ADDIS ABABA UNIVERSITY COLLEGE OF DEVELOPMENT STUDIES

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THE LINK AMONG FOREIGN DIRECT INVESTMENT, ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN ETHIOPIA

BY

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The Link Among Foreign Direct Investment, Electricity Consumption and Economic Growth in Ethiopia

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Declaration

I, the under signed, declare that this thesis entitled "The Link Among Foreign Direct Investment, Electricity Consumption and Economic Growth in Ethiopia'' submitted in partial fulfilment for the requirements of master's degree to the center for Regional and Local Development Studies of Addis Ababa University is completely my work and has not been submitted for completion of any degree at any university to the best of my knowledge, all the sources I used in this study are well acknowledged.

_________________________ **December 2020**

Gebremichael Zeray

Certification

This is to certify that this thesis entitled “The Link Among Foreign Direct Investment, Electricity Consumption and Economic Growth in Ethiopia’’ submitted in partial fulfilment for the requirements of a master’s degree to the Center for Regional and Local Development Studies of Addis Ababa University is an orginal work done by student Gebremichael Zeray ID No. GSE/6520/10 under my supervision.

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This is to certify that the thesis prepared by Gebremichael Zeray Kfleyohans entitled "The Link Among Foreign Direct Investment, Electricity Consumption and Economic Growth in Ethiopia." and submitted in partial fulfillment of the requirements for the Degree of Master of Art in Regional and Local Development Studies complies with the regulation of the university and meets the accepted standards concerning originality and qualiy.

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Contents

List of Tables

List of Figures

List of Acronyms

ADF: Augmented Dickey Fuller Test

AIC: Akaike Information Criterion

ARDL: Auto Regressive Distributed Lag

CSL: Co-integration, Saikkonen and Lütkepohl

EC: Electric Consumption

ECM: Error Correction Model

ECT: Error Correction Term

EEP: Ethiopian Electric Power

GERD: The Grand Ethiopian Renaissance Dam

GMM: Generalized Methods of Movements

IDP: Investment Development Path

IEA= International Energy Agency

LR: Long-run

MNC: Multi-National Corporations

MNE: Multi-National Enterprises

NOI: Net Outward Investment

POG: Population Growth

R&D: Research and Development

RGDPPC: Real Gross Domestic Product Per Capita

RWA: Rolling Window Approach

SR: Short-run

TNC: Trans National Corporations

VAR: Vector Auto Regression

VECM: Vector Error Correction Model

Abstract

In Ethiopia context, electricity consumption – foreign direct investment – economic growth nexus is not well studied and the knowledge gap needs to be studied and filled. This paper explores the link among the use of electricity, foreign direct investment and economic growth in Ethiopia, using annual data from 1988 to 2018. The study applies the augmented Dickey Fuller test for stationarity and Johansson co-integration test used to determine whether there is a long run relationship between variables. The Johansson co-integration test result recommended the presence of relationship between the variables in long run. Moreover, Vector Error Correction model is applied to estimate both short and long run models related with Real Gross Domestic Product per capita of Ethiopia. The empirical results suggest that in the long run, electricity consumption, foreign direct investment and money supply have been found to have positive effect on economic growth while government expenditure has negative impact. In the short run, Government expenditure, population growth at two period's lag affect economic growth positively while foreign direct investment, money supply at two period's lag are found to have negative impact on real Gross Domestic Product Growth. However, electricity use and population growth do not have a short-term and long-term effect on economic growth. The magnitude of the Error Correction Term coefficient is -0.2625 justified about 26% of the disequilibrium annually converge towards long run equilibrium in the following year. The Granger causality test indicates a uni-directional causality between Electricity consumption and economic growth running from electricity consumption to economic growth in Ethiopia for the period under study. The result supports growth hypothesis; meaning an increase in electricity consumption could cause an increase in Gross Domestic Product Growt level. Therefore, electricity consumption has a vital role in production process of Gross Domestic Product Growt that confirm the importance of heavy hand of the government in the energy sector.

Keywords: *Economic Growth, FDI, Electricity Consumption, Money Supply, Population Growth and VECM, Ethiopia*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the study

In developing countries, the gross domestic savings as proportion of GDP is low and the gap between domestic investment and savings has remained wide due to the low levels of income and domestic savings. It becomes unlikely for the countries to realize economic growth by mobilizing the meager domestic savings (Montiel, 2008).

Although countries can fill portion of this saving gap by loans and development assistance from multilateral agencies such as the World Bank or by private foreign investment, FDI is found to be the most important alternative source of foreign capital. Nevertheless, studies on the energy consumption, FDI and economic growth nexus in most developing countries have shown that subject to vital factors like the degree of openness, human capital base in the host nation, trade regime, banking system and financial market regulations, FDI may have a positive impact on overall economic growth (Agrawal and Khan, 2011).

As it has been shown in OECD (2007) report, rapid economic growth, population growth and industrialization have been found to be the driving force for increase in consumption of energy in developing countries. The demand for energy is also estimated to rise and the growth rate is expected to be 1.4% per year until 2035 (UNEP, 2011). Alam (2013) in his study confirmed that both economic growth and FDI impacted by electric power consumption.

Consequently, the vast literature on FDI determinants in developing countries clearly indicates the significance of skills, infrastructure, functioning institutions and macroeconomic stability as imperatives for attracting FDI (Ozturk, 2007; Mahe, 2005).

One of the most important reasons for countries to emphasize on promoting and attracting FDI inflow is to speed up their economic growth and make it sustainable. This in turn lessens unemployment rate, improves the living standard of the people and increase the rate of economic integrations with other nations. This is because FDI plays a vital role in improving and strengthening the ability of the recipient countries to take an action on the opportunities provided by international economic integration, which is recognized as one of the principal aim of any development strategies (Cho, 2003).

FDI is also the key element of the globalization and of the world economy. It is important as a driver of employment, technological progress, productivity improvements and ultimately economic growth. It plays the vital roles of filling the development, foreign exchange, investment, and tax revenue gaps in developing countries (Smith, 1976).

Globally, countries have been working hard to attract more foreign direct investment and boost their economic growth by creating employment and transferring knowledge. However, compared to other parts of the world, the performance of African countries mostly Sub-Saharan African countries is poor in attracting foreign direct investment (UNCTAD, 2015).

Many countries that needed to absorb foreign direct investment have undergone structural reforms and changes to increase competition by creating friendly domestic investment policies, ensuring a higher degree of protection and providing various incentives to make their countries attractive for potential investors (Paez, 2011).

Countries could differ in attracting FDI due to their policies and strategies towards FDI they adhere. Different factors could attribute to the difference between or among countries in attracting FDI volume, for instance the existence of openness, skilled manpower, infrastructure, the incentives they provide are among them. One of the key infrastructures to attract FDI and drive economic growth is the availability of cheap energy. Razavi (2012) in his work, points out that Ethiopia as one of the developing countries is heavily dependent on energy and encounters a rapid demand for electricity consumption as a reaction to the economic expansion and industrialization overtime.

The supply of and demand for electricity consumption is unmatched as the demand for electricity consumption is rising from time to time. Although Ethiopia is endowed with renewable energy resources primarily wind, solar and hydropower energy, the Ethiopian energy sector is challenged with limited access to modern energy and heavy reliance on traditional biomass energy sources to meet growing demand. While Ethiopia has seen dramatic economic growth in recent years, sustaining this growth into the future will require dramatic expansion of energy supply (Bryan, 2018).

Nowadays, in order to meet the continuously rising demand for electricity, the Energy Strategy in Ethiopia is a high priority. Thus, Ethiopia has an important current policy that increases the share of renewable energy by attracting FDIs to reduce reliance on fossil fuels and reduce pollution and improve its economic development.

Thus, the link among energy consumption, FDI inflow and economic growth should be studied to take improvement actions to bridge the gap.

In view of this, the purpose of the study is thus to scrutinize the link between energy consumption, FDI and economic growth in Ethiopia.

1.2. Statement of the Problem

African nations have very low savings rates because of absolute poverty. This makes it hard to finance investments needed for growth and development. Empirical evidence suggests that given the rate of population growth on the continent, to reverse the spread of poverty, Africa would have to achieve economic growth of between 7 and 8 percent, well above twice that of the population as a minimum requirement (Loots & Kabundi, 2012; Anyanwu & Erhijakpor, 2003). Such a growth rate needs investment of about 25 per cent of GDP per annum. However, with the rate of about 9 per cent, the financing deficit amounts to 16 per cent of GDP (Ndulu, *et al*., 2007) and it is FDI that can close this gap and reverse the spread of poverty.

While there is yet no consensus on the relationship between FDI and growth, there is a growing view in recent years that FDI is positively correlated with growth. For instance, Findlay (1978) tried to postulate that through a "contagion" effect from the more advanced technologies and management methods used by international corporations, FDI increases the pace of technological development in the host nation.

