Denotes Average unit price of Petroleum products, t denotes time period a, p, q and r are shares of LF, DCI and PC and AUPP respectively. Expression of equation (3.3) in log linear form by taking the logarithmic transformation of the production function on both sides gives;

$\log Y_t = \log(A_t) + a \log LF_t + p\log DCI_t + q\log PC_t + r\log AUPP_t$ …….. (3.4)

The basic concept of growth implies periodical changes in input from periodical changes in outputs (Banister 2000) i.e. Y is changed when the values of A, LF, DCI, PC and AUPP changes over time.

3.4.2. Empirical Model Specification

The empirical counterpart of equation (3.3) can be written as:

$$\text{In}RGDP_t = \alpha_o + \alpha_1 \text{In}LF_t + \alpha_2\, lnDCI_t + \alpha_3 lnPC_t + \alpha_4 lnAUPP_t + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.5)$$

Where: InRGDPt = Natural logarithm of RGDP,

InLFt = Natural Logarithm of Labour force ,
InDCIt = Natural Logarithm of demostic capital ,
InPCt = Natural Logarithm of Petroleum Consumption ,
$lnAUPP_t$= Natural Logarithm of Average unit price of petroleum products,
And $\alpha_{o,}\alpha_1, \alpha_2\alpha_3\ \alpha_4 \wedge \alpha_5$ are parameters to be estimated and e_t is a random error term.

3.5. Data Analysis

According to Kothari (2020) states that statistical analysis is a set of closely connected methods aimed at analysing obtained data and modelling it in a way that addresses a particular issue." In this study, both descriptive analysis using Microsoft Office Package of Excel, the trend, line graphs and tables and charts are used to Present the data and the Inferential statistics econometrically analyzed using STATA such as stationary, Granger Causality Test and co integration test are used and the assumption of Normality, Homoscedastic, Autocorrelation are cheeked for to determine the degree of integration to avoid the problem of spurious regression and Additionally, the research employed the Error Correction Model for co-integration test, which was developed by Pesaran and Shinet (2001) to determine the long and short-term correlations between economic growth and the factors that influence it in specific Petroleum Consumption and other independent variables. The econometric software programs STATA 17 was used to perform the analysis of assessments.

3.5.1. Econometric Data Analysis

In many macroeconomic variables the estimators' characteristics and application for estimation and hypothesis testing are determined by how well the data performs. When analysing the usual regression model, we did not consider the time period of the explanatory variable(s) on the dependant variable. The typical regression model assumes that a change in one of the explanatory variables results in a change in the dependent variable during the same time period. However, such specifications are rare in economics. In economic phenomena, a cause frequently generates an effect after a period of time, which is known as a lag. As a result, accurate representations of economic interactions frequently involve the inclusion of lapped explanatory values or lagged dependent variables.

In economics many macroeconomic time series variables are not stationary at level, and OLS regressions between them are frequently spurious. A linear combination of variables, on the other hand, can be stationary even if a single variable is not. According to Granger (1988), those variables are co-integrating for time t, implying a substantial relationship over time exists.

3.6. The nature of Time Series Data

Time series data differs from cross-sectional data in one clear way it is ordered in period of time. A time series Y_t refers to a process monitored sequentially throughout period of time (t = 1, …, T). Where t represents the dependence on time, we apply new notation with the subscript t denoting the particular observation and T denoting the number of observations. Due to the sequential structure of time series, we anticipate that Y_t and Y_{t-1} are not independent. Thus, traditional assumptions are invalid. When studying time series data, we must remember that the past can influence the future but not vice versa. economists study time series data like import-export, GDP, Consumption, Interest Rate, National Income ,inflation and so on are the most common time series data that are important in economic analysis and interpretations'. The data was collecting, organizing, presenting, analyzing and interpreting only at the national level. Unfortunately, time series data hold their own challenges and Components. These are Trend, Seasonal, Cyclical, Ordinal, and Irregular Components, but for this paper we show the trend and Seasonal components variations of time series data.

Trends: Trends are the consistent upward or downward movements of variables across time. It might be difficult to distinguish trends over time. Trends may be compromising the consistency and approximate normality of OLS. Many macroeconomic variables have long-term trends, such as actual gross domestic product and actual consumption per capita (in this instance, petroleum consumption) and other determinant variables

When we talk about trends, there are two common types of trends:

Deterministic Trends: $E(Y_t) - E(Y_{t-1}) = a$. The trending variable changes by a steady amount at every time interval.

Stochastic Trends, $E(Y_t) - E(Y_{t-1}) = b + V_t$, Shows every time period $V_t$the trending variable varies by an arbitrary proportion.

3.7. Stationary and non-stationary stochastic Processes

3.7.1. Stationary Stochastic Processes

A time series process, also known as a stochastic random process, is a series of random variables that are indexed by time. A group of random variables arranged periodically is called a stochastic or random process. When we collect a time series data set, we obtain one possible outcome, or realization, of the stochastic process.

Stationary stochastic processes are a type of stochastic process that requires a lot of focus when performing time series analysis. In general, a stochastic process is said to be stationary when its mean

and variance remain unchanged over time and the value of the covariance between two time periods is determined simply by the distance/gap or lag between the two time periods rather than the actual time at which the covariance is calculated. In the time series literature, this type of stochastic process is referred to as weakly stationary /covariance stationary or second-order stationary stochastic process. In other words, if a time series is stationary, its mean, variance, and auto covariance (at certain lags) remain constant regardless point we measure them at time invariant.

3.7.2. Non-Stationary Stochastic Processes

A non-stationary time series (weak stationary) is one that is not stationary in the way that has just been defined. In other terms, a no stationary time series is one that has a time-varying mean, variance, or both. A time-series exhibits a trend if its mean changes over time, E(X_t) =μ_t . As a result, the presence of a trend implies a violation of mean stationary, which produces all of the issues concerning inference from statistical data.

3.7.3. Test of Stationary

To determine if a time series is stationary or not, statistical methods such as the Augmented Dickey-Fuller (ADF) test, unit root test, the KPSS test, or a visual assessment of the plot can be used. If the time series is not stationary, it could be essential to make it stationary by means of the differencing technique. The ADF test is a popular method for determining the stationary of a time series. It looks for the presence of a unit root in the data. The KPSS test is another common test that examines for trend stationary in data and is frequently used in conjunction with the ADF test.

3.8. Estimation Method

The investigation was examined at how petroleum use affected Ethiopian economic growth from 1992/93 to 2022/23. So far, many approaches to time series data analysis have been employed to investigate the relationship between the variables of interest under consideration. They include OLSE, VAR, and ECM. However, in this research, the Error correction model (ECM) and Co-integration test in the form of the Unrestricted were employed.

The ARDL model is recommended among many conventional time series data models due to offers several advantages. Firstly, the ARDL technique is able to used regardless of either the repressors are I(1) or I(0). Secondly, although Johansen co-integration approaches required a large number of samples for reliability, the ARDL method produces statistically significant results with small numbers of samples (Pesaran, Shin, et al. 2001). It eliminates the issue of biased caused by small numbers of samples (Chaudhry & Choudhary 2006). Thirdly, the ARDL technique produces unbiased and reliable

estimations of the long-run model even when part of the regressive variables are endogenous (Pesaran, Shin et al. 2001; Harris and Sollis 2003).

Furthermore, the ARDL method uses only one simplified formula, whereas the other co-integration methods estimate long-run correlations in the context of system equations. The ARDL Method allows for the inclusion of a dummy variable in integration tests, unlike Johansen's method (Rahimi and Shahabadi, 2011). To fulfil the study's aims, the model of economic growth equation is estimated using the ECM economic method. Following Pesara et al. (2001),

$$\Delta y_t = a + \rho y_{t-1} + \beta x_{t-1} \sum_{j=1}^{q} \delta \Delta y_{t-j} + \sum_{j=1}^{p} \gamma \Delta x_{t-j} + e_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.6)$$

Where Δ indicates the first differential operation, y_t is for a vector of dependent variables, x_t is a vector of p determinants of y_t regressors, e_t is the residual term which is taken to be white noise. Essentially, the ARDL Method to co integration (Pesaran and Shin 1995) includes estimating of the error correction model (ECM) version of ARDL model for the determinant's growth of the economy. Using the variables under examination, such as a log of real GDP per capita, petroleum consumption, values of petroleum consumption, labour force, and domestic capital the model above becomes

$$lY_t = a + \beta_o lY_{t-1} + \beta_1 lLF_{t-1} + \beta_2 lDCI_{t-1} + \beta_3 PC_{t-1} + \beta_4 AUPP_t + \sum_{j=1}^{p} \gamma^o \Delta lY_{t-j} + \sum_{j=1}^{p} \gamma^1 \Delta lLF_{t-j} + \sum_{j=1}^{p} \gamma^2 \Delta lDCI_{t-j} + \sum_{j=1}^{p} \gamma^3 \Delta lPC_{t-j} + \sum_{j=1}^{p} \gamma^4 \Delta lAUPP_{t-j} + e_t \ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

Where, lYt, lLFt, lDCIt, lPC t, $AUPP_t$ and t respectively are the natural logarithm of real GDP, labor force, domestic capital investment, Petroleum consumption and Average Unit Price of Petroleum Products at time t.

$\beta_o, \beta_1, \beta_2, \beta_3, , \wedge \beta_4$ are coefficients that are measure long run relationships.

$\gamma^0, \gamma^1, \gamma^2, \gamma^3, and \gamma^4$, are coefficients that measure short run relationships. All Other things are as they are defined earlier.

3.8.1. Unit root test

The initial step in analysing time series data was to check whether the series stationary or not. These required checking for unit roots in order to accurately test a hypothesis about the relationship between variables having unit roots, which have an integration of a minimum degree one. As the consequence, we determined whether the time series met the requirements of condition (1). For this writing paper the Augmented Dickey Fuller (ADF) and Persons test was used to determine whether a time series was stationary or not.

A variable is stationary if its mean, variance, and auto-covariance remain constant across time. However, the majority of macroeconomic variables in real life are not stationary. This takes place when a variable exhibits consistent long-run movement or becomes unpredictable over a long period. Thus, adequate care needs to be done to ensure that the variables are steady in order to prevent the problem of

spurious regression before proceeding with the estimation. **Spurious regressio**n is common when least square regression is applied to non-stationary variables. In this situation, a significant association can be found even when the variables are unrelated and the study's results can be applied to determine the behaviour of the variables at one point of time but not for the different period under study.

Because most macroeconomic time series data are unlikely to be stationary, the first step is to test for the presence of unit roots in order to avoid the issue of Spurious Regression (Tadesse 2011). Several methods have been used to convert non-stationary time series variables to be stationary. If a variable has a deterministic trend and including it in the regression eliminates the trend component and makes it stationary and the process is called **trend stationary**. However, most time series variables have a characteristic of stochastic trend so it needs to be differenced in order to obtain stationary and the process is called **difference stationary process** (Gujarati and porter 2004). The number of unit roots in a given variable determines how many times the variable should be differenced in order to make it stationary.

The ADF regression model used to test unit root in time series Y_t is written as follows:

$\Delta Y_t = \rho_{1_t} + \rho_{2t} X_{t-1} + \sum_{i=2}^{q} \rho_i \Delta X_{t-i} + e_t$ ……. (3.8)

In this model, Y_t is a time series dependent variable that is depends on other independent variable and X_t is dependat varaiable at time t, t is a time trend variable, Δ indicates the first difference operator, $\rho_i is$the estimated parameters, e_t is the error term or white noise with zero mean and constant variance, q is the optimal lag length of each variable chosen so that first-differenced terms are introduced to remove serial correlation in the residual.

In the ADF test statistics in the null hypothesis test a unit root is exist in a time series sample/the series is non stationary/. However, in the alternative hypothesis unit roots does not exist/ the series is stationary/.

The ADF model's parameter of interest isρ, and the null and alternative hypotheses test are as follows:

$H_O: \rho i = 0,\ V_s\ H_1: \rho i \neq 0$……..…… (3.9)

The decision criteria: The ADF Unit root test specifies that the ADF test statistic value must be greater than the Mackinnon Critical Value at 5% level of significance, then the series are side to be stationary at a level and if otherwise. In another way, do not reject the null hypothesis—that is, the unit root exists, when the computed ADF test statistic value is less than the ADF critical value at a 5% level of significance. All of the series are once differenced to make them stationary if they are not stationary in levels. As a result, it is argued that these series are integrated of order one l(1). The variables in the current study had unit roots, meaning they weren't stationary at levels, but after their initial differencing, they became stationary.

3.8.2. Co-integration test

When the variables in the current study were stationary', hence, the next step was the co integration tests are conducted to find situations in which two or more non-stationary time series are co integrated relationship in the level form, in such a manner that their long-term deviation from equilibrium is avoided. Co-integration analysis was performed to determine whether or not the variables of interest have a long-run relationship after the unit root test was used to evaluate the order of integration of the variables under consideration. The Engle–Granger, Johansen, and Phillips co-integration tests are the most often utilized techniques for testing co-integration.

Pesaran, Shin, et al. (2001) state that the bound test approach for co-integration can be used to determine the long run relationship or co-integration among the variables of interest. The joint Wald test or F-test, which overall distribution is unconventional under the null hypothesis of no co-integration, is the primary basis for the bond test approach. Such a co-integration test can be performed by formulating the following null hypothesis of no co-integration test.

H0:$\rho_0, \rho_1, \rho_2, \rho_3, \rho_4, \rho_5, = 0$, means there is no long-run relationship among the variables of interest.

H1:$\rho_0 \neq \rho_1 \neq \rho_2 \neq \rho_3 \neq \rho_4 \neq \rho_5$ means there is long-run relationship among the variables of interest.

Decision criteria: Given that the test is referred to as a bound test, the upper and lower bound critical values are compared with the computed F-statistics. According to the test's criteria, if the computed F-statistics are higher than the appropriate upper bound of the critical value, the alternative hypothesis can be accepted and the null hypothesis—that there is no co integration among the variables can be rejected. On the other hand, if the computed F-statistics is less than the appropriate lower bound critical value, then the test it cannot be rejected; on the other hand, if it is between the lower and higher bounds, the result is not conclusive.

3.8.3. Error Correction Model

After testing the co integration test in relationship l (1) was founded, the Error Correction Model (ECM) was estimated. If the test shows cointegration, ECMs are prepared in terms of first differences, which typically remove trends from the variables complicated, and they determine the problem of spurious regression. In order to manage non-stationary data, an Error Correction Model (ECM) considers both the short-term dynamics and the long-term equilibrium relationships between time series variables. The process by which departures from the long-run equilibrium are gradually corrected is referred to as "**error correction.**" The error correction term in an ECM expresses how much the disequilibrium from the previous period affects the corrections made in the current period. This enables the model to represent both transient variations and the rate at which the variables revert to their initial states.

Estimating the ECM

i). The short-run Dynamics: To estimate the short-run dynamics regress the differenced variables and incorporate the lag in the error correction term; which tracked any shifts in the first differential between the variables GDP (Y) and petroleum consumption (PC).

$\Delta y_t = a + \rho(L)\Delta PC_{t-1} + ae_{t-1}$……...(3.10)

ii). Long-run Relationship: Estimate the long-run relationship using ordinary least squares (OLS): $Yt=\beta 0+\beta 1Xt+\varepsilon t$. Which means assessed the relationship between both variables' levels (Y and PC). To evaluate the long-term association between $variables$, the static model must be estimated.

$Y_t = \rho_1 + \rho_2 PC_t + \rho_3 LF_t + \rho_4 DCI_t + \rho_5 AUPP_t + e_t$ …….. (3.11)

From equation 3.10, the ECM can be specified as follows;

$\Delta Y_t = \rho + i = 1 \sum \rho_2 PC_{t-1} + \sum_{i=1}^{q} \rho_t \Delta PC_{t-i} + e_{t-1}$…….. (3.12). Where; $\Delta Y_t and\ \Delta PC_t$are the first difference of variables, and e_t is the error term from a regression of $Y_t \sim PC_t$. Whereas PC_t, represents preceding periods equilibrium error (or disequilibrium term) period. If $e_{t-1} > 0$, indicates that PC_{t-i} is too high above its equilibrium, hence in order to recover the equilibrium, ΔY_t must be negative which means that the error correction coefficients must be negative, ensuring that (equation 3.12) is stable in a function of time. Because $PC_{t-i}$is above its equilibrium, then it will begin to decline in the following period in the equilibrium and the error will be repaired in the model, hence the error correction model. According to equations (3.11) and (3.20), PC is the long run parameter while Y and a are short run parameters.

3.8.4. Granger Causality Test

The Granger Causality Test determines the direction of causality (unidirectional or bidirectional) between time series variables in the VAR models. Both X^2 and F-statistics are used to test the joint null hypothesis of Granger-non-causality, which states that there is no unidirectional or bidirectional causality between the variables under consideration.

Granger (1969) devised a time series data-driven approach to determining causality. When x aids in the prediction of y, it has an impact on it, according to Granger. In this method, "useful" means that x can improve the dependability of the forecast for y when compared to a forecast that only examines y's past values. Throughout this study, we sought to see if the distinct aspects of petroleum consumption "Granger cause" economic growth and the opposite is true.

A long-run association was established; hence a Granger-causality test was used to determine whether petroleum consumption contributes significantly to explaining the temporal course of GDP growth.

Assume two time series Y_t and X_t, a Granger causality test designed to determine whether Xt affects future Yt values and vice versa. The unrestricted equations are written as follows.

$Y_t = \beta_0 + \sum_{j=0}^{J} \beta_i Y_{t-j} + \sum_{k=0}^{K} \gamma_k PC_{t-k} + U_t$ ……. *(1)* And

$PC_t = \alpha_0 + \sum_{j=1}^{J} \alpha_j PC_{t-j} + \sum_{k=1}^{K} \beta_k Y_{t-k} + V_t$ ……. *(2)*

Where: Ut and Vt are serially uncorrelated white noise residuals or random error terms,

j, k is lag lengths for each variable, and α_0, α_j, . .β_0,,,, β_k are parameters to be estimated

PC_{t-k},Y_{t-j} refers to lagged values of dependent variables in equation (1)

PC_{t-j},Y_{t-k} refers to lagged values of independent variables in equation (2)

We tested for Granger causality by analysing the statistical significance of the coefficients of PC_{t-k} on equation (1) and Y_{t-k} in equation (2) was statistically significant. The null hypothesis investigated in equation will be that PC does not Granger-cause. i.e.

i) Ho: Yo = Yi = Yk =0 and Y does not Granger-cause PC (Ho: $PC_1 = PC_2 = PC_i = PC_k$ =0)

ii) H1: Not Ho

3.9. Diagnostic Tests

Model diagnostic tests are applied before evaluating and interpreting the estimated parameters. Diagnostic and stability tests assess the model's reliability of the variables and are performed to determine whether the model and predicted parameters are accurate and interpreted correctly or not. It determines whether significant variables are eliminated and irrelevant variables are included, the models are correctly formulated and parameters are estimated and assumptions are satisfied. The tests include are normality test, model representation, serial correlation, and the stability of the model. A further criterion for the error term's distribution is its normality. The influence of the variables included in the error term is minimal and at best random if they are normal for every observation. The varied lag values of the error term are tested for correlation using the serial correlation test. The model definition specification, which verifies that the used model is free of bias or error, is the other important test. It also verifies the structural form of the model, assumptions made, and the exclusion or inclusion of significant factors as well as unrelated variables.

3.10. Optimal lags selection

There is no set of standards for choosing the ideal lag length and it is mostly an empirical issue. Damodar Gujarati Basic Econometrics, say that there is no predetermined guideline for the maximum length of the lag. The researcher must keep in mind that when successive lags are estimated, the number of degrees of freedom available decreases, making statistical inference relatively unstable. Economists are rarely fortunate enough to have a long series of data from which to estimate several delays. More crucially, in economic time series data, subsequent values (lags) are highly correlated, increasing the possibility of multi collinearity in the model.

In a modern approach using annual data, the number of lags is often minimal, 1 or 2 lags, such that degrees of freedom are preserved. With quarterly data, 1 to 8 lags are adequate and in a monthly data, 6,12,or 24 delays can be employed if there are enough data points.

For example, if there are few observations in VAR estimation, it is common practice to utilize AIC to determine the lag length that "prefers" the more parsimonious models. However, the information criterion with the least criteria value, which indicates the best lag length, was used.

3.11. Model Selection Criteria

The research applied the criteria to determine the quality and best good fit of the model selected based on the common model selection criteria. The chosen model's reliability is determined using a standard assessment. The AIC and BIC are two popular model selection measures in time series analysis. Both criteria are used to evaluate the quality of fitted models while considering the level of complexity. The model with the lowest AIC is considered to be the best fit in terms of goodness of fit, and it is chosen.

3.12. Model Stability

The general stability of the long-run and short-run coefficients is examined using the CUMSUM square recursive residuals and CUMSUM recursive residuals tests, which are suggested by Pesaran and Shin (1997). In order to evaluate the given parameter consistency, Pesaran and Shin (1997) proposed that the cumulative sum (CUMSUM) and the cumulative sum of squares (CUMSUMSQ) of the recursive residual test, as proposed by Brown et al. (1975), are a better way to examine structural stability of the long-run and short-run relationships for the entire period. If the cumulative sum crosses the two key lines and stays outside of the region, the regression equation is correctly defined, according to the null hypothesis of these tests.

3.13. Test for omitted variables

The final diagnostic test involves applying Ramsey's RESET test to check if there is a misplaced variable in the model and determine whether or not the model has omitted variable bias. When one or more independent variables are incorrectly excluded from the linear regression model equation, it is known as omitted variable bias. The Wald test, which adds independent variables to the model equation and assesses whether they explain the dependent variable, can be used to test this. The process involves measuring the bias after first removal vector of misplaced variables.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.0. Introduction

This section covers the findings of an empirical analysis using the econometric framework presented in chapter three, along with the preparatory tests that need to be performed in order to determine the Granger Causality Test, ECM, method to co integration. The thesis is designed with considering 1992fy as base and 2023 as need year with the main objectives of the possible production of biofuel from molasses and share gasoline -motor transport fuel, for bill reduction, CO2 emission reduction by substituted ethanol and others renewable energy sources.

The study investigates the impact of petroleum consumption on economic growth, as well as the short and long run interactions, within the context of the constructed Error Correction Model (ECM) and the co-integration relationship between the variables using the latest co-integration test approach published by Pesaran et al. (2001). The results of the studies obtained from the collected data are presented and discussed with inferential and descriptive statistics.

4.1. Petroleum consumption in the Economic Sector

Ethiopia's economy is among the fastest-growing in Africa, with average GDP growth above 10% in the last few years. The main economic sectors are largely depending on agriculture which accounts for 41.1% of GDP and Employs 80% of the labor force of Ethiopian population. However, the service sector is also rapidly expanding and accounts for 41.1% of the total GDP and industry is 17.8% of GDP. At increment of petroleum consumption, the value of petroleum is highly increased at increasing rate because of increase in world Price of cured oil. Petroleum is used in Ethiopia's transportation, commercial, industrial, and residential sectors. The Ethiopian economy's on-going variability in the supply and market price of petroleum products and power demonstrates inefficiencies in meeting demand and highlights the difficulty. The Ethiopia’s economic structure categorize in three sub sectors, these are agriculture, industry and service sectors. In Ethiopian economy the last 31 years the contribution of Agriculture and Service in economic growth is 41.1 and industry sector is 17.8 percent. Despite the COVID-19 pandemic's effects and the violence in the north part of countries, the GDP was 32.5% in 2020/21 and RGDP increased by 6.3% for the fiscal year 2020/21, which was marginally more than the 6.1% growth in the previous year. The country imports around 3.9 million metric tons of refined petroleum products in 2022/23 at a cost of roughly 223.2 billion Birr. The transportation sector in Ethiopia uses 54.29% of the total volume of petroleum products consumed, followed by the

agricultural sector. From the total value of imported petroleum products, 66.40% was AGO, 17.14% MGR, 13.73% jet fuel, 1.57% kerosene, and the reset 1.16% are other products. For these products the sector-wise distribution of petroleum consumption in Ethiopia is concerned as the transport sector uses 54.29% of the total volume of petroleum products consumed, followed agricultural (32.87) %), industrial (11.50%) and Household and other service sectors (1.34%).