FDI is welcomed and actively sought by virtually all African countries. The countries widely recognized that the contribution of FDI to their economic development and the role that it plays in integrating them with the rest of the world economy is paramount. Hence, they have made substantial efforts and tried their best over the past decade to bring change and improve their investment climate. They have relaxed their investment policies and have offered incentives to foreign investors. More importantly, the economic performance of the region had substantially improved from the mid-1990s. Nonetheless, the expected growth of FDI inflow into Africa has not been realized as prospective investors discount the African continent as a location for investment due to the negative image of the region (UNCTAD, 1999).

Likewise, studies in Ethiopia have shown a negative long-term relationship between foreign direct investment flows and the economic growth of the region. The adverse relationship was primarily due to weak institutional structures and the funds were not always related to the productive sectors (Admasu, 2017).

FDI inflows in terms of global and regional distribution, developed economies are the recipients of the bulk of world FDI inflows. Specifically, in the period 1990-2016 around 63% of world FDI flowed to advanced countries, 34% to developing countries and 3 per cent to transition economies (World Investment Report, 2018).

One of the sources of difference in FDI inflow among countries is the availability of infrastructure of which reliable electricity is one of the key infrastructures that can attract FDI. Although Africa's infrastructure is improving, it is starting from a low base and lack of efficient basic infrastructure such as electricity is a major cause of Africa's low levels of competitiveness and productivity, along with low numbers of exporters and limited intra-regional trade (African Economic Outlook, 2014).

Electric power remains Africa's single greatest infrastructure constraint, with low access, poor reliability, and high cost as key issues. According to a World Bank Enterprise Survey (2011/2013), 37% of foreign manufacturing firms identified electricity as a major constraint for doing business in Africa (Chen *et al*., 2015). Reliability of electricity supply is a major problem. African manufacturing enterprises experience power outages 56 days per year, on average, resulting in a loss amounting to 6% of annual sales (ibid). Moreover, the average effective electricity tariff in sub-Sahara Africa is high, around USD 0.13 per kWh compared to USD 0.04–0.08 per kWh in other developing countries.

Like other developing countries, Ethiopia is also suffering from intermittent energy service and outage as it does not yet meet its ever-increasing energy requirements in the power sector and Electricity Consumption still accounts for only 2% of total Energy Consumption (Bryan *et al*., 2018).

Ethiopia has been taking some measures and trying its best to address the issue by opening the energy sector for private sector in addition to the grand investment being made on renewable energy by the government. This move has been intended to improve the countries competitiveness in provisioning cheap energy as compared to other African countries, to attract and be one of the destinations for FDI inflow. However, the challenges remain untouched and there are still doubts whether the country is benefiting from it or not.

To the best of the researcher's knowledge, to date, three pieces of researches were done analyzing the case of Ethiopia. The first single-country study was entitled "Energy consumption and economic growth in Ethiopia" (Nyasha, 2016). This study focused on the wider scope of the energy sector specifically on the major traditional energy sources such as fuelwood, charcoal and dung cakes based on the data collected from the periods 1971 to 2013. The second study was a multi-country study under the title "The Analysis of Relationship between Economic Growth and Electricity Consumption in Africa" done for 11 African countries including Ethiopia by (Bildirici, 2013).

The third study was the first single-country study which was entitled "Energy consumption-FDI-economic growth nexus in Ethiopia" (Tesfaye, 2019). This study focused on the interrelationship among energy consumption, FDI and economic growth based on the data collected from the periods 1988 to 2017.

The second and the third studies are like what this thesis investigating but the second and the third studies failed to include variables like financial development and population which are believed to be among the determinants of Electric Consumption, FDI and economic growth. Furthermore, most of the recommendations that are believed to alleviate the discrepancies and inconsistencies between the various studies results observed in the literature are not incorporated.

Therefore, based on the recommendations given by researchers like for instance by (Apergis, 2009), (Jakovac, 2017) and (Tesfaye, 2019) in the intention of increasing the robustness of the final causality results, this research, in addition to the three target variables (Electricity Consumption, FDI and Economic Growth), has incorporated additional variables namely: financial development and population in the analysis. In doing so, this research has tried to minimize omitted variable bias to some extent, since these variables can affect Economic Growth, FDI as well as Electricity Consumption. Apart from that, this thesis is a single country study for Ethiopia and focuses on the period 1988–2018 and the corresponding data, this makes the research to match the causal relationship analysis to the sampling period because, since 1991, Ethiopia has gradually moved to the path of economic growth.

Even the International organizations like WB and IMF witnessed that Ethiopia has performed very well in terms of attracting FDI and improving economic growth. However, the country is still encountered with many challenges like Scarcity of Finance, Low Performance, Capacity, Low Private Investment (Foreign Direct Investment), low and non-cost reflective, tariff, high losses and frequent power outages, high population growth and high unemployment. Besides, Ethiopia does not yet meet its ever-increasing energy requirements in the power sector and Electricity Consumption still accounts for only 2% of total Energy Consumption. The ability to establish the exact causal relationship between Electricity Consumption, FDI and Economic Growth will have paramount relevance to the country's policy direction towards FDI, energy sector and overall economic growth. Thus, to come up with relevant findings and provide useful inputs for policy makers and to fill the knowledge gap in the subject matter, the nexus between electricity consumption, FDI and economic growth needs to be investigated separately in the Ethiopian context by considering them simultaneously in a modeling framework. And to the best of the researcher's knowledge, none of the empirical studies have focused on investigating the nexus between energy-FDI-growth via the simultaneous equations model by incorporating variables like financial development and population in the analysis.

In Ethiopia context, the link among electricity consumption, foreign direct investment and economic growth is not well studied and the knowledge gap needs to be studied and filled.

1.3.Objective

1.3.1. General Objective

The general aim of the study is to examine the possible causal links among electricity consumption, foreign direct investment and economic growth.

1.3.2. Specific Objectives

The specific objectives are:

- To assess the short-run and/or long-run relationships among Electricity Consumption and Economic Growth/GDP,

- To examine the link between FDI and Economic Growth/GDP,
- To investigate the relationship between energy consumption and FDI
- To identify the direction of relationship between the variables

1.4.Significance of the Study

This research is expected to contribute to the undertaking for the following reasons:

- It may create an equal awareness to policy makers and policy implementers whether the governments' policies and strategies towards the energy consumption-FDI-economic growth nexus are effective or not.
- It is also believed that, this study will help identify the basic problems in formulating and implementing the countries growth policies towards energy, FDI, population and financial development.
- The findings of the paper may attract the attention of the concerned officials to see for more efficient and effective formulation of growth policies and strategies.
- This could also help the government to re-think and revise its investment promotion strategy to ensure that it yields maximum benefits to the country.
- This paper may also encourage professionals to study about the problem in a wider scope and contribute relevant and constructive ideas about the growth policies of the nations.
- The findings of the research could also be used as an input for further investigation of the researcher.
- Lastly it is supposed that the result of this paper is expected to serve as an input for decision makers to take proactive measurements.
- Finally, the study can contribute to the existing literature on EC, FDI, Population and EG relationship.

1.5. Scope and Limitation of the Study

This research aimed at investigating the causal relationship and the direction of influence between economic growth and electricity consumption in Ethiopia by incorporating additional variables indicated above. The data used in the analysis cover the period 1988–2018. The electricity consumption data used in the analysis only covers electricity net consumption of the main electricity grid users.

In addition to the three target variables namely Economic growth, electricity consumption and FDI, due to time constraint and limitation of the scope, the analysis only incorporated macro level data like government expenditure, financial development and population growth as additional variables in the analysis. However, the study did not decompose government expenditure into investment and consumption, where government investment is proxied by government total capital expenditure less capital spending on health and education, while private investment is proxied by private capital formation. It did not also include other variables like net export and CO_2 emission because of multicollearity. On top of this, even though it is easier to find evidence for causal effects using more disaggregated micro level data, the study did not use disaggregated micro level data to see the distinct features of the different sectors of the economy.

1.6. Structure of the Thesis

The rest of the paper is organized as follows: Chapter two presents the review of conceptual, theoretical and empirical literature related to the interrelationship among energy consumption, FDI and economic growth while chapter Three deals with the research design, model specification, data source, data analysis method and techniques. Chapter four focuses on data analysis, presentation, and interpretation. The fifth chapter which is the closing one focuses on conclusion and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Concept of FDI

According to UNCTAD (2010), FDI is defined as ‘‘the category of foreign investment in which an enterprise resident in one country (a direct investor) acquires at least 10% interest in an enterprise resident in another country (a direct investment enterprise).'’’

According to Ghazali (2004), foreign investment is classified in two categories:

- The movement of capital and other resources across borders and should be narrowly defined as FDI because it deals with financial control over organizations or companies as a crucial believe the definition; and
- The protection of foreign investment which provides a broader definition of the concept of investment because it includes differing kinds of assets, titles and contractual rights.