Tabel 4. 1. Percentage distribution of GDP by major economical sectors structure

Sector	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Agriculture	34.9	33.3	32.5	32.5	33.9	36.3
Industrial	27.0	28.1	29	29.3	27.8	24.7
Service	39.2	40	39.5	39.2	37.3	39
Growth in Real GDP	7.7	9.0	6.1	6.3	5.3	5.8

Source: National Bank of Ethiopia annual report 2022/2023

i) Agriculture

The agriculture sector is most dominant economic performance in Ethiopian economics sector. The petroleum products for this sector plays vital role in irrigated farms of water pumps and its uses 32.87% of the total consumption of petroleum products in 2022/23FY. The expansion of agricultural farms (cotton, sugar-cane and fruit farms) and related agro-industrial processing units (ginnery, sugar-cane, fruit canning) can also be supported by hydro- or geothermal-based electricity, provided that additional inputs and methods for producing ethanol are available. This benefited from the creation of jobs and savings on foreign exchange through the development of commodity exports or import substitution and the manufacturing of ethanol can reduce the amount of gasoline used. In certain cases, the agricultural sector can even contribute to the growth of the energy sector. For example, if petroleum prices raise gradually, sugar-cane plantations producing ethanol—a proven gasoline extender at a 20 percent blend—might prove to be financially viable. In order to help satisfy household energy needs, additional fuel-wood plantation afforestation and replanting is being worsened by population growth and urbanization.

ii) Industry

The availability of a varied set of energy resources can also benefit and facilitate economic sector. Furthermore, industry may help the energy sector by creating and storing energy. The availability of hydroelectricity, geothermal, coal and petroleum products can have a significant impact on the economic viability of various energy-intensive industries, including mining (such as gold), mineral processing and refining, chemical and building materials, as well as the production of instruments and

implements, energy utilizations and equipment, textile mills, food processing industries, breweries, and wood-based businesses.

Generally, process heat would come from coal and geothermal hydropower, while motive power and regulator energy would come from petroleum. On the other hand, electricity is flexible and may supply all of a plant's energy requirements. For the purpose of meeting Ethiopia's construction steel needs, a fictitious steel plant with an annual production capacity of 100,000 tons would need about 600 million kwh of electricity for the refining, melting, and manufacturing of steel from minerals.

The cost of producing that much hydroelectricity would be around 60 million Birr. However, if electricity were generated from thermal sources (particularly oil), it would cost at least three times as much. The petroleum products, especially diesel, HFO, and LFO products play a significant role and it consumes 11.50% of the total imported petroleum products due to this in the construction and production of another output of industry use of petroleum the exhale palliated the environment.

iii) Transport

Due to the increase number of vehicles in the country the demands of petroleum in the transport sector also increase this shows the growth of social and economic activities. In Ethiopia above 1.2 million vehicles and 154 air craft were resisted for to give service and these vehicles are used AGO, Jet Fuel and MGR petroleum products for Motor engine and the sector accounts for about 54.29% of the total petroleum consumption. Petroleum imports consumed about 40 to 60 per cent of the foreign exchange and export of goods earnings of the country in the 2022s. Given the increasing function of the modern transport sub-sector and increases in petroleum prices, a more efficient use of petroleum in the transport sector can have negative suggestions on the economy as a whole. Such efficiency improvements can take the form of better maintenance and upkeep of vehicles to keep down the fuel consumption of vehicles, optimized the use of haulage capacities and fuel consumption monitoring, modal shift to mass transport systems such as buses in cities, train and electrical vehicles etc.

Due to the increment of petroleum price in the nearest years' country uses other alternative methods of transport. Now in the near 10-years trolley buses is work on Addis Ababa to Dire Dewa and Djibouti to give trnspaort and cargo service but now the number to give the service is decreased due to electric drop system, mentainance and lake of skill man power. But trolley do not appear to be a viable alternative to urban bus transport until such a time when gasoil prices rise significantly. Now in recent 4 years Ethiopia is experiencing a rapid transition to electric vehicles (EVs) had driven by a government prohibition on the import of gas-powered cars and reduced import taxes on Evs. Due to this EVs give service can be a superior alternative to other modes of transport in cases where passenger/cargo transport demand level is sufficiently high and electricity supply is not a limitation.

The country currently has about 100,000 EVs However, the government estimates that number will quadruple, at the year of 2032. So, Electric vehicles are better way to reduce values of imported petroleum consumption and reduce environmental Pollutions and CO2 emissions. For example, in the year 2007/08 the value of imported diesel and gasoline which are almost used 65.8% and kerosene 16.7% was used for in the transport sector, thus out of the total petroleum imported in the year 2007/08, 82.5% was used for transport sector.

iv) **Households and Communities**

Households and communities used from the total of 1.34 % petroleum Products consumption and mostly can take advantage of the relatively abundant biomass-based energy for cooking and lighting. Urban residents, in particular, can benefit from hydroelectric power now and potentially from natural gas extracts in the future. Photovoltaic technology has the potential to alter rural households and communities' life styles. At the projected low prices, PV energy can be used for lighting, television, radio, clinics, hospitals, mills and water lifts. In contrast, rural households can aid the energy sector by planting fuel-wood and animal dung. Households can also make significant contributions to the sustainability of domestic energy supply and environmental protection by utilizing more efficient cooking stoves. For example, in 2018/19 from the total values of imported petroleum 74 TCal (1.16%) was used for household cooking and 10.8% is used for light and heavy fuel type used in finances and boilers.

Tabel 4. 2. Shows 5 Years trends petroleum consumption in economic sector (in Tcal)

Year	2018/2019		2019/2020		2020/2021		2021/2022		2022/2023	
Agriculture	1784	28.05%	1896	28.15%	2134	32.95%	2356	31.41%	2673	32.87%
Industry	834	13.11%	713	10.59%	623	9.62%	895	11.93%	935	11.50%
Transport	3669	57.68%	4050	60.13%	3639	56.19%	4125	54.99%	4415	54.29%
Households	74	1.16	76	1.13%	80	1.24%	125	1.67%	109	1.34%
Total	6361	100%	6735	100%	6476	100%	7501	100%	8132	100%

Source: - Ethiopian Water and Energy Minister

4.2. Petroleum Energy

Petroleum energy dominates the commercial energy market in Ethiopia, providing more than 70% of the country's total commercial energy consumption, of which roughly 54.3% was used by the transportation sector. It is a major economic growth determinant of the country for industry, agriculture and Service Sector. Petroleum's impact as an energy source is evident and primarily felt in the economic development. In this study the role of petroleum as an energy resource that boosts economic growth is downplayed not because it is the least important.

4.2.1. Trends in Petroleum Products consumption in Ethiopia

Ethiopia imports refined petroleum products directly from abroad; it does not own a refinery. The most important petroleum products that are imported into our country include Diesel, MGR, Jet fuel, HFO, LFO, and Kerosene. These fuels are used for the application of transportation, industry, water pumping, household cooking and lighting and manufacturing. Out of all petroleum products imported in the 202/21 FY, three fuels (diesel, MGR, and jet fuel) accounted for 90 per cent of volume at 3,617,242 metric tons, and 94.76% of the total cost at 111,417,923 in thousand Birr. This indicates the economic activity in agriculture, transport, construction of buildings, roads and high activity of industrial sectors of such economic activity is higher and depends on petroleum products and other petroleum products account for 149,932(10%) in Volume and 6,165,998(5.24%) in thousands Birr in value of the total imported petroleum products. In Ethiopia the demand and Consumption of petroleum products are increased in the past five years and the amount of petroleum imported was rapidly increasing. In the last five years Ethiopia had double digit economic growth. However, the rate of increment of petroleum price in the last five years was much higher than the rate of volume of petroleum consumed in the country. For example in the fiscal year 2021/2022 the amount of petroleum the country imported was showed 0.66 % decrease from the previous year while in the same period expenditure on petroleum price was increased by 24.62 %. One of the major reasons for this disparity is the sharp increase in the price of petroleum in the international market in the last few years. Thus in the last five years, the cost of petroleum import increased almost exponentially. Such high cost of petroleum import pose serious challenges to the country's developmental activities.

Tabel 4. 3. Shows the %age Change of Volume in MT and value in '000 Birr of petroleum products in 2019/2020 up to 2022/2023

	2019/2020		2020/2021		Percentage Change	
Products	Volume(Y1)	Value(X1)	Volume(Y2)	Value(X2)	Y2/Y1	X2/X1
MGR	633,952	19,698,388	693,329.00	31,555,450	9.37	60.19
AGO	2,603,509	70,831,580	2,609,662.00	106,996,142	0.24	51.06
kerosene	69,853	1,899,265	63,107.00	2,587,387	- 9.66	36.23
Jet fuel	565,984	20,887,955	441,518.00	23,249,081	- 21.99	11.30
Others	82,034.89	1,478,519.72	76,774.00	2,082,225.00	- 6.41	40.83

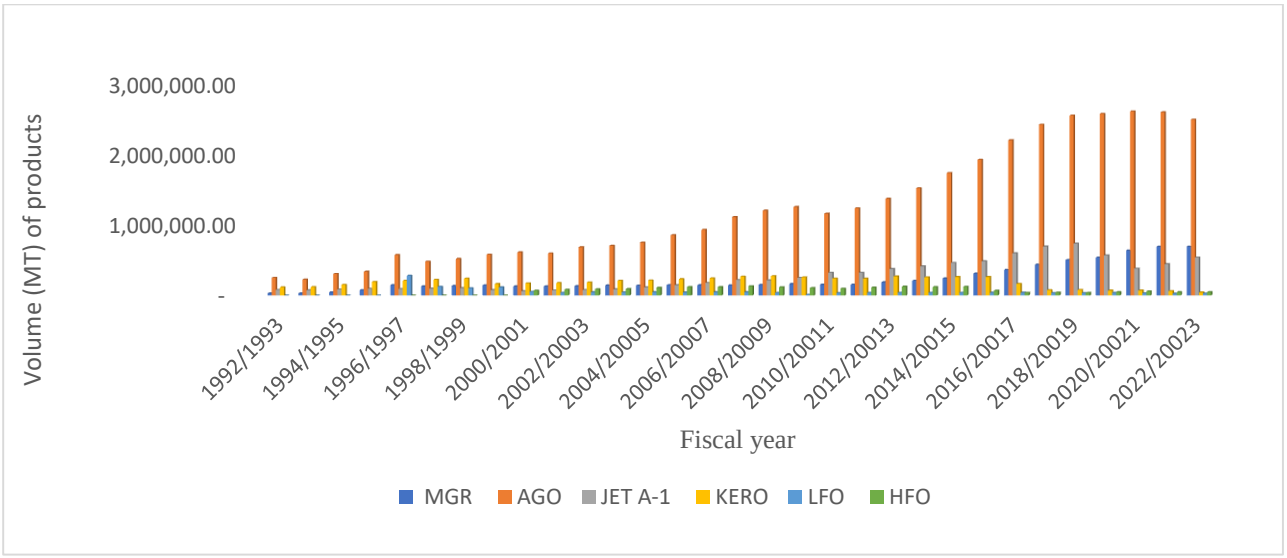
	2021/2022		2022/2023		Percentage Change	
Products	Volume(Y1)	Value(X1)	Volume(Y2)	Value(X2)	Y2/Y1	X2/X1
MGR	693,329	31,555,450	688,747	39,324,820	- 0.66	24.62
AGO	2,609,662	106,996,142	2,591,077	142,509,235	- 0.71	33.19
Kerosene	63,107	2,587,387	61,227	3,367,485	- 2.98	30.15
Jet fuel	441,518	23,249,081	535,744	35,180,800	21.34	51.32
Others	76,774.00	2,082,225.00	71328.00	2798513.00	- 7.09	34.40

When we see Table 4.3 above four years the amount of imported petroleum products in 2019/20 to 2020/21 and 2021/2022 to 2022/2203 FY of AGO and MGR are increased whereas Jet fuel decreased in relatively to previous year due the impacts of Covid-19 pandemic and to the security issue of northern part of Ethiopian region most of the economic activities are limited and the transport are used by Ethiopian airline travel, where as in jet fuel are increased and its values also sharply increase this is due to sharp increase of world petroleum price and economic activities.

Figure 4. 1. *Shows the Volume in (MT = metric ton) and value in thousands Birr of imported petroleum products.*

As we see in the figure 4.1. Above the volume and values of all petroleum products are increased in parallel as the data obtained from 31 years. This indicates the consumption of petroleum increase and its values are also higher increase and the consumption of diesel is 60% of the total petroleum consumption this shows diesel is the most widely used petroleum products at all economic activities in Ethiopia.

Figure 4. 2. Shows trends of Annual consumption of petroleum products Volume in MT



A). Diesel (AGO); - As shown in the fig 4.2 above diesel is the most widely imported petroleum products in the country. The figure shows in the last 31 years the total volume and values of imported diesel is 60% and 61% share distribution from the total imported petroleum products in Ethiopia. The

amount of diesel from 1992/93 to 2021/22 FY is increase exponentially this indicates the increase in transport vehicles, industry and agricultural sector of in economic activity in the country. At the same time the value of products is parallel with rapid increase in the price of petroleum products in the global cured oil market price. But the demand of petroleum has also sharply increased due to high economic activity of the country.

B). Gasoline (MGR); - The second most imported petroleum products in Ethiopia. The figure shows in the last 31 years the total volume and values of imported MGR is 11% and 15% share distribution from the total imported petroleum products. The amount of imported MGR from 1992/93 to 2021/22 FY is increase exponentially and the amount of imported gasoline in 2021/22 FY shows a 9.34% increment change from the previous year. When compared to the percentage share of gasoline from the total petroleum import was increased from 11% in 1992/93 to 18% in 2022/23. Similarly, the percentage share of value was increase at increasing rate in from 9% in 1992/92 to 18% in 2022/23. This indicates that the economic activities of water pump in agriculture and automotive vehicles are increase in the country.

C). Jet Fuel: - The third most type of imported petroleum products in the country. In the above fig 4.1 the volume and values of jet fuel imported is 13% and 17 % respectively shared distribution for the total imported petroleum products. In the last ten consecutive years from 2009/2010 to 2019/20 the imports of jet fuel show higher increments both in volume and values. In year 2009/10 compared with total volume of jet fuel imported in 2019/20 was increased from 3.26% to 6.69% and its value from 2 % to 9% this shows the growth of economic activities of exit and enter of Ethiopian airline travel and Cargo activates, now a day the Ethiopian Airlines offers daily and multiple departures with a minimal layover in Addis to nearly 155 international passenger and 68 cargo destinations, including 63 African cities. The airline operates over 270 flights per day to a wide range of international destinations and local travels.

D). Kerosene: Kerosene is the most used fuel type of imported potoleum products in rural area for purpose of household cooking and lighting. The volume and value of Kerosene accounts for 10% and 5% of the total imported petroleum product. In the last ten years the consumption kerosene is decrease at decreasing rate from year 2009/10 to 2019/20. For example, in the year 2009/10 the volume of kerosene consumption is 6% decrease from the previous year and 2019/20 the volume decreases to 11% from previous year. This indicates the country uses solar and electric power instead of kerosene for purpose of lighting and household cooking. However, the unit price and Value of kerosene is

increasing at increasing rate in the last ten year as same unit price to diesel to minimize the adulteration of kerosene to diesel.

E) Other: The others imported petroleum products are LFO and HFO are share distribution of volume 6% and value 2% of the total imported petroleum products in the last 31 fiscal Years of the study periods. The LFO and HFO petroleum products are commonly used in small- and Large-scale manufacturing industry and construction of roads. The consumption of LFO and HFO does not show the consecutive increase or decrease consumption trends of the graph and but the values are increase at decreasing rate based on the increment of world cured price.

Generally: - The increase in demand of petroleum consumption is highly increased from year to year. For example, in the initial year of this study period 1992/93 the total volume of imported petroleum products is 1.09% and in 2022/23FY is 6.37% increment from the total of imported petroleum products of 31 years.

4.2.2. The impacts of petroleum Consumption on economic Growth

In the 31 years' study period from 1992/93 to 2022/23 Ethiopia imports almost 69.5 million MT of petroleum products with value of 1.08 billion in thousand birr this was used almost 85% Ethiopian export earnings for purchasing of imported petroleum products. For example, in the fiscal years 1992/93 import of petroleum consumed up to 43% of the country export of goods earnings and in 2004/05- 2006/07, petroleum import accounted for 78, 86 and 84% of the country's export earnings, respectively. But in now, all the export earnings of the country was not sufficient to pay for the import of petroleum. This indicates the amount of money used to import petroleum was increased expontaliy in comparison with the amount of income gained from export of goods in the country. So, the amount of value used to import petroleum was sharply increased in comparison with the amounts of income gained from country's exports of goods and services. This was the period where petroleum price is shocking its highest peak in the international curd oil price market. So, to import other commodities of machineries, spare part, medicines and others goods the country must find the required foreign currency through other means of loan and foreign aid. This is clearly showed the impacts of petroleum consumption on economic growth of developing country like Ethiopia. Due to this to lower the impacts of petroleum consumption on economic development and to reduce the environmental Pollution of CO2 emission and finical development in the country, it is important to investigate and invest on another alternative energy source as partial substitutes for imported petroleum products, to balance the export- import income of country and gained for money from foreign currency.

4.3. Descriptive Statistics

The table 4.5 below displays the variables' descriptive statistics summary. With the exception of Domestic capital investment and the values of petroleum consumption, all variables have a normal distribution, as shown by a skewness coefficient of between -2 to +2. Whereas, all positive values of skewness indicate that the tail is on the right side of the distribution. Similarly, kurtosis in the VPC & DCI shows a positive excess value (> 3) indicate the distribution is peaked and possesses thick tails and the distribution is leptokurtic result with the exception of the VPC and DCI and LF value, is less than 3 indicate the distribution is flatter than the normal curve and implies platykurtic.

Tabel 4. 4. shows the discrivitive Summary Statistics

Statistics

Variables		Petroleum Consumption in MT(PC)	Average Unit Price of Petroleum Consumption Thousands Birr /MT /(AUPP)	Domestic Capital Investment in Million Birr (DCI)	Real Growth Domestic Products (RGDP)	Labor Force (LF)
Observation	N	31	31	31	31	31
Mean		2240910	11.20308	3751.452	1025533723.48	37779660.23
Median		2035573.38	12050139.00	1692.99	732242115.91	36102315.00
Std. Deviation		1095638.262	13.07931	6272.477	683084624.103	11704006.526
Skewness		.1893831	1.877	3.624	0.81	0.3398731
Std. Error of Skewness		.421	.421	.421	.421	.421
Kurtosis		1.72602	6.488479	14.31819	-.676	-1.083
Std. Error of Kurtosis		.821	.821	.821	2.24	1.896367
Sum		69468210	347.2955	116295	31791545428	1171169467

4.3.1 Correlation Coefficient result

Tabel 4. 5 correlation coefficient of variables

correlate lnRGDP lnPC lnVPC lnDCI lnLF

(obs=31)

	lnRGDP	lnPC	lnAUPP	lnDCI	lnLF
lnRGDP	1.0000				
lnPC	0.7722	1.0000			
lnAUPP	0.9380	0.6007	1.0000		
lnDCI	0.3908	0.3005	0.2968	1.0000	
lnLF	0.9524	0.8631	0.9013	0.3704	1.0000

The table 4.5 above result shows a positive correlation coefficient between variables indicates that an increase in the first variable would correspond to an increase in the second variable, thus implying a direct relationship between the variables.

4.4. Testing Stationarity

Based on the obtained data and observations of stochastic process, statistical inference can be drawn by making certain assumptions about the structure for a simplified understanding of the process of time invariant is called stationary. Stationary is the essential assumption building time series statistical models and statistical properties of a time series over time. Stationarity test is a cornerstone property that facilitates the analysis and processing of random signals in the time domain. Although time varying signals are abundant in nature, in many contemporary applications the information of interest resides in more irregular domains that can be conveniently represented using a graph. It is important and palys a crucial role to estimating time series data analysis. When conducting time series regression analysis on non-stationary data will result a spurious regression. Before conducting any tests of the time series model or regression, the study variables data must have to be individually stationary.

4.4.1. Unit Root Tests

To measure the degree of integration, the study firstly tested for causality and co-integration to see if the series had a stable, trend and if not, to create integration orders. The unit root test applies both the standard research Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to assess statistical stationary across all variables. Moreover in applying ARDL model all the variables entered in the regression should not be integrated of order two. To check these conditions, unit root test is conducted before any sort of action taken. Even though the ARDL framework does not require per-testing variables to be done, the unit root test could convenience us whether or not the ARDL model should be used. For the purpose of this study to test stationarity both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PPerron) (1988) were used. However, to avoid non-stationarity the researcher uses a level aand first differences of the variables. The statistical result of ADF and PPerron tests are shown in table 4.6 below.

Tabel 4.6.Shows Stationary test result of ADF and PPerron

Unit root test app.	Variables	At level			At first difference		
		Test statistics	5% critical Value	Mackinnon app.P-v for z(t)	Test statistics	5% Critical Value	Mackinnon app.P-v for z(t)
ADF	lnRGDP	1.364	-2.986	0.9969	-3.778	-2.989	0.0031
	lnPC	-1.737	-2.986	0.4122	-4.836	-2.989	0.0000
	lnAUPP	0.405	-2.986	0.9817	-4.083	-2.989	0.0010
	lnDCI	-1.399	-2.986	0.5826	-11.183	-2.989	0.0000

	lnLF	-0.49	-2.986	0.8939	-5.198	-2.989	0.0000
PPerron	lnRGDP	1.044	-2.986	0.9947	-3.70	-2.989	0.0041
	lnPC	-1.674	-2.986	0.4444	-4.824	-2.989	0.0000
	lnAUPP	0.051	-2.986	0.9625	-4.126	-2.989	0.0009
	lnDCI	-1.478	-2.986	0.5746	-12.43	-2.989	0.0000
	lnLF	-0.498	-2.986	0.8924	-5.197	-2.989	0.0000

Source: Authors own calculation by STATA 17, 2024

The result from table 4.6 above in all p- values is greater than level of significance indicates all variables are insignificant and non-stationary at level. The variables are unit root at level, it is impossible to make analysis of any regression models directly. Hence, we need to solve the problem of non-stationarity by making the first difference of all the variables and checking the stationarity at first difference. However, at first difference of all variables are stationary at 5% level of significant.

4.5. Optimal Lag Length Determination

After verifying for stationary, the VAR model must be used to determine the ideal lag length. The researcher used a variety of information criteria to find the ideal lag length. The most commonly used information criteria are FPE, AIC, HQIC, and SBIC.

Tabel 4.7. Shows the optimal lag length selection

varsoc lnRGDP lnPC lnAUPP lnDCI lnLF

Selection-order criteria

Sample: 1996 - 2022 Number of obs = 27

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-16.4943				3.4e-06	1.59217	1.66352	1.83214
1	171.175	375.34	25	0.000	2.1e-11	-10.4574	-10.0293	-9.01759
2	201.736	61.123	25	0.000	1.7e-11	-10.8694	-10.0845	-8.2297
3	268.25	133.03	25	0.000	1.5e-12	-13.9444	-12.8028	-10.1049
4	363.42	190.34*	25	0.000	4.6e-14*	-19.1422*	-17.6438*	-14.1029*

Source: Authors calculation by STATA 17, 2024

Endogenous: lnRGDP lnPC lnAUPP lnDCI lnLF

Exogenous: _cons

To test for co-integration among variables, we need to first identify the lag length in the VAR estimate. As a consequence, table 4.7 indicates that based on all lag length selection criteria, the optimal least value for proposed lag length was four.

4.6. Co-itegration Test

After determining the stationary properties of the time series, co integration tests were performed. The study were used the Johansen Test to determine co integration. The test in Table 4.8 compared log likelihood ratios to t statistics at 5% critical levels. Johansen tests were utilized in the study to assess co-integration. Table 4.8 provides the test results for trace statistics and maximal Eigen value tests at the 5% significance level.