As per The United Nations Conference on Trade and Development (2008) definition, FDI is defined as a long-term relationship between companies within the source country (the investor) and another company within the host country (country of investment). While the definition given to FDI by the Arab Investment and Export Credit Guarantee Corporation (1987) describes FDI as the flow of capital in the form of financial assets or production assets, material or otherwise coming from outside the host country, and which features in independent or joint investment projects for business purposes.

As Ali (2014) indicated it, in addition to the possible influence available to the investor on the company's board of directors, FDI typically includes a long-term partnership between the direct investor and the target company. The direct investor may be a person or legal entity from the public or private sector, a group of individuals, a business or group of companies, a government or a government agency, or some other organization such as an international financing organization.

El-Fergani (2004) listed numerous forms of FDI. The most important associated with developing countries, are the following:

(I) Investment in the field of natural resources, where FDI plays an important role in the production of raw materials in developing countries and the export of these materials for consumption in external markets. An example of this is oil exploration.

(II) In some cases, where obstacles are imposed by governments on imports, investment in local production becomes more feasible than exporting foreign products to these markets. This type of investment focused on the manufacturing sector during the 1960s and the 1970s as the policy of import substitution became popular among developing countries.

(III) Investments seeking quality performance as the case with some companies in the industrialized countries, which move their businesses to other countries in order to cut production costs and increase their profits. The high cost of labor in industrialized countries has forced companies in these countries to move into developing countries in search of cheap labor.

(IV) Some FDI can be described as strategic investment. This type of FDI is at the very advanced stage in which the multinational corporations (MNCs) seek the honing of skills through investment in relevant countries. Examples include the numerous centers for R&D in Singapore, the computer programming development centers in India, and the airline booking centers in the Caribbean.

(I) Cutting down production costs using the production methods that rely on intensive labor.

(II) The low cost of locally produced commodities, and the use of prices as a strategy for competition.

(III) The maximum use of the appropriate technology to minimize labor.

(IV) Making the maximum use of locally produced raw material to minimize imports.

(V) Concentrating on commodities which are in high demand in foreign markets.

As it has been indicated in UNCTAD (2005), as these companies grew during the 1990s, foreign investment expanded at both the geographical and sect oral levels, with attention focused on remote developing countries as potential markets. In addition, they were able to overcome custom tariffs and other obstacles imposed by industrialized countries on imports, as well as the acquisition of technological know-how. Consequently, location has become significantly more important for exploring new markets, particularly those located close to the EU and the US.

2.2. Overview

2.2.1. Effect of FDI

FDI inflows inspired scholars to make intensive debate and conduct more research on the impact of FDI on host economies. Generally, it has got recognition that domestic firms can inherently benefit from FDI. According to Brooks (2003), in addition to increasing output and income, host economies can benefit from FDI in five ways:

(I) Foreign firms bring in superior scientific or managerial technology to the host economy.

(II) Foreign investment steers up competition in the host economy. The entry of a new firm would tend to increase sectoral output and reduce the domestic price.

(III) Foreign investment typically results in increased domestic investment.

(IV) Foreign investment gives advantage in terms of export market access arising from economies of scale in marketing of foreign firms or from the ability to gain market access abroad.

(V) Foreign investment can help in bridging a host country's foreign exchange gap.

2.2.2. Types of FDI Inflows

Ali (2014) in his study on FDI tried to compare efficiency-seeking and market-seeking. And demonstrated that the effect of FDI on economic growth is specific, since efficiency-seeking FDI is superior to market-seeking FDI in enhancing greater growth in the host economies. He also argued that FDI is expected to have more growth effect in the manufacturing sector compared to that of the primary sector which is natural resource seeking in which FDI is expected to have a limited impact on growth.

Colen *et al*. (2008) in their study found that the impact of FDI on economic growth is greater when FDI directed to high labor-intensive and less technology intensive industries than to that of capital intensive where the technology gap between foreign and domestic firms is narrowed.

Different debates are raised on the scope of the operation of FDI as a factor in determining the growth effect of FDI in the host country. Alfaro (2003) and UNCTAD (2005) revealed that the extent for linkages between foreign firms and domestic suppliers is often restricted to the primary sector.

Therefore, FDI tends to have a positive impact on growth while FDI tends to have ambiguous effect in service sector, where the scope of linkages is limited.

In summary, the empirical studies suggest that the growth effect of FDI is not automatically, but it is dependent on some conditional factors. For example, the technology gaps, the level of human capital development, financial market development, the macroeconomic conditions and so on. These factors are expected to explain why the growth effects of FDI are quite different between countries at the same level of development, the same sectors and the same types of firms (Ali, 2014).

Thus, from the above theoretical review of different FDI theories, it can be understood and said that these theories yield a large variety of effects of FDI on countries' economic growth, at the firm, industry, international levels. These theories include findings that can offer policy makers valuable tools for increasing FDI by anticipating TNCs behavior, acting on fundamental decision-making variables at corporate level and monitoring the FDI position of a national economy with respect to competitors' nations taking own competitive advantage.

Moreover, the policy implications of major FDI theories can be assessed that they can assist policymakers in optimizing the entire FDI enhancement process, firm strategic planning to the analysis phase and implications including the use of appropriate policy instruments and efficiency control.

2.3. Review of Theoretical Literature

2.3.1. Theories of Imperfect Markets

The failure of the neoclassical theory to explain and predict how, where and why FDI occurs and to highlight the social and economic consequences of FDI has led to the development of new explanations of international investment. Hymer (1976) was the first to point out that the structure of market and the specific characteristic of firm play an important role in explaining the FDI. Some of the major theories which are related to this head include:

- Industrial Organization theory.
- Transaction Cost Approach,
- Eclectic theory of International Production,
- Product Cycle Theory,
- Oligopolistic Reaction theory.
- Currency Capitalization Approach,
- IDP Paradigm,

According to Hymer's (1976) observation, micro economic theories are mainly *theories of market structure imperfections* which are the real cause of the existence of MNCs. The Industrial Organization Approach is based on the idea that due to structural market imperfections; some firms enjoy advantages vis-a-vis competitors.

According to this theory, market structure and competitive conditions are important determinants of the types of firms, which engage in FDI.

The theory uses firm specific advantages to explain MNCs international investment. These firm-specific advantages include patents, superior knowledge, product differentiation, expertise in organizational and management skills and access to overseas markets.

The *industrial organization hypothesis* has received some support in subsequent literature by Dunning (1974); Vaitsos (1974)11 and Cohen (1975). Graham and Krugman (1989) used this theory to explain the growing inflow of FDI in US post 1975.

The scholar argued that due to decline of US technological and management superiority, FDI increased manifolds over that period. This theory, however, fails to explain why firms need to engage in FDI to capitalize on the advantages when cheaper forms of expansion (for example, exporting) would allow them to compete equally and successfully in international markets.

The *transaction cost* or *internationalization approach* is developed to explain international production and FDI. The transaction cost or internationalization approach is developed to explain international production and FDI which suggests that FDI takes place as a result of firms replacing market transaction with formal transaction. One of the leading proponents of this approach is Buckley and Casson (1976). This approach interprets the FDI activities of MNCs as a response to market imperfections, which causes increased transaction cost. Buckley and Casson present the MNEs as essentially an extension of the multi-plant firm. They further note that the operations of firms, especially large ones take the form not only for producing of services but activities such as marketing, training, R&D, management techniques and involvement with 'financial products' taking the form of either material products or knowledge and expertise

Under this approach, markets and firms are considered as the alternative modes of organizing production. This theory is also termed as general theory of FDI. At theoretical level, although the hypothesis received much support, no direct empirical tests have been conducted because of its high degree of generality. The transaction cost theory or international theory is a model of private welfare maximization based on MNC's operations.

Dunning (1981) has developed the *Eclectic Paradigm* which links together industrial organization approach, location theory and internationalization theory to explain FDI and international production activities. This paradigm of FDI suggests that three preconditions need to be fulfilled if a firm is to directly invest in a foreign country.

First, it must have ownership specific assets which gives it an advantage over other firms, and which are exclusive to the firm. Second, it must internalize these assets within the firm rather than through contracting or licensing. Third, there must be advantage in setting- up production in a foreign country rather than relying on exports.

This hypothesis has been used by Dunning to evaluate *Ownership* and *Locational* aspects in describing the industrial pattern and sales of the US affiliates in 14 manufacturing industries in seven countries. However, this theory fails to explain international differences in FDI by MNCs from countries with different cultural backgrounds and macro-economic structures. Moreover, it fails to provide a framework for analysis of the micro-economic effect of the FDI in the host country.

Vernon (1966) is considered as the leading in propounding the *Product Cycle* hypothesis. This theory attempts to combine a three-stage theory of innovation, growth, and maturity of a new product with R&D factor theory. This paradigm explains that the possible emergence of innovation as a developed country's export, extend its life cycle by being produced in more favorable foreign location during its maturity phase and ultimately once standardized, become a developing country's export and developed country's import. Thus, FDI, occurs when the product matures and competition becomes fierce, the innovator decides to shift production in developing countries because lower factor costs make this advantageous.