Tabel 4.8. Shows the Johansen tests for co-integration (trace and Eigen value test)

vecrank lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4) max

Johansen tests for cointegration

Trend: constant Number of obs =27

Sample: 1996 - 2022 Lags = 4

Max rank	Eigen Values	Trace Test		Maximum Eigen Test	
		Trace Statistic	5% Critical Values	Max-Eigen Values	5% Critical Values
0	.	284.308	68.52	123.1964	33.46
1	0.98957	161.1119	47.21	79.0035	27.07
2	0.94639	82.1086	29.68	37.4370	20.97
3	0.75007	44.614	15.41	33.7635	14.07
4	0.71364	10.908	3.76	10.9080	3.76
5	0.333235				

Source: Authors calculation by STATA 17, 2024

From the result table 4.8 above all trace statistic and maximum Eigen values are greater than 5% critical values. This indicates that, the null hypothesis of no co-integration is rejected and the alternative hypothesis there is co-integration among variables are accepted. This shows that, in the long run, all variables are converge to equilibrium. This indicates that we have to use VECM.

4.7. Diagnostic Test

To ensure that my empirical work is appropriate and that my estimation is properly handled. I employ a set of tests known as diagnostic tests. Autocorrelation, Heteroscedasticity, normalcy, and stability tests are employed to ensure residual stability. If the model is free of these biases, the findings can be used in the analysis. To validate the diagnostic tests, all p-values should be more than 5%.

4.7.1. Heteroscedasticity Test

To test hetroscedasticity of VEC model, the Breusch–Pagan/Cook–Weisberg test is used. In decision rule, the theory states that, if the test result of Pro Chi2 -value is less than 5% level of significance, reject the null hypothesis that means the model has no constant variance i.e. The model is heteroscedasticity, otherwise accepted.

H0: constant variance/Homocedasticty/ Vs. H1: no constant Variance/Hetroscedasticity/

Tabel 4. 9. Shows Testing Hetroscedasticity

reg lnRGDP lnPC lnAUPP lnDCI lnLF

estat hettest

Breusch–Pagan/Cook–Weisberg test for heteroscedasticity

Ho: Constant variance

Variables: fitted values of lnRGDP

Variable: resid

H0: Constant variance

Chi2(1) = 0.59

Pro> $chi^{2=}$ 0.4442

Source: Authors calculation by STATA 17, 2024

From the above table 4.9 shows that the Breusch–Pagan/Cook–Weisberg test for heteroskedasticity, the probability value of the chi-square statistic is greater than 5% level of significant. Therefore the null hypothesis of constant variance wasn't rejected at a 5% level of significance. It implies there is no presence of heteroscedasticity in the residuals or error terms and the model is well-fitted, there should be no pattern to the residuals plotted against the fitted values.

4.7.2. Normality Test

The test of normality shows the distributions of residuals are skewness and kurtosis.

Tabel 4. 10. Shows Testing Normality

Skewness and kurtosis tests for normality

				Joint test	
Variable	Obs	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)	Prob>chi2
resid	31	0.0320	0.8832	4.65	0.0975

Source: Authors calculation by STATA 17, 2024

From table 4.10. above Skewness and Kurtosis test shows the number of observations (which is 31) and the chi2 probability of skewness and Kurtosis which is 0.0975 which is greater than 0.05 implyes its insignificance at a 5% level. This indicates that skewness and Kurtosis is asymptotically normally distributed (p-value of both > 0.05). Consequently, the null hypothesis cannot be rejected. Therefore, according to the Skewness/Kurtosis test for normality, indicates residuals /errors/ are identically and normally distributed.

4.7.3. Autocorrelation Test

To test the autocorrelation of the model assumption the LM test are used the result is shown below.

Tabel 4. 11. Shows Lagrange-multiplier Autocorrelation test

vec lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4)
veclmar, mlag(4)

Lagrange-multiplier test

Lag	chi2	df	Pro>chi2
1	26.8059	25	0.36565
2	65.2915	25	0.69306
3	45.8305	25	0.26212
4	56.5124	25	0.08520

H0: no autocorrelation at lag order

Source: Authors calculation by STATA 17, 2024

H0: No autocorrelation at lag order Vs. H1: There exist an autocorrelation

The presence of autocorrelation is tested by using Lagrange-multiplier test of autocorrelation. According to the result on Table 4.11, P-value at all lags are greater than 5% level of significance. This indicates that there is no autocorrelation at lag order on ECM estimates.

4.7.4. Stability Test

When estimating a ECM, testing stability is crucial to ensure that the VEC model dynamics are well-behaved over time and for reliable estimation and forecasting. Particularly, to analysis the ECM for the RGDP estimated equation, it is important the parameters are stable in the study period.

Tabel 4. 12. Shows stability test

vec lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4)
Vecstable

Eigenvalue stability condition	
Eigen value	Modulus
0.886791 + 0.570404i	1.0544
0.886791 - 0.570404i	1.0544
1	1
1	1
1	1
1	1
0.1583919 + 0.9390632i	0 .952328
0.1583919 - 0.9390632i	0.952328
0.3490737 + 0 .8804304i	0.947106
0.3490737 - 0.8804304i	0 .947106
0.7761871 + 0.4504058i	0 .897403
0.7761871 - 0.4504058i	0 .897403
0.5067515 + 0 .7188472i	0.87951
0.5067515 - 0.7188472i	0.87951
0.8695229	0.869523
0.8691055	0.869106
0.6455191 + 0.3334956i	0 .726577
0.6455191 - 0 .3334956i	0 .726577
0.2856333 + 0 .3771061i	0 .47307
0.2856333 - 0.3771061i	0 .47307
The VECM specification imposes 4 unit moduli.	

Source: Authors calculation by STATA 17, 2024

Based on table 4.12 shows the VECM specification imposes 4 unit moduli, which indicates there are four co-integrating relationships in the ECM, and except for the 6 unit moduli (eigen values with a modulus of 1 and above), the moduli of all other eigen values are less than 1, which is inside the unit circle. In conclusion, the table eigen value stability condition result indicates that the ECM is stable at this study period and the specification of the number of co-integrating vectors are correct. This stability condition suggests the ECM estimation converges to its long-run equilibrium, making it suitable for further analysis and interpretation.

4.8. Error Correction Model (ECM)

When the presence of co-integration relationship between variables and all variables are stationary at first difference, then it is obviously to analyze ECM using one less lag length from the lag selection. However, the optimal lag length of the model was 4, hence the vector error correction model requires 3 lag length to run the regression.

Tabel 4. 13. Shows the Long-run ECM Test

Co-integration equations					
Equation	Parms	chi2	P>chi2		
_ce1	4	2342.923	0.0000		
Identification: beta is exactly identified Johansen normalization restriction imposed					
	beta	Coefficient	Std. err.	Z	P>|z|
_ce1					
	lnRGDP	1			
	lnPC	-0.6616097	0872498	-7.58	0.000
	lnAUPP	-0.4724313	0.04455	-10.6	0.000
	lnDCI	-0.1892492	0.021495	-8.80	0.000
	lnLF	0.7373852	0.302320	-2.44	0.015
	_cons	-22.06557	.	.	.

Source: Authors calculation by STATA 17, 2024

Table 4.13 shows ECM long-run relationship between economic growths (lnRGDP), petroleum consumption (lnPC), Average unit price of petroleum products (lnAUPP), domestic capital investment (lnDCI), and labor force (lnLF) for four co-integrating vector in Ethiopia from 1992 to 2022. The long-run economic growth (lnRGDP) equation of ECM is shown below.

lnRGDP = -22.07 - 0.66lnPC - 0.47lnAUPP - 0.19lnDCI + 0.74lnLF

Table 4.13, all the coefficients of the variables are statistically significant at 5% significant level. The result of this equation shows that petroleum consumption (PC) has a negative statistical significant on the economic growth (RGDP) at 5% significant level. Which, indicates for 1 unit change in petroleum consumption is negatively impacts with 0.66 change in economic growth keeping all other variables constant. Mean that consuming more petroleum suggests less output gains, due to enhancing expense of imported petroleum, production capability and efficiency of a country. This finding is in line with Mehra (2006), Asafu-Adaye (2000), and Jumbe (2004) that they claimed petroleum consumption has not significant impact on economic growth. However, this finding is contrary to Ebbon (1996); Toman

and Jamelkova (2003), and Stern et al.(2019) that they claims petroleum consumption has a positive impact on economic growth.

The impact of average unit price of petroleum products is negative and statistically significant on economic growth at 5% level of significant. i.e., A 1 unit increase in average unit price of petroleum products (AUPP) is associated with decrease by 0.47 on economic growth (RGDP), holding all other variables constant. This negative relationship indicates that an increase in the average unit price of petroleum products decreases economic growth in Ethiopia, as a firms face high energy input costs leads to decrease an investment and output of a country.

Domestic capital investment(DCI) has negative and statistically significant at 5% level of significant on economic growth. Thus, a negative relationship indicates that an increase (decrease) in domestic capital investment has related to decrease (increase) in economic growth in Ethiopia.

Labor force (LF) has positively statistically significant impact on economic growth at 5% level of significant. A 1unit change in labor force is associated to increase in economic growth by 0.74, holding all other variables constant. This positive relationship between labor force and economic growth indicates that labor force is structural issue of an economy in a country, such as unemployment or skill mismatches of a labor force in a certain sectors.

vec lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4)

Error-correction model

Sample: 1996 – 2022 Number of obs = 27
AIC = -14.36029
Log likelihood = 282.8639 HQIC = -13.09016
Det(Sigma_ml) = 5.47e-16 SBIC = -10.08883

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnRGDP	17	0 .009031	0.9959	2405.095	0.0000
D_lnPC	17	0.251404	0.6701	20.31082	0.2586
D_lnAUPP	17	0 .386568	0.5292	11.24217	0.8437
D_lnDCI	17	0 .847026	0.8419	53.24795	0.0000
D_lnLF	17	0 .002133	0.9986	7012.193	0.0000

Tabel 4. 14. Shows the Short-run ECM Test

	Coefficient	St.err.	Z	P>|z|
CointEq1	-0.9747643	0.0948887	-10.27	0.000
D(lnRGDP(-1))	-0.076388	0.0558823	-1.37	0.172
D(lnRGDP(-2))	-0.2767646	0.0276504	-10.01	0.000
D(lnRGDP(-3))	-0.1253965	0.0518648	-2.42	0.016
D(lnPC(-1))	-0.1545798	0.0334293	-4.62	0.000
D(lnPC(-2))	-0.1222205	0.0161639	-7.56	0.000
D(lnPC(-3))	-0.0809913	0.0244277	-3.32	0.001
D(lnAUPP(-1))	-0.2149024	0.0341474	-6.29	0.000

D(lnAUPP(-2))	-0.1744437	0.0213899	-8.16	0.000
D(lnAUPP(-3))	-0.0782042	0.0252999	-3.09	0.002
D(lnDCI(-1))	-0.0694336	0.0105494	-6.58	0.000
D(lnDCI(-2))	-0.038164	0.0075219	-5.07	0.000
D(lnDCI(-3))	0.0029891	0.0059091	0.51	0.613
D(lnLF(-1))	5.741366	1.170668	4.90	0.000
D(lnLF(-2))	9.7036	1.753489	5.53	0.000
D(lnLF(-3))	-7.304059	1.874977	-3.90	0.000
_Cos	0.6646831	0.0720861	9.22	0.000
R-Squared	0.9541		AIC	-14.360
Adj R-Square	0.9470		HQIC	-13.090
Log likelihood	282.8642		SBIC	-10.089
F-Statistic	135.08		Prob(F-statistic)	0.0000

Source: Authors calculation by STATA 17, 2024

After the estimation of long run ECM, the next step is to estimate short run ECM. The short-run Error Correction Model (ECM) equation based on the provided output from Table 4.14 Short-run above can be expressed as follows:

$\Delta lnRGDP_t = 0.665 - 0.277\Delta lnRGDP_{t-2} - 0.125\Delta lnRGDP_{t-3} - 0.155\Delta lnPC_{t-1} - 0.122\Delta lnPC_{t-2} - 0.081\Delta lnPC_{t-3} - 0.215\Delta lnAUPP_{t-1} - 0.174\Delta lnAUPP_{t-2} - 0.078\Delta lnAUPP_{t-3} - 0.069\Delta lnDCI_{t-1} - 0.038\Delta lnDCI_{t-2} + 5.741\Delta lnLF_{t-1} + 9.704\Delta lnLF_{t-2} - 7.304\Delta lnLF_{t-3} - 0.975ECT_{t-1}$

The adjustment coefficient of the error correction term (-0.975) is statistically significant at 5% level, it indicates that, the errors of the past years (deviation from long-run equilibrium) are corrected for within the current year at a convergence speed of 97.5%. This means that each explanatory variables shock on economic growth would move towards a long-run equilibrium by 97.5%. The coefficients of the second and third lagged RGDP are negative relationship with the past values of RGDP growth and statistically significant at 5% level. This indicates that the short-run dynamics of economic growth (RGDP) has a relation to its own past values. The higher RGDP growth in the past years may leads to a lower growth rate in the current period.

Petroleum consumption has negative and statistically significant 5% level, which affects the economic growth in Ethiopia. It has a negative significant impact in both short-run and long-run on economic growth. This indicates the increment use of petroleum consumption in the past three periods affects or decreases to the economic growth of Ethiopia.

The average unit price of petroleum products has a negative and statistically significant at 5% level, suggests that an increase in the unit price of petroleum products in the past periods are associated with reduced current economic growth.

Domestic capital investment has negative and statistically significant at 5% level, this indicates that increased Domestic capital investment in the past periods decrease current economic growth, possibly by inflationary pressure.

Moreover, labor force has positive and negative in the first two lags, and the third lag respectively, which is statistically significant at 5% level. High labor force in the past periods boost economic growth. However, the negative coefficient of the third lag indicates a potential diminishing returns or adjustments in the labor market that could slow growth after a certain threshold.

In conclusion, the result of short-run ECM indicates there are a strong negatively association between economic growth and explanatory variables. The error correction term shows a significant role for economic growth to return to the equilibrium after deviations, indicating the significance of long-run relationships among these explanatory variables. The negative impacts of the past petroleum consumption and positive labor force on economic growth, shows that the policies aimed to enhancing these factors could be important for economic growth in Ethiopia. However, the negative impacts of the past average unit price of petroleum products and domestic capital investment on economic growth indicates these factors needed some policy improvements in the country.

4.9. Granger causality test

The Granger causality test is a statistical test used to examine if one time series variable may predict another or not. This test assesses the ability to estimate future values of a time series based on the previous values of another time series. In economic theory, Granger causality exists in at least one direction. However, the investigators confirm the direction of these causal relationships between factors. In this investigation, chi-square statistics and probability values were used to determine whether or not causality existed between variables.

Tabel 4. 15. Shows the Granger causality Wald Tests

var lnRGDP lnPC lnAUPP lnDCI lnLF, lags(1/4)
vargranger

null Hypothesis	Chi2	df	Pro>Chi2
lnRGDP does not Granger cause lnPC	187.42	4	0.000
lnRGDP does not Granger cause lnAUPP	468.98	4	0.000
lnRGDP does not Granger cause lnDCI	638.02	4	0.000
lnRGDP does not Granger cause lnLF	512.31	4	0.000
lnPC does not Granger cause lnRGDP	80.8	4	0.000
lnPC does not Granger cause lnAUPP	52.313	4	0.000
lnPC does not Granger cause lnDCI	35.3	4	0.000
lnPC does not Granger cause lnLF	65.795	4	0.000

lnAUPP does not Granger cause lnRGDP	22.546	4	0.000
lnAUPP does not Granger cause lnPC	22.162	4	0.000
lnAUPP does not Granger cause lnDCI	15.69	4	0.003
lnAUPP does not Granger cause lnLF	32.524	4	0.000
lnDCI does not Granger cause lnRGDP	35.813	4	0.000
lnDCI does not Granger cause lnPC	24.977	4	0.000
lnDCI does not Granger cause lnAUPP	30.249	4	0.000
lnDCI does not Granger cause lnLF	59.265	4	0.000
lnLF does not Granger cause lnRGDP	11.065	4	0.026
lnLF does not Granger cause lnPC	14.569	4	0.006
lnLF does not Granger cause lnAUPP	7.4739	4	0.113
lnLF does not Granger cause lnDCI	76.072	4	0.000

Source: Authors calculation by STATA 17, 2024

Table 4.15 shows the result of Granger causality Wald test that denote the rejection of the null hypothesis or not. The null hypothesis is rejected when the probability value is less than 5% level, otherwise do not reject the null hypothesis. In this table the result indicates there are 19 significant relationships at 5% level. Therefore, the change in economic growth (RGDP) causes a change in petroleum consumption, average unit price of petroleum products, domestic capital investment, and labor force in Ethiopia, the reverse also true. This indicates there are a bi-directional causal relationship between RGDP, PC, AUPP, DCI, and LF. However, the relationship between labor force and average unit price of petroleum products are statistically insignificant at 5% level. Which indicates a change in labor force are not a cause for a change in average unit price of petroleum products in this study period in Ethiopia. Except, for a unidirectional relationship between labor force and average unit price of petroleum products, all relationships are a bi-directional causal impact between each other. The overall, result indicates there are several strong bi-directional Granger causal relationship between the variables. However, labor force does not statistically significant impact on average unit price of petroleum products. The economic growth as measured RGDP and petroleum consumption are strongly relationship.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

This paper investigates on analyzing the impacts of petroleum consumption on economic growth in Ethiopia using error correction model (ECM) of yearly data spanning from 1992 to 2022 time period. The analysis shows that economic growth (GDP) in Ethiopia is significantly influenced by its own lagged values and by macroeconomic variables such as, petroleum consumption, unit price of petroleum products, domestic capital investment and labor force participation. The study's findings show that there is a short- and long-term association between petroleum consumption and GDP. Furthermore, the findings show a one-way link between petroleum consumption and GDP.

The petroleum consumption negatively influences economic growth; the rising costs associated with unit price of petroleum products and the dynamics of domestic capital investment and labor force participation also negatively impact economic growth. These findings highlight critical areas for policy intervention to enhance the effectiveness and other sources of energy for to replace petroleum consumption and optimize investment strategies.

The development of renewable energy resources and biofuels will bring direct opportunities to developing countries through the production of local jobs from growing raw materials to their manufacture. Further more, the local production of biofuels in developing countries will help to decrease the dependency on costly fossil fuel imports" the number of available jobs in rural areas would increase and thus rural to urban migration would be limited. With respect to energy balance, an energy analysis for different biofuel crops concluded that with today's technology, biofuels do not qualify as renewable sources of energy. Bioethanol provides a number of benefits including higher engine efficiency, achieved from the high octane number and high heat of vaporization of ethanol, and lower ozone and smog formation in its use as compared to the conventional gasoline because of its low volatility and photochemical reactivity (Dufey, 2006). Other than using the existing petroleum infrastructure, its blended use with gasoline in any proportion up to 10 percent, in some cases represented as E5 for 5% bioethanol blend (5% bioethanol and 95% gasoline) and E10 for 10% bioethanol blend, reduces fossil fuel consumption and supply oxygen to advance further complete combustion. This reduces exhaust emission of carbon monoxide and unburned hydrocarbon without the need for engine modification (Wyman, 1996; Dufey, 2006). To ensure competitiveness of bioethanol from the most efficient producer countries, mainly developing nations due to the current high gasoline price. It also decreases the burden of foreign currency outgoings for poor countries that are net importers of petroleum products and have potential to produce and use bioethanol.

5.2. Recommendation

Based on the findings, the government concerned bodies should prioritize the following recommendations:

- **Minimization petroleum consumption**: - petroleum consumption has a negative impact on economic growth. However its price value has also has a negative impact on economic growth by increasing import costs. Since the government should have implement policies that to optimize petroleum consumption, investing in energy efficiency and alternative renewable energy sources to minimize its cost to boost economic growth.
- **Promote Domestic Capital investment**; - to mitigate its negative impact, the government should encourage domestic capital investment on other renewable energy sources through incentives such as diverse energy sources is strongly advised as a solution to this issue in order to lower the amount of money spent on imported petroleum products, while simultaneously addressing global warming of environmental issues, promoting production of biofuel product and goods reducing tax or different subsidies to stimulate economic activities.
- **Labor Market Reform; -** to address the issue of labor force like mismatches of unskilled manpower and unemployment problems economic growth is deficit, so the government should facilitate different training and education and creation of job opportunities.
- **Economic Diversification**; - the government should foster economic diversification within the economy to reduce the economy dependence on energy of imported petroleum consumption and diversify the other renewable energy dependency of economic activities and minimize vulnerability of petroleum price fluctuation.

The finding of the studies shows that there is a short and long-run relationship between petroleum consumption and GDP, as well as a unidirectional relationship going from petroleum consumption to GDP, implying that increased petroleum consumption decreases economic growth. As a result, energy policy targeting petroleum consumption can be conducted in such a way that it promotes economic growth while also encouraging investment in other renewable energy resources to minimize petroleum price. Despite this, petroleum usage may be encouraged because it benefits the country's economy. In this regard, the local price of petroleum should be decreased to encourage both home and transport and industrial consumption and Economic reforms, such as tax reductions, will help to reduce the current high fuel prices. According to the Keynesian consumption function, as income rises, so does demand for ordinary goods. As a result, it will be in the present government's best interest to solve issues such as high inflation and a falling currency rate in order to increase petroleum customers' disposable income and spending power. This way, individuals and enterprises will have more money to spend on petroleum as well as other items, and structural concerns such as the absence of sufficient storage facilities that can stabilize prices while prices during petroleum stocks are indeed necessary.

5.3. Areas for Further Research

The study's results are cleared since they do not seek to distinguish between the various sectors of GDP. For example, does the link hold for the disaggregated forms of GDP, such as agricultural GDP, industrial GDP and service GDP? Which of these sectors has the strongest resistance to petroleum consumption?

The result also indicates negative impacts of petroleum consumption on GDP and this implies that growing petroleum consumption will lead GDP to decrease or vice versa. This is because there are other factors affecting petroleum consumption include petroleum prices, environmental pollution, the exchange rates given that Ethiopia depends wholly on imports for its petroleum products stock, shipping and logistics problems, security issues of road and vehicles spare part increments are other factors.

The study is supposed the linear relationship, so there is a need for to investigate nonlinear relationship between petroleum consumption and GDP. Other potential areas that might require further investigations include; the impact of energy prices on economic growth, the relationship between gas consumption and economic growth, impact of biomass on economic growth and the impact of energy consumption on total factor productivity.

Ethiopia economy relies merely on imports for petroleum products, however the values of imported petroleum products is highly affecting the economic growth so, the government could investigate a regulations to minimize the values of petroleum consumption expenditure throughout blading of benzene by ethanol and diesel by biodiesel products form country’s molasses biofuel production and by production of petroleum in the country’s resource, and others renewable energy potential resource of countries and to support electrical vehicles to minimize the cost and protect environmental pollution of the country.

Reference

Abdouli, M. & Hammami, S. (2017). Exploring links between FDI inflows, energy consumption, and economic growth: Further evidence from MENA countries. Journal of Economic Development.

Abel M. (2016). The Relationship between National Saving and Economic Growth in Ethiopia: ARDL and Granger causality Approaches. Addis Ababa university, Ethiopia.

Ahmed, M. and Azam, M. 2016. Causal nexus between energy consumption and economic growth for high, middle and low income countries using frequency domain analysis. Renewable and Sustainable Energy Reviews.

Apaydin, Gungor and Tağdogan, 2019, The Link between Energy Consumption and Economic Growth: Evidence from Transition Economies.

Berhanu A and Amare G. (2014). Impact of Petroleum on Developing Economies and Prospect of Liquid Biofuel Substitute: Scenario in Ethiopia .

Bezawit T(2019), Assessment of oil and gas project implementation challenges in Ethiopia.

Birouke T, Frehiwot F, and Zewdu A(2012), Implications of Oil Price Shocks and Subsidizing Oil Prices to the Ethiopian Economy: A CGE Analysis, Ethiopian Development Research Institute, Ethiopia.