However, this hypothesis fails to incorporate other countries' FDI in its analysis; the analysis done was only concerned with FDI by US. According to Vernon (1979), this theory is believed to be more relevant in case of FDI carried out by small firms in developing countries.

Knickerbocker (1973) in his study on the *Oligopolistic Reaction theory*, discovered that in oligopolistic industries, market leaders who had ventured abroad were automatically followed by rival companies from the home country and this reduces the intensity of oligopolistic reaction. This model has been slightly adjusted by Graham (1978) and used it to explain the investment behavior of TNCs. However, this theory has been criticized on the ground that it does not recognize FDI as one of the several methods of FI. Besides, this model fails to explain the motivation for the initial investment by the market leader in addition to neglecting the role of medium-sized TNCs in modernizing industries in transition countries.

Aliber (1970) in his study suggested that weak-currency countries are likely to attract FDI due to the higher purchasing power and more efficient hedging capacity of investors operating from strong-currency countries. Exchange rate was considered as a potential FDI determinant and this work got serious attention only in late 1980s and early 1990s. Caves (1989) in his study on inward investment flows into the USA from over a dozen different countries, found that the strength of a country's currency relative to the US dollar was an important explanatory variable for that country's direct investment in the U.S.A.

The basic notion of *Investment Development Path* (IDP) implies that the outward and inward FDI position of a country is directly related and the level of its economic development in relation to the rest of the world. Dunning (1981) formulated the Investment Development Path (IDP) paradigm suggesting that countries pass through five main stages of development. They can be classified according to their propensity to be inward and/or outward direct investment.

‘‘A positive Net Outward Investment (NOI) position [as difference between inward and outward FDI stock] mean that the country has become a net outward investor and vice-versa in the case of a negative NOI position. The IDP suggests that companies tend to invest in markets with lower per capita GDP than their home countries at least until they reach the fifth stage.’’

Yu and Ito (1988) in their study found that FDI is propagated by behavior of competitors related to host countries and firm related factors. Their research further demonstrated that firms in oligopolistic industries consider their competitor's activities and make decision of FDI because of economic factors.

According to Cleveland (2004), *Physical theory* or *Physical science* shows that energy is considered as necessary for economic production and therefore growth but the mainstream theory of economic growth, except for specialized resource economics models, pays no attention to the role of energy.

Models that incorporate the role of resources including energy in the growth process have been developed by resource economists, but these ideas remain segregated in the resource economics. However, the theory of growth has not been free of criticism, especially because of the implications of thermodynamics for economic production and the long-term prospects of the economy. Extensive studies have been conducted on the role of energy in the growth process. The primary findings are that energy used per unit of economic output has declined, but that this is to a large extent due to a shift in energy use from direct use of fossil fuels such as coal to the use of higher quality fuels, and especially electricity.

The pioneer work of Nobel prize-winning Robert Solow (1956) termed as the *neoclassical growth model* is one of the mainstream theories of growth. Initially, the model was not able to incorporate energy resources; however, later it was extended with nonrenewable resources, renewable resources, and a few waste assimilations services. These extended models, however, have only been applied within the perspective of debates about environmental sustainability, not in normal macroeconomic applications (Cleveland, 2004).

Georgescu-Roegen (1971); Cleveland *et al*. (1984); Hall *et al*. (2001); Ayres and Warr (2009); Murphy and Hall (2010) under Ecological Economics, referred to as the biophysical economics approach that relies on thermodynamics, usually argue that substitution between capital and resources, like energy, will solely play a restricted role in mitigating the insufficiency of resources. Moreover, some ecological economists like Stern (1996) argue that there's very little role left for technological amendment in driving economic growth.

Thus, whatever less attention is paid to the role of energy in production, economic growth and development by the conventional growth theory, the theoretical and empirical evidence has shown that energy use and performance are found to be closely linked to energy availability, playing an important role in enabling growth. The experience of developed countries also shows that the electricity sector played a critical role in their economic growth, not only as a key input to their industrial development, but also as a key factor in improving the quality of life of their people, which is essential for the general well-being of individuals and societies (Rosenberg, 1998). (Rosenberg, 1998).

Energy economists are debating about the relationship between energy consumption and this has led to the emergence of two contrasting views. Solow (1978), Denison (1985) and Cheng (1995)) suggest that energy is the key source of value as other factors of production such as labor and capital cannot do without energy. Hence, energy consumption is expected to be a proportion of gross domestic product (GDP), and, it is unlikely to have a significant effect on GDP growth. It has also been debated that the possible influence of energy consumption on growth will be dependent on the structure of the economy and the level of economic growth of the country concerned. It is believed that the production structure is likely to shift towards services which are not energy intensive activities as the economy grows.

As it has been seen from the work of Soytas and Sari (2003), the findings vary not only across countries but depend also on methodologies within the same country. While a country-specific causality study between energy consumption and economic growth can provide insight for the design of future energy policies, it is also important to come up with concrete evidences that can be used as an input for policy formulation and implementation. Various causality studies have been conducted for many countries in the world; however, none have focused on the causal relationship between energy consumption and GDP; for Ethiopia also, no study has been conducted except the one study conducted by Tesfaye (2019). Thus, this study attempts to examine this causal relationship. The mismatch between energy supply and demand in Ethiopia raises some important questions: does long-term equilibrium exist between energy consumption and GDP, between energy consumption and FDI, between FDI and GDP, between energy consumption and Population in Ethiopia? How do they influence each other in the short term? Answers to these questions are necessary to define and implement the appropriate energy development policies in Ethiopia.

2.3.2. Hypotheses on the Relationship Between Electric Consumption and Economic Growth

Numerous studies concentrate on the causal correlation between consumption of energy or consumption of renewable energy and economic development, as this is a significant indicator of the right policy decisions. In the case of the existence of bidirectional causality (feedback hypothesis) between energy consumption and economic growth, this suggests the interdependence of the two variables. Whereas if the relationship of causality is unidirectional but runs from economic growth to energy consumption (conservation hypothesis), this may reflect the little or no effect on economic growth of energy conservation policies. In contrast, the unidirectional causality that runs from energy consumption to economic growth (growth hypothesis) suggests the importance of energy to economic growth, which means that economic growth may be adversely affected by energy conservation policies. This represents the negligible impact of energy saving policies on economic growth in cases where there is no causality between economic growth and energy use (neutrality hypothesis) (Apergis and Danuletiu, 2014; Isa et al., 2015).

2.3.3. Growth Models related to Natural Resources and Technological Change

As Smulders (1999) indicates, research on growth with non-renewable resources in combination with endogenous technological change has been somewhat limited. Some models make very specific assumptions.

Smulders and de Nooij (2003), for instance, conclude that energy consumption has a growth rate in addition to a potential one-time decrease in the amount of energy use. Smulders (1999) provides a survey of earlier endogenous growth work and Smulders and de Nooij (2003) provide references to the more recent literature.

2.3.4. Substitution and Complementarity of Energy and Capital

Econometric studies conducted by Berndt and Wood (1979); and Apostolakis (1990) showed varying conclusions concerning whether capital and energy are complements or substitutes. Based on the differences between time series and cross-sectional results, Apostolakis (1990) deduced that capital and energy act more as substitutes in the long run and more as complements in the short run.

2.4. Empirical Review

More than a few studies have been conducted to examine the link between foreign direct investment, energy use and economic growth, but mixed and inconsistent results have been reported by methodologies and countries.

Many researchers who have been engaged in examining the impact of FDI on economic growth found mixed results. Ramadhan and Kossele (2016) examined the impact of FDI on GDP using yearly secondary data of Mozambique and South Africa covering the period1996-2014. GDP was used as a dependent variable while Total Labour Force, human capital and Gross Fixed Capital Formation variables were regarded as independent variables. By using Ordinary Least Square method of regression, the results from regression shown FDI was found to be insignificant but have positive relationship with economic growth for Mozambique. While for South Africa, FDI and total labor force are significant at the 10% level but have negative and positive relationship respectively with economic growth.

A research conducted by Bezuidenhout (2009) employing a modified production function model integrating Gross Domestic Product, Gross Capital Creation, Labor Force and Foreign Direct Investment, of which GDP was dependent variable, while the other three were independent variables. The findings have confirmed that all factors of production function, i.e. Capital, Labor and FDI support GDP and further estimate that every 1% rise in FDI will result in a 0.036% increase in GDP.

Adewumi’s (2006) work on the effect of FDI on growth in developing countries came up with a mixed result. It was discovered that contribution of FDI was positive in some countries and not positive in others. In most of the countries and for the continent, the relevant coefficient estimate is not significant. However, the author suggested that it is not logical to conclude that FDI is not needed in those countries that have no positive signs for FDI for the following reasons. Some impacts of FDI in the host country cannot be measured quantitatively, e.g. knowledge acquisition, technology and international image, and it may take a considerable time before these variables affect growth. Moreover, the methodology used for the empirical analysis has problem with low sample size and therefore might be able to show the effects of these variables on growth. Besides, FDI flow to Africa is relatively small, and this might contribute to the reasons why its contribution to growth is not large (Lensink and Morrissey (2006).

Using micro-data, Gorg and Greenwood (2002) looked at the spillovers from foreign firms to domestic firms; their results showed that FDI inflows generates negative effect on growth. Chowdhury and Mavrotas (2003) argued that the impact of FDI inflows to economic growth cannot be accessed within short-run period since its impact to economic growth rely on other factors such as the level of openness in the economy and human capital base in the host country. FDI impacts to economic growth should be measures in the long-run period.

Borensztein *et al*. (1998) examined the role of FDI on economic growth for developing countries. Their findings indicate that FDI was an effective intermediary between technology and economic growth. However, they stated that the effectiveness of FDI would be dependent on the existence of high human capital in the relevant host country for the economy to be more effective. Omran and Bolbol (2003) in their study found that both high correlation and significant causation between FDI and economic growth for Arab countries through a Causality test and OLS regression, respectively.

2.4.1. Energy profiles of Ethiopia

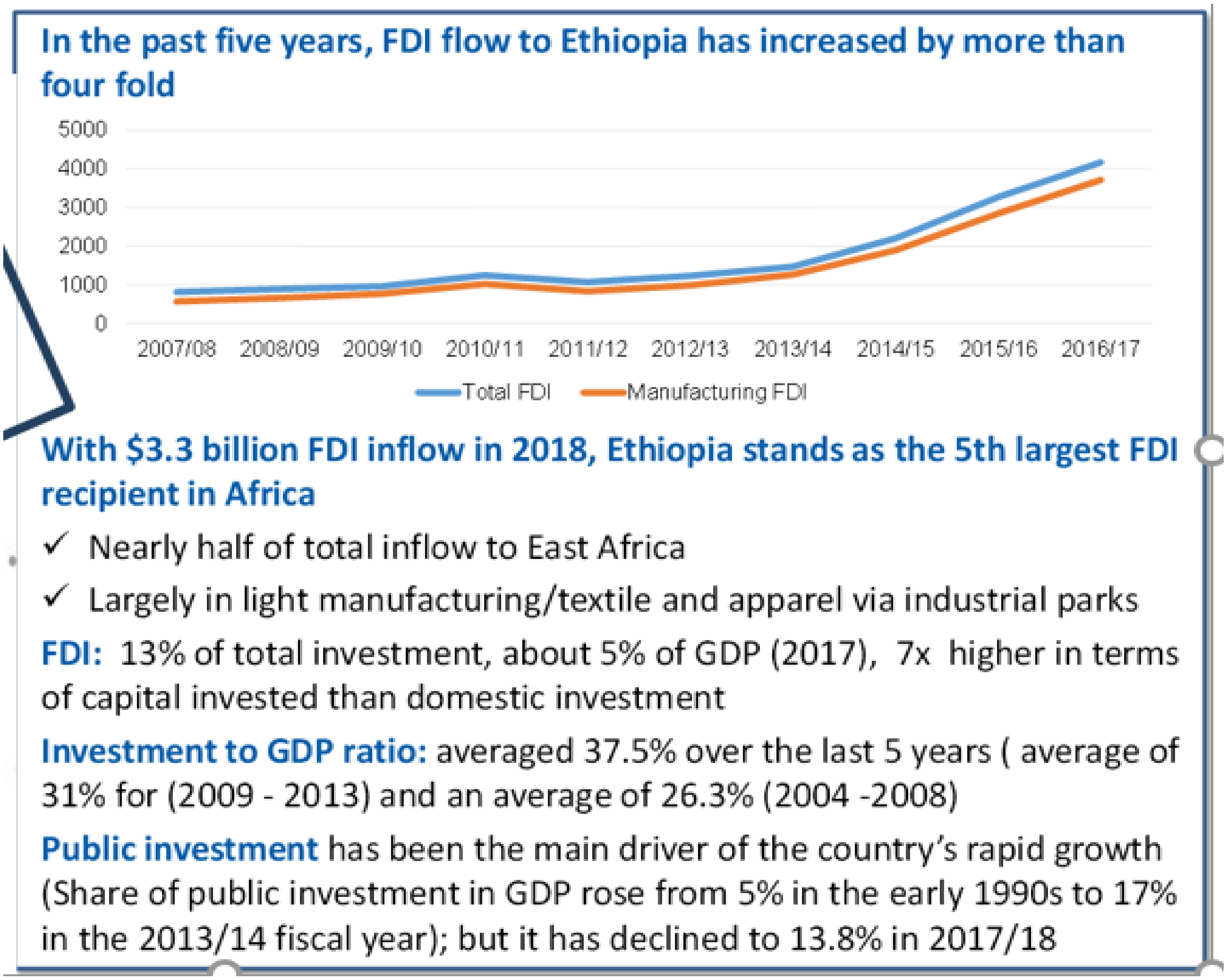
Generally, scholars agreed that access to modern energy supports both income generation activities and the national development agenda through improving education, reducing indoor air pollution, and ensuring environment sustainability. Moreover, having access to modern energy sources is essential for economic development and livelihood improvement. The assessment conducted by Bryan (2018) on Ethiopian energy status and demand scenarios shows that limited access to modern energy and heavy reliance on traditional biomass energy sources to meet growing demand are considered as the dual challenges to the Ethiopian energy sector. Although Ethiopia has seen dramatic economic growth in recent years, sustaining this growth into the future will require dramatic expansion of energy supply.

Studies show that power generation for the electric grid in Ethiopia currently depends almost entirely on hydropower and this needs to be changed and diversified. At the same time, in 2018, only about 45% of the total population is connected to the national grid. There are significant differences in the rate of electricity access in urban and rural areas: although in urban areas, 92% of the population has access to electricity, while in rural areas electricity access remains extremely low at about 33% (World Bank database, 2018).

Although Ethiopia is endowed with various renewable energy resources, the primary source of energy in Ethiopia is biomass, which accounts for 91% of energy consumed.

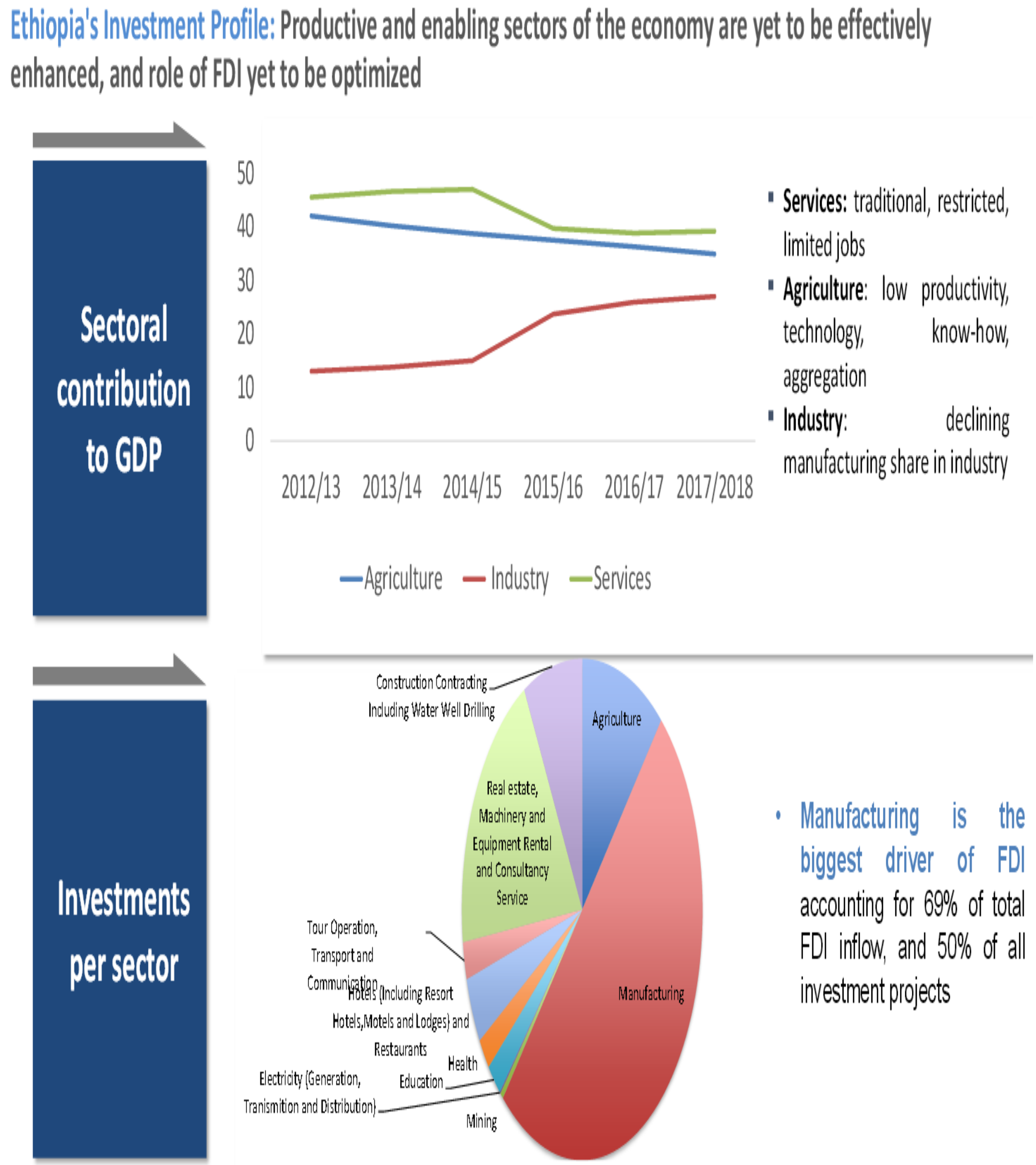
2.4.2. Overview of the Ethiopian Economy

Figure 1. Ethiopia's Investment Profile



Source: EIC (2019)

Figure 2. Sectoral contribution of Investment to GDP



Source: EIC (2019)

Regarding studies conducted on the causal relationships between Economic Growth and Electricity Consumption in Ethiopia, Tesfaye (2019) investigated the short-run and long-run causal relationships between Economic Growth and Electricity Consumption as target variables in Ethiopia during the period 1988–2017. The research also included additional variables such as FDI, Government Expenditure and Net Export which is the first in its kind on this topic while studied as a single country study in the Ethiopian case. As an econometric approach, the thesis employed the ARDL and Error Correction Model (ECM). The findings have shown that the variables have a co-integration relationship, but there is no causal relationship between the use of electricity and economic growth.

For the period from 1971 to 2013, Odhiambo (2016) investigated the causal correlation between energy use and economic growth in Ethiopia. They employed a multivariate Granger-causality framework that incorporates financial development, investment and trade openness. They used ARDL bounds testing approach and the error-correction model-based causality model; the results show that in Ethiopia, there is a distinct unidirectional Granger-causality from economic growth to energy consumption.

2.4.3. Challenges of the Energy Sector in Ethiopia

2.4.3.1 Financing

According to UN Sustainable Development goals (2015) report, the power sector requires huge capital investment and the world needs to triple its investment in sustainable energy infrastructure per year; from around $400 billion now to $1.25 trillion by 2030.The World Bank (2010) also estimated that $860 billion would be needed to connect 600 million additional households to achieve universal accessby2030.

According to IEA (2011) forecast, worldwide universal energy access by 2030 will require an investment of USD 34 billion per year over and above the baseline investments, with USD 32 bn per year extra for electricity and USD 2 bn for cooking fuels. About 60% of these additional investments (USD 20 bn per year) would have to be in Africa just for universal electricity access by 2030. The IRENA (2012) report reveals, in comparison, total African power sector investment including operation and maintenance per year requires billions of US$.

Estimations show that, to meet increasing demand and support economic growth, the power sector in Africa needs to install an estimated 7,000 megawatts (MW) of new generation capacity each year. Adequately financing the development of the energy sector in sub-Saharan Africa is expected to require the mobilization of funds in the order of USD 41 billion per year, which represents 6.4 per cent of the region's GDP. A large financing gap exists because much of the current spending goes to maintenance and operation of the existing power infrastructure, with little remaining to fund long-term investments and to address the power supply gap (UNEP,2012).

2.4.3.2. High costs of supplying rural and peri-urban households

The sparsely populated of many rural and peri-urban areas and a very high percentage of poor households and their low demand for electricity and low infrastructure expansion makes it difficult to provide electricity service and cost-wise ineffective. Studies show that many households consume less than 30 kilowatt-hours (kWh) per month. The combination of these factors results in high costs of supply for each unit of electricity consumed (World Bank, 2010).

2.4.3.3 Lack of appropriate incentives

According to World Bank (2010), the energy sector is not in a position to attract investment in rural electrification due to the high costs of electricity supply in rural areas and the limited capacity of households to pay for the service. And the system of tariffs and subsidies that ensures sustainable cost recovery while minimizing price distortions is absent in many countries.

2.4.3.4 Persistent poverty

Reliable power and other infrastructure (particularly water, telecommunications, and transportation) which favors to those haves than the have nots have had a notably adverse impact on growth and has contributed to perpetuating poverty. This leads to the idea the rich get richer and the poor get poorer. The shortage of capital means power is rationed and that only those regions, major industrial or commercial consumers, or residential consumer blocks that can pay, have a chance of receiving reliable power (Beyene, 2018).

2.4.3.5 Debt and deficits

The power sector in many developing countries is burdened with large debts accumulated from years of not charging cost recovery tariffs, not collecting from all consumers, not disconnecting consumers who do not pay, and using the utility as a vehicle for subsidies and political support for jobs and other favors. These power sector debts have led to non-payment to the central government and to governments having to channel sizable shares of their budgets into subsidizing the power sector (Beyene, 2018).

2.5. Literature Gap

As it has been seen from Soytas and Sari (2003) studies, the findings vary not only across countries but depend also on methodologies within the same country while a country-specific causality study between energy consumption and economic growth can provide insight for the design of future energy policies. It is also equally important to reach unambiguous results for policy implementation. Multiple causality studies have been done for many countries in the world. Neverthles, few studies concentrated on a causal relationship between FDI and economic growth, it is assumed that foreign investment is positively related to the economy. And the previous works did not incorporate population and financial development as independent variables in their research while studying the relationship among energy consumption, FDI and GDP growth. Furthermore, none have focused on the causal relationship between energy consumption, FDI and GDP for Ethiopia except the one study conducted by Tesfaye (2019). This study attempts to examine this causal relationship. The mismatch between energy supply and demand in Ethiopia raises some important questions:

- Does long-term equilibrium exist between energy consumption, FDI and economic growth in Ethiopia?
- How do they influence each other in the short term? Answers to these questions are necessary to define and implement the appropriate energy development policies in Ethiopia.

2.6. Conceptual Framework of the Study

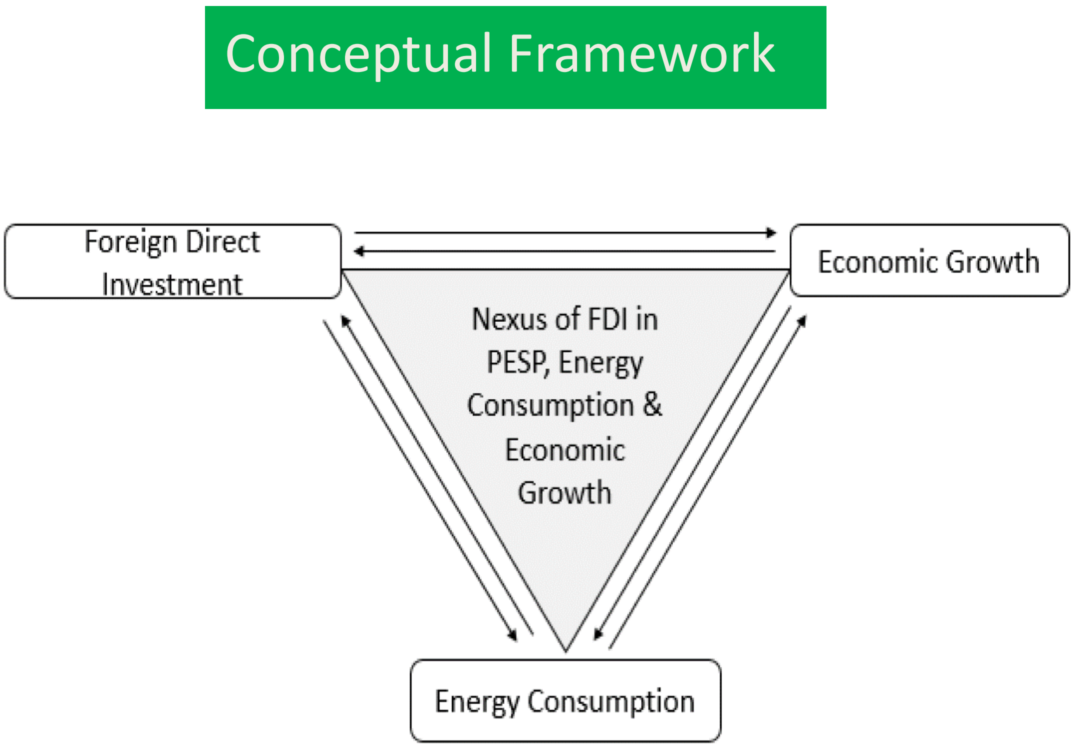
The conceptual framework of the study and the analysis procedure flow chart followed by the researcher for the analysis is depicted and presented in Figure 3 below:

The conceptual framework indicates economic growth proxied by real GDP Per Capita is dependent on: FDI proxied with net inflows, financial development represented by broad money supply as percentage of GDP, energy consumption measured by net consumption of total electricity, government expenditure as percentage of GDP, population growth as a proxy for market size. Economic growth is expected to be enhanced when appropriate reform or improvement actions are taken on these variables and the reform is expected to catalyze the economic growth.

In this chapter, the researcher reviewed literature on the relationship between FDI, energy consumtion, financial development, government expenditure, population and economic growth and their impact on the economy. Evidences show that economists differ in their viewpoints regarding the role of these variables in economic growth. Four different views are found in the literature concerning the potential role of the variables on economic growth. The first view considers the existence of these variables leads to economic growth. The second view regards economic growth positively affects the variables at hand. The third view the variables and economic growth have bidirectional causality or feedback from each other. And, the fourth view the variables and economic growth have independence from each other or no causality.

GDP= C+I+G+ (X-M)

Figure 3: Conceptual Framework of the Study



Source: Customized by the researcher, 2020

CHAPTER THREE

3. RESEARCH METHEDOLOGY

The goal of this paper is to investigate the long run relationship and pattern of causation among electricity consumption, economic growth and foreign direct investment. Therefore, this section is devoted to providing a methodological framework from which the effects of electricity consumption and foreign direct investment on economic growth can be determined. And the methodological and analytical approaches to be used in the thesis are drawn from the empirical literature focusing on energy consumption, FDI and economic growth. The research reviews extensive theoretical and empirical literature that underpins the interrelationship between energy consumption, FDI and economic growth.

3.1 Research Design

This section provides a description of the data set used in this paper and the procedure used to construct the dependent variable and the regressors. This research work has empirically been supported by various findings and literature review.

3.2 Model Specification and Procedure of Analysis

The study employs the linear Granger (1969) causality test in the VECM theme, to examine the short-run and long-run linearity relationship among the variables in bivariate and multivariate mode. To provide accuracy in the estimate of the relationship, it is thus necessary to prior determine the presence of unit root and cointegration between the time series. This helps in implementing VECM scheme which presumes that all variables are endogenous.

The researcher used Vector Error Correction Model (VECM) with the help of Eviews version 10 throughout the analysis. Vector Error Correction Model is used to evaluate the long-term and short-term relationship of the model. The important advantage of the method is that it provides the speed of adjustment parameter that specifies how swiftly the system back to equilibrium after a random shock.

In the beginning, Economic Growth was considered as the dependent variable and Electric Consumption, FDI, Population, Government Expenditure and money supply were taken as independent variables and the analysis carry on by making the remaining variables as a dependent.

The VECM has been used to determine the relation between Economic Growth, Electricity Consumption, FDI, Government Expenditure, Population and Money supply; it includes the below steps:

3.3 Determine Optimal Lag Length (k) for the model

Here we determine how many lags we should use in the system to be developed. An appropriate lag selection is chosen based on Akaike information criterion (AIC).

3.3 Augmented Dickey-Fuller (1981) Stationary Test

The study applies Augmented Dickey-Fuller (henceforth ADF) test developed by Dickey and Fuller (1981) to examine the unit root in each series with the following hypothesis: $H0$: $\theta = 0$ i.e., the time series is non-stationary and need to be differenced (has a unit root) Ha: $\theta < 0$ i.e., the time series is stationary (has no unit root) The ADF test is expressed by the following ordinary least square (OLS) relationship:

$$\Delta y_t = \alpha_0 + \beta t + \theta yt{-}1 + \sum_{i=1}^{p} \delta i \Delta y_{t-I} + \boldsymbol{\varepsilon_t} \quad \ldots\ldots \ldots\ldots \ldots. \ldots\ldots \ldots\ldots \ldots. \ldots\ldots \ldots\ldots \text{(1)}$$

where, t is a deterministic trend, α and β are the constants, p is the lag order selected based on Schwarz Bayesian Criterion (SBC). If the calculated value, in absolute term, is more than the t-statistic value (or the p-value less than 5%), this rejects the null hypothesis ($\theta = 0$) and conclude that the time series is stationary. If the null hypothesis rejected at level (without differencing), then the order of the stationary series is designated as I (0) whereas if the null hypothesis rejected at first difference then the order of the stationary series is designated as I (1).

3.4 Johansen-Juselius (1990) Cointegration Test

If the time series are non-stationary at level and when the variables are integrated of same order, the Johansen test of cointegration developed by Johansen and Juselius (1990) can be applied to obtain the number of cointegrating vector(s). Johansen-Juselius (1990) multivariate cointegration model can be expressed as:

$$\Delta y_t = \alpha_0 + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

where, Π and Γ_i are the coefficient matrices, Δ is the symbol of difference operator and p is the lag order selected based on Schwarz Bayesian Criterion (SBC). Johansen-Juselius (1990) techniques use two probability ratio test statistics to obtain the number of cointegrating vector(s), i.e. the Trace test and the Maximum Eigenvalue test, which can be computed respectively as:

$$T(r) = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \qquad (3)$$

$$\lambda_{max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \qquad (4)$$

where, $\hat{\lambda}_i$ is the expected eigenvalue of the characteristic roots and T represents the sample size. The null hypothesis of the Trace test (equation 3) investigates the number of r cointegrating vectors against the n cointegrating vector alternative. The null hypothesis (equation 4) of the Maximum Eigenvalue test tests the number of r cointegrating vectors versus the alternative r+1 cointegrating vector. So, if the variables are found to be cointegrated after applying Johansen-Juselius test then it can be concluded that there exists long-run equilibrium relationship between the variables. Further, that long-run equilibrium relationship can be examined by applying VECM scheme.

3.5 Vector Error Correction Model (VECM)

It can be understood that co-integration indicates the presence of causality among two-time series, but it does not detect the direction of the causal relationship. According to Engle and Granger (1987), the presence of co-integration among the variables shows unidirectional or bi-directional Granger causality among those variables. Further, they demonstrate that the co-integration variables can be specified by an Error Correction Mechanism (henceforth ECM) that can be estimated by applying standard methods and diagnostic tests. The VECM regression equation can be expressed as follows:

$$\Delta y_t = \alpha_1 + p_1 ecm1_{t-1} + \sum_{i=0}^{n} \beta_i \Delta y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta x_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta z_{t-i} + \varepsilon_{1t} \quad (5)$$

$$\Delta x_t = \alpha_2 + p_2 ecm2_{t-1} + \sum_{i=0}^{n} \beta_i \Delta y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta x_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta z_{t-i} + \varepsilon_{2t} \quad (6)$$

where, β_i, δ_i and γ_i are the short-run coefficients, Δ is the symbol of difference operator, p is the lag order, $ecm1_{t-1}$ and $ecm2_{t-1}$ are the Error Correction Term (henceforth ECT) and $\boldsymbol{\varepsilon}_{\mathbf{1t}}$ & $\boldsymbol{\varepsilon}_{\mathbf{2t}}$ are the residuals. Further, the $ecm1_{t-1}$ is the lagged value of the residuals derived from the cointegrating regression of y on x (equation 5) whereas the $ecm2_{t-1}$ is the lagged value of the residuals derived from the cointegrating regression of x on y (equation 6). Now, unidirectional causality between y to x (i.e., y Granger cause x) will happen in the equation 5 if, the set of estimated coefficients (δ_i and γ_i) on the lagged values of 'y' is jointly significant (short-run causality) and the ECT coefficient p_1 is negative and statistically significant (long-run causality). Similarly, unidirectional causality between x to y (i.e., x Granger cause y) will happen in the equation 6 if, the set of estimated coefficients (βi and γi) on the lagged values of 'x' is jointly significant (short-run causality) and the ECT coefficient p_2 is negative and statistically significant (long-run causality). Thus, if both variables Granger cause one another, then it can be inferred that there is a two-way feedback relationship between y and x. Thus, the VECM representation allows us to discriminate amongst the long-run and short-run dynamic relationships.

Some Tests

Perform diagnostic tests: Normality, Serial correlation, Heteroscedasticity (White Test)

After estimating VECM models there are some diagnostic tests which are vital for ensuring that the results obtained from VECM estimation can be used for forecasting. Important post-estimation tests which are mostly performed on the residual of the model are Lagrange Multiplier (LM) test for residual autocorrelation, Jarque-Bera test for residual normality, White Test for the presence of heteroscedasticity in the residuals and test for model stability. Autocorrelation testing helps to detect any correlations that might exist between the regression residuals' current values and any of their lagged values (Brooks, 2002). The null hypothesis of

the LM test for autocorrelation is that the residuals are not serially correlated, while the alternative is that the residuals are serially correlated. Generally, we reject the null hypothesis if the P-value is less than 005 (Harris, 1995).
To evaluate if the regression errors are normally distributed, the Jarque-Bera normality test is used. The Test Statistic has a Chi-Square distribution under the null hypothesis of normally distributed errors. Thus, if the Jarque-Bera statistic is significant, that is, the p-value is less than 0.05; the null of normality is rejected at the 5% level of significance (Brooks, 2002: 181). Moreover, the test for heteroscedasticity tests whether or not the variance of the model errors is constant. To detect the existence of heteroscedasticity in the residuals and model stability, the White Test is used.

The null hypothesis notes that the residuals are homoscedastic and independent of the regressors in the White test for heteroscedasticity, and that there is no question of misspecification. For the White test statistic to be significant, the P-value should be less than 0.05 and the homoscedasticity null hypothesis and no incorrect definition will not be accepted (Brooks, 2002: 445).

Step 1. Test for existence of serial correlation:

The research uses Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test

H0 = there is serial correlation,

Rule if prob. Chi-Square (2) < 0.05 or 5% we can reject H0

Step 2. Test for Heteroscedasticity:

We use Breusch-Pegan Godfrey test

H0 = there is no **Heteroscedasticity,**

Rule: if prob. Chi-Square (2) < 0.05 or 5% we can reject H0

Step 3. Test of normality, which is residual test, test of Jarque –Bera test:

H0 = residual is normally distributed,

Rule: if prob. Chi-Square (2) < 0.05 or 5% we can reject H0

Step 4. Perform Causality Test:

Granger-causality

The presence of a long-term relationship between the variables does not show which variable affects the other. Hence, the granger-causality test is applied to find the path of causality between the variables. Granger-causality works in such a way that a time series electricity consumption induces another time series FDI if FDI can be better predicted using the previous electricity consumption values than by not doing so. This means that if the previous electricity consumption values contribute significantly to the forecasting of FDI, then it implies that electricity consumption grangers cause FDI and that the causality of FDI to electricity consumption can be explained in the same way. The VECM is used in the long and short run to assess the relationship between the variables and can identify sources of causation. The VECM is defined by Equation (7) - Equation (12). Each equation, the independent variables and the term for error correction, describes the dependent variable by itself.

$$\Delta \mathrm{lnRGDPPC}_t = \alpha_{10} + \sum_{i=1}^{p} \alpha_{11}\, \Delta lnRGDP\mathrm{PC}_{t-i} + \sum_{i=1}^{q} \alpha_{12}\, \Delta lnFDI_{t-i} + \sum_{i=1}^{r} \alpha_{13}\, \Delta lnEC_{t-i} + \sum_{i=1}^{s} \alpha_{14}\, \Delta \mathrm{GEXPGDP}_{t-i} + \sum_{i=1}^{t} \alpha_{15}\, \Delta \mathrm{POG}_{t-i} + \sum_{i=1}^{u} \alpha_{16}\, \Delta \mathrm{M2\_GDP}_{t-i} + \Psi_1 ECT_{t-1} + \varepsilon_{1t} \quad \text{....................(7)}$$

$$\Delta \mathrm{lnFDI}_t = \alpha_{20} + \sum_{i=1}^{p} \alpha_{21}\, \Delta lnFDI_{t-i} + \sum_{i=1}^{q} \alpha_{22}\, \Delta ln\ lnRGDP\mathrm{PC}_{t-i} + \sum_{i=1}^{r} \alpha_{23}\, \Delta lnEC_{t-i} + \sum_{i=1}^{s} \alpha_{24}\, \Delta \mathrm{GEXPGDP}_{t-i} + \sum_{i=1}^{t} \alpha_{25}\, \Delta \mathrm{POG}_{t-i} + \sum_{i=1}^{u} \alpha_{26}\, \Delta \mathrm{M2\_GDP}_{t-i} + \Psi_2 ECT_{t-1} + \varepsilon_{1t} \quad \text{.............(8)}$$

$$\Delta \mathrm{lnEC}_t = \alpha_{30} + \sum_{i=1}^{p} \alpha_{31}\, \Delta lnEC_{t-i} + \sum_{i=1}^{q} \alpha_{32}\, \Delta ln\ lnRGDP\mathrm{PC}_{t-i} + \sum_{i=1}^{r} \alpha_{33}\, \Delta lnFDI_{t-i} + \sum_{i=1}^{s} \alpha_{34}\, \Delta \mathrm{GEXPGDP}_{t-i} + \sum_{i=1}^{t} \alpha_{35}\, \Delta \mathrm{POG}_{t-i} + \sum_{i=1}^{u} \alpha_{36}\, \Delta \mathrm{M2\_GDP}_{t-i} + \Psi_3 ECT_{t-1} + \varepsilon_{1t} \quad \text{.............(9)}$$

$$\Delta \mathrm{GEXPGDP}_t = \alpha_{40} + \sum_{i=1}^{p} \alpha_{41}\, \Delta \mathrm{GEXPGDP}_{t-i} + \sum_{i=1}^{q} \alpha_{42}\, \Delta ln\ lnRGDP\mathrm{PC}_{t-i} + \sum_{i=1}^{r} \alpha_{43}\, \Delta lnFDI_{t-i} + \sum_{i=1}^{s} \alpha_{44}\, \Delta \mathrm{EC}_{t-i} + \sum_{i=1}^{t} \alpha_{45}\, \Delta \mathrm{POG}_{t-i} + \sum_{i=1}^{u} \alpha_{46}\, \Delta \mathrm{M2\_GDP}_{t-i} + \Psi_4 ECT_{t-1} + \varepsilon_{1t} \quad \text{........(10)}$$

$$\Delta \mathrm{POG}_t = \alpha_{50} + \sum_{i=1}^{p} \alpha_{41}\, \Delta \mathrm{POG}_{t-i} + \sum_{i=1}^{q} \alpha_{52}\, \Delta ln\ lnRGDP\mathrm{PC}_{t-i} + \sum_{i=1}^{r} \alpha_{53}\, \Delta lnFDI_{t-i} + \sum_{i=1}^{s} \alpha_{54}\, \Delta \mathrm{EC}_{t-I} + \sum_{i=1}^{t} \alpha_{55}\, \Delta \mathrm{GEXPGDP}_{t-i} + \sum_{i=1}^{u} \alpha_{56}\, \Delta \mathrm{M2\_GDP}_{t-i} + \Psi_5 ECT_{t-1} + \varepsilon_{1t} \quad \text{..........(11)}$$

$$\Delta M2\_GDP_t = \alpha_{60} + \sum_{i=1}^{p} \alpha_{61}\, \Delta M2\_GDP_{t-i} + \sum_{i=1}^{q} \alpha_{62}\, \Delta lnRGDPPC_{t-i} + \sum_{i=1}^{r} \alpha_{63}\, \Delta lnFDI_{t-i} +$$

$$\sum_{i=1}^{s} \alpha_{64}\, \Delta EC_{t-i} + \sum_{i=1}^{t} \alpha_{65}\, \Delta GEXPGDP_{t-i} + \sum_{i=1}^{u} \alpha_{66}\, \Delta M2\_GDP_{t-i} + \Psi_6 ECT_{t-1} + \varepsilon_{1t} \quad \text{.........(12)}$$

Where

Δ represents the difference operator

α_{it} is the constant term

ECT refers to the term for error correction arising from long-term cointegrating relationships

The t-statistics in ECT terms are used to measure the importance of the speed of change. ECTt-1's statistical significance with a negative sign confirms that there is a long-term causality flowing between the variables. The Wald test is applied to differentiated and lagged differential terms of the independent variables to investigate the short-term causality.

After examining, in the earlier sections, the unit root and co-integration in the time series setting, the next step is to know the direction of causality. And for this, Granger Causality test was applied.

- The test represents that for two variables (say X and Y); if X is influenced by both lagged values of X ancd lagged values of Y, then it is called as Y Granger causes X (Y→X). Similarly, if Y is influened by its lag and the lagged values of X, then we call it X Granger causes Y (X→Y). However, between X and Y, if X Granger causes Y and Y Granger causes X, we call it bi-directional causality. If only one exists, then it is the case of uni-directional causality. If both do not exist, then the variables are independent to each other. The Pairwise Granger-causality test method is selected to be used in this study over other alternative techniques because of its favorability, particularly, for small samples in empirical works, as cited in Seung-Hoon Yoo, 2004.
- This study applied Pairwise Granger Causality test.
- Pairwise Granger Causality test tells the direction of Causality:
- H_0 = no Granger Causality,
- H_A = the null hypothesis is not true,
- Decision Criteria: Reject the null hypothesis if the Probability Value of F-Statistic is less than or equal to 0.05 (F-Statistic ≤ 5%).

3.3. Data Sources

The study utilizes Annual Time-Series Secondary data, from 1988 to 2018. The National Bank of Ethiopia (NBE), the Ethiopian Economics Association (EEA), the World Bank (Word Bank Development