Ebbon, 1996; Toman and Jamelkova, 2003. Impact of Petroleum Consumption on Economic Growth in Kenya

Gebreegziabher, Z., and A. Mekonnen. (2011). "Sustainable Financing of Ethiopia's Energy Infrastructure

Gebreegziabher, Z, Hailu Y. and Gebrekirstos K. (2010). Energy, growth and environmental interaction in the Ethiopian Economy. Mekelle University, Ethiopia

Girma M. (2021), Interaction among Energy Consumption, Growth and Environment in Ethiopian Economy, Debre Berehan University, Ethiopia

Google scholar for FAQ on Current World Bank Group Engagement in Ethiopia Dec, 2022

Google scholars, the world Bank of Ethiopia https://www.worldbank.org/en/country/ethiopia/overview.

Hou, Q. (2009). The relationship between energy consumption growths and economic growth in China International Journal of economics and finance, 1(2),

International Energy Statistics. 2015. Key World Energy Statistics. International Energy Statistics.

James H. Stock, Mark W. Watson. 2nd ed,Introduction to econometrics /., Boston: Pearson Addison Wesley, 2007

June 2014, reports of petroleum and energy authority implementation of fuel marketing reform.

Kaka Mai Bukar and Samaila Adamu (corresponding author) Department of Economics, Borno State University, Maiduguri Nigeria petroleum energy consumption, trade openness and foreign direct investment: a tripartite approach to economic growth in nigeria.

Kassim, Fatima and Isik, Abdurrahman (2020). The link between energy consumption and economic growth: Evidence from transition economies, Nile University of Nigeria.

Lin, B., & Nelson, B. I. (2018). Causal relationships between energy consumption, foreign direct investment and economic growth for MINT: Evidence from panel dynamic ordinary least square models. Journal of Cleaner.

Ministry of Water and Energy (MoWE). 2011. Energy Balance and Statistics for the Years 2005/06 to 2009/10. MoWE, Addis Ababa.

MoFED (Ministry of Finance and Economic Development). (2022). The ten-Year (2010/11-2029/30) Growth and Transformation Plan. MoFED, Addis Ababa

MWE,(2023) . Energy balance and statistics report for years 2022/23 .

NBE (2023). Annual Report, National Bank of Ethiopia, Addis Ababa.

Oakland institute report (2013). Development Aid to Ethiopia. Overlooking Violence, Marginalization and Political Repression. A Publication of the Oakland Institute, USA.

Omri, A., & Kahouli, B. (2014). Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneousequations models.

Pesaran, H. and Y. Shin (1999), “An Autoregressive Distributed Lag Modeling Approach to Co-integration Analysis”, Cambridge, England.

Salazar-aramayo, J. L., & Rodrigues-da-silveira, R. (2013). A conceptual model for project management of exploration and production in the oil and gas industry

Schiffer, H. W. (2016). World Energy Resources. London: World Energy Council.

Sheilla N, Yvonne G, Nicholas M. (2016). Energy consumption and economic growth in ethiopia: a dynamic causal linkage.

Stern and Cleveland, 2004:7. Department of Economics, Rensselaer Polytechnic Institute, Energy and Economic Growth.

Stern, D.I., (1993). "Energy and Economic Growth in the USA: A Multivariate Approach" Energy Economics,

Stern, D.I., (2004). "Energy and Economic Growth in the USA: A Multivariate Approach" Energy Economics,

Sylvester, D. C., Shima, N., Rani, A., & Shaikh, J. M. (2011). Comparison between oil and gas companies and contractors against cost , time , quality and scope for project success in Miri , Sarawak , Malaysia,

Tanaka, H. (2014). Toward project and program management paradigm in the space of complexity : a case study of mega and complex oil and gas development and infrastructure projects. Procedia - Social and Behavioral Sciences,

Tasew, T. (2011).Foreign Aid and Economic Growth in Ethiopia, Munich: Munich Personal RePEc Archive.

Tewodros, G. (2015). The determinants of economic growth in Ethiopia, Time series analysis.

Umeh Anthony Chinedu, Ochuba Chinedu Daniel, Ugwo Callistus Ezekwe.(2019). Impact of Energy Consumption on Economic Growth in Nigeria: An Approach of Time Series Econometric Model.

Xia Chen a , Md Atikur Rahaman. Causality analysis of the impacts of petroleum use, economic growth, and technological innovation on carbon emissions in Bangladesh

Zenebe G, Alemu M, Tadele F and Gunnar K. Profitability of Bioethanol Production in Case of Ethiopia.

Wanjiku, E, (2011). impacts of petroleum consumption on economic growth in Kenya.

William H. Greene. 6th ed., Upper Saddle River, N.J. : Prentice Hall, 2008. Econometric Analysis.

[1]

[1]

Appendix

Varaible Describtion

Contains data from C:\Users\alemnew\Documents\Thesis\Alemew Research Dated
  obs: 31
 vars: 16 2 July 2024 14:46
 size: 2,418

Variable Name	Storage type	display format	value label	variable label
Year	int	%10.0g		Annual Year
RGDP	double	%14.2f		Real Growth Domestic Products
PC	double	%14.2f		Petroleum Consumption
AUPP	double	%14.2f		Average Unit Price of Petroleum Products
DCI	double	%14.2f		Domestic Capital Investment
LF	long	%14.2f		Labor Force
lnRGDP	float	%9.0g		
lnPC	float	%9.0g		
lnAUPP	float	%9.0g		
lnDCI	float	%9.0g		
lnLF	float	%9.0g		
dlnRGDP	float	%9.0g		
dlnPC	float	%9.0g		
dlnAUPP	float	%9.0g		
dlnDCI	float	%9.0g		
dlnLF	float	%9.0g		

Sorted by: Year

Descriptive Statistics

Summarize lnRGDP lnPC lnAUPP lnDCI lnLF

Variable	Obs	Mean	Std. Dev.	Min	Max
RGDP	31	1.03e+09	6.83e+08	3.63e+08	2.48e+09
PC	31	2240910	1095638	663916	3948123
AUPP	31	11.20308	13.07931	.6772417	56.52834
DCI	31	3751.454	6272.477	654.2683	31105.62
LF	31	3.78e+07	1.17e+07	2.16e+07	6.00e+07

Correlation Coeffeeicent

pcorr RGDP PC AUPP DCI LF
(obs=31)
Partial and semi partial correlations of RGDP with

Variable	Partial Corr.	Semipartial Corr.	Partial Corr.^2	Semipartial Corr.^2	Significance Val
PC	0.1562	0.0332	0.0244	0.0011	0.4273
AUPP	0.5478	0.1376	0.3001	0.0189	0.0025
DCI	0.3523	0.0791	0.1241	0.0063	0.0660
LF	0.7184	0.2170	0.5161	0.0471	0.0000

Unit Root Test

Unit root test app.	Variables	At level			At first difference		
		Test statistics	5% critical Value	Mackinnon app.P-v for z(t)	Test statistics	5% Critical Value	Mackinnon app.P-v for z(t)
ADF	lnRGDP	1.364	-2.986	0.9969	-3.778	-2.989	0.0031
	lnPC	-1.737	-2.986	0.4122	-4.836	-2.989	0.0000
	lnAUPP	0.405	-2.986	0.9959	-3.591	-2.989	0.0059
	lnDCI	-1.399	-2.986	0.5826	-11.183	-2.989	0.0000
	lnLF	-0.49	-2.986	0.8939	-5.198	-2.989	0.0000
PPerron	lnRGDP	1.044	-2.986	0.9947	-3.7	-2.989	0.0041
	lnPC	-1.674	-2.986	0.4444	-4.824	-2.989	0.0000
	lnAUPP	0.051	-2.986	0.9927	-3.533	-2.989	0.0072
	lnDCI	-1.478	-2.986	0.5746	-12.43	-2.989	0.0000
	lnLF	-0.498	-2.986	0.8924	-5.197	-2.989	0.0000

Variable Selection Criteria

varsoc lnRGDP lnPC lnAUPP lnDCI lnLF

Selection-order criteria

Sample: 1996 - 2022 Number of obs = 27

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-16.4943				3.4e-06	1.59217	1.66352	1.83214
1	171.175	375.34	25	0.000	2.1e-11	-10.4574	-10.0293	-9.01759
2	201.736	61.123	25	0.000	1.7e-11	-10.8694	-10.0845	-8.2297
3	268.25	133.03	25	0.000	1.5e-12	-13.9444	-12.8028	-10.1049
4	363.42	190.34*	25	0.000	4.6e-14*	-19.1422*	-17.6438*	-14.1029*

Endogenous: lnRGDP lnPC lnAUPP lnDCI lnLF

Exogenous: _cons

Tests for cointegration

vecrank lnRGDP lnPC lnVPC lnDCI lnLF, lags(4) max

Johansen tests for cointegration

Trend: constant Number of obs =27

Sample: 1996 - 2022 Lags = 4

Max rank	Eigen Values	Trace Test		Maximum Eigen Test	
		Trace Statistic	5% Critical Values	Max-Eigen Values	5% Critical Values
0	.	284.308	68.52	123.1964	33.46
1	0.98957	161.1119	47.21	79.0035	27.07
2	0.94639	82.1086	29.68	37.4370	20.97
3	0.75007	44.614	15.41	33.7635	14.07
4	0.71364	10.908	3.76	10.9080	3.76
5	0.333235				

Testing ECM

The ECM specification imposes 4 unit moduli.

Co-integration equations

Equation	Parms	chi2	P>chi2
_ce1	4	2342.923	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

	beta	Coefficient	Std. err.	Z	P>|z|
_ce1					
	lnRGDP	1			
	lnPC	-0.6616097	0872498	-7.58	0.000
	lnAUPP	-0.4724313	0.04455	-10.6	0.000
	lnDCI	-0.1892492	0.021495	-8.80	0.000
	lnLF	0.7373852	0.302320	-2.44	0.015
	_cons	-22.06557	.	.	.

Source: Authors calculation by STATA 17, 2024

Error-correction model

vec lnRGDP lnPC lnaAUPP lnDCI lnLF, lags(4)

Sample: 1996 – 2022 Number of obs = 27

AIC = -14.36029

Log likelihood = 282.8639 HQIC = -13.09016

Det(Sigma_ml) = 5.47e-16 SBIC = -10.08883

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnRGDP	17	0 .009031	0.9959	2405.095	0.0000
D_lnPC	17	0.251404	0.6701	20.31082	0.2586
D_lnAUPP	17	0 .386568	0.5292	11.24217	0.8437
D_lnDCI	17	0 .847026	0.8419	53.24795	0.0000
D_lnLF	17	0 .002133	0.9986	7012.193	0.0000

Tabel 4. 14. Shows the Short-run ECM Test

	Coefficient	St.err.	Z	P>|z|
CointEq1	-0.9747643	0.0948887	-10.27	0.000
D(lnRGDP(-1))	-0.076388	0.0558823	-1.37	0.172
D(lnRGDP(-2))	-0.2767646	0.0276504	-10.01	0.000
D(lnRGDP(-3))	-0.1253965	0.0518648	-2.42	0.016
D(lnPC(-1))	-0.1545798	0.0334293	-4.62	0.000
D(lnPC(-2))	-0.1222205	0.0161639	-7.56	0.000
D(lnPC(-3))	-0.0809913	0.0244277	-3.32	0.001
D(lnAUPP(-1))	-0.2149024	0.0341474	-6.29	0.000
D(lnAUPP(-2))	-0.1744437	0.0213899	-8.16	0.000
D(lnAUPP(-3))	-0.0782042	0.0252999	-3.09	0.002
D(lnDCI(-1))	-0.0694336	0.0105494	-6.58	0.000
D(lnDCI(-2))	-0.038164	0.0075219	-5.07	0.000
D(lnDCI(-3))	0.0029891	0.0059091	0.51	0.613
D(lnLF(-1))	5.741366	1.170668	4.90	0.000
D(lnLF(-2))	9.7036	1.753489	5.53	0.000
D(lnLF(-3))	-7.304059	1.874977	-3.90	0.000
_Cos	0.6646831	0.0720861	9.22	0.000
R-Squared	0.9541		AIC	-14.360
Adj R-Square	0.9470		HQIC	-13.090
Log likelihood	282.8642		SBIC	-10.089
F-Statistic	135.08		Prob(F-statistic)	0.0000

Source: Authors calculation by STATA 17, 2024

Granger causality Wald tests

var lnRGDP lnPC lnAUPP lnDCI lnLF, lags(1/4)
vargranger

null Hypothesis	Chi2	df	Pro>Chi2
lnRGDP does not Granger cause lnPC	187.42	4	0.000
lnRGDP does not Granger cause lnAUPP	468.98	4	0.000
lnRGDP does not Granger cause lnDCI	638.02	4	0.000
lnRGDP does not Granger cause lnLF	512.31	4	0.000
lnPC does not Granger cause lnRGDP	80.8	4	0.000
lnPC does not Granger cause lnAUPP	52.313	4	0.000
lnPC does not Granger cause lnDCI	35.3	4	0.000

lnPC does not Granger cause lnLF	65.795	4	0.000
lnAUPP does not Granger cause lnRGDP	22.546	4	0.000
lnAUPP does not Granger cause lnPC	22.162	4	0.000
lnAUPP does not Granger cause lnDCI	15.69	4	0.003
lnAUPP does not Granger cause lnLF	32.524	4	0.000
lnDCI does not Granger cause lnRGDP	35.813	4	0.000
lnDCI does not Granger cause lnPC	24.977	4	0.000
lnDCI does not Granger cause lnAUPP	30.249	4	0.000
lnDCI does not Granger cause lnLF	59.265	4	0.000
lnLF does not Granger cause lnRGDP	11.065	4	0.026
lnLF does not Granger cause lnPC	14.569	4	0.006
lnLF does not Granger cause lnAUPP	7.4739	4	0.113
lnLF does not Granger cause lnDCI	76.072	4	0.000

Source: Authors calculation by STATA 17, 2024

Test for heteroskedasticity

estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of lnRGDP

chi2(1) = 0.59

Prob > chi2 = 0.4442

predict resid, residuals

. reg lnRGDP lnPC lnAUPP lnDCI lnLF

```
      Source |       SS       df       MS              Number of obs   =        31
-------------+------------------------------           F(4, 26)        =    135.08
       Model |  12.1313427     4  3.03283569            Prob > F        =    0.0000
    Residual |  0.58373685    26  0.022451417           R-squared       =    0.9541
-------------+------------------------------           Adj R-squared   =    0.9470
       Total |  12.7150796    30  0.423835987           Root MSE        =    0.14984

------------------------------------------------------------------------------
      lnRGDP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnPC |   0.3972911   0.1680009     2.36   0.026     0.0519603    0.742622
     lnAUPP |   0.3940963   0.0873397     4.51   0.000      0.214567    0.5736256
      lnDCI |   0.0603678   0.0330969     1.82   0.080    -0.0076638    0.1283993
       lnLF |  -0.1316688   0.5653693    -0.23   0.818     -1.293802    1.030464
      _cons |    15.92824   7.411096     2.15   0.041     0.6945106    31.16196
------------------------------------------------------------------------------
```

hettest resid

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: resid
chi2(1) = 12.07
Prob > chi2 = 0.0005

. sum resid

Variable	Obs	Mean	Std. Dev.	Min	Max
resid	31	1.35e-09	0 .1394916	-0.1633697	.3463536

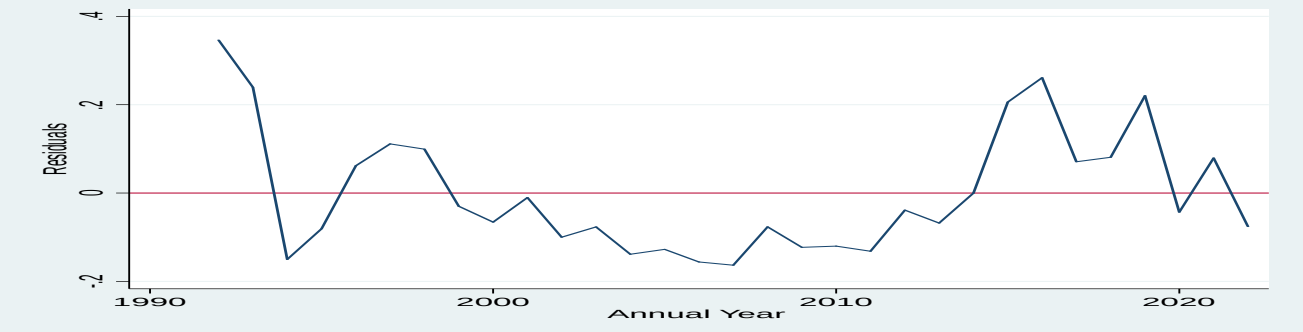
estat imtest, white

White's test for Ho: homoskedasticity
against Ha: unrestricted heteroskedasticity

chi2(14) = 25.18
Prob > chi2 = 0.0328

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	25.18	14	0.0328
Skewness	11.12	4	0.0253
Kurtosis	0.22	1	0.6418
Total	36.52	19	0.0091



Normality Teset

sktest resid

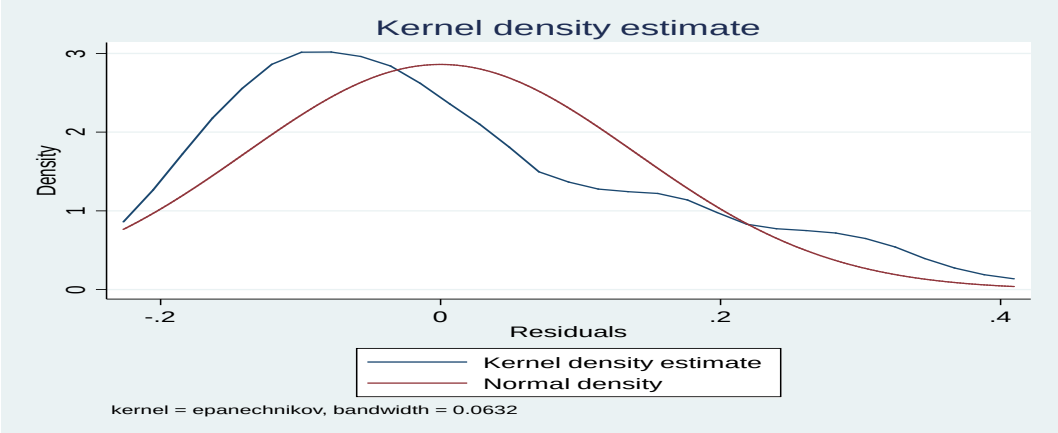
Skewness/Kurtosis tests for Normality
------ joint ------

Variable	Obs	Pr (Skewness)	Pr (Kurtosis)	adj chi2(2)	Prob>chi2
resid	31	0.0320	0.8832	4.65	0.0975

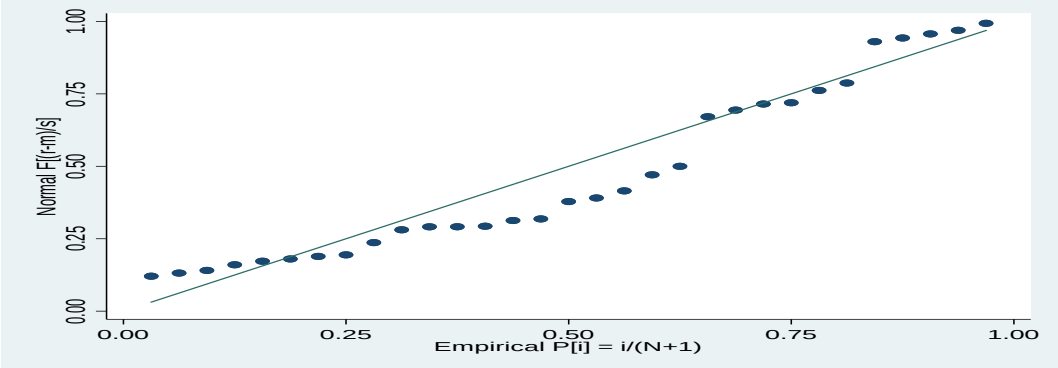
regress lnRGDP lnPC lnAUPP lnDCI lnLF

predict r, resid

kdensity r, normal



Bpnorm r



Autocorrelation Teset

vec lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4)
veclmar, mlag(4)

Lagrange-multiplier test			
Lag	chi2	df	Pro>chi2
1	26.8059	25	0.36565
2	65.2915	25	0.69306
3	45.8305	25	0.26212
4	56.5124	25	0.08520
H0: no autocorrelation at lag order			

Stability Test

vec lnRGDP lnPC lnAUPP lnDCI lnLF, lags(4)
Vecstable

Eigenvalue stability condition	
Eigen value	Modulus
0.886791 + 0.570404i	1.0544
0.886791 - 0.570404i	1.0544

1	1
1	1
1	1
1	1
0.1583919 + 0.9390632i	0 .952328
0.1583919 - 0.9390632i	0.952328
0.3490737 + 0 .8804304i	0.947106
0.3490737 - 0.8804304i	0 .947106
0.7761871 + 0.4504058i	0 .897403
0.7761871 - 0.4504058i	0 .897403
0.5067515 + 0 .7188472i	0.87951
0.5067515 - 0.7188472i	0.87951
0.8695229	0.869523
0.8691055	0.869106
0.6455191 + 0.3334956i	0 .726577
0.6455191 - 0 .3334956i	0 .726577
0.2856333 + 0 .3771061i	0 .47307
0.2856333 - 0.3771061i	0 .47307

The VECM specification imposes 4 unit moduli.

Source: Authors calculation by STATA 17, 2024

Tests for Model Specification

ovtest

Ramsey RESET test using powers of the fitted values of lnRGDP

Ho: model has no omitted variables

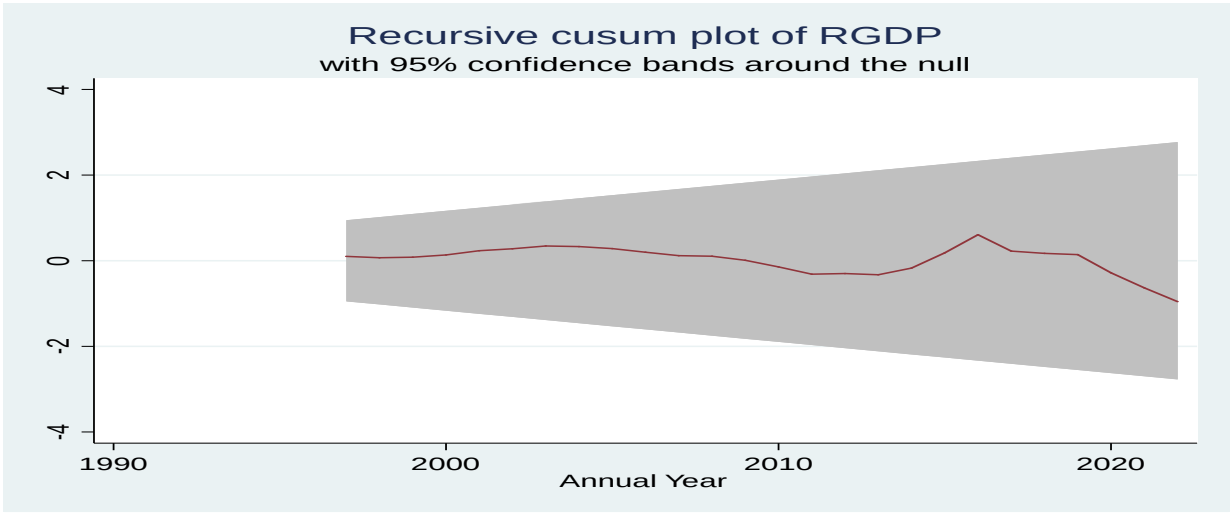
F (3, 23) = 8.93

Prob > F = 0.0004

linktest

Source	SS	df	MS	Number of obs = 31
Model	12.1944423	2	6.09722113	F (2, 28) = 327. 91
Residual	0.520637339	28	.018594191	Prob > F = 0.0000
Total	12.7150796	30	.423835987	R-squared = 0.9591
				Adj R-squared = 0.9561
				Root MSE = .13636

lnRGDP	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interva l]	
_hat	-5.12672	3.326122	-1.54	0.134	-11.93997	1.686532
_hatsq	0.1486951	0 .0807192	1.84	0.076	-0.0166506	0.3140409
_cons	63.05141	34.23693	1.84	0.076	-7.079764	133.1826



estat sbcusum
Cumulative sum test for parameter stability

Sample: 1992 - 2022 Number of obs = 31
Ho: No structural break

Statistic	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
recursive	0.3182	1.1430	0.9479	0.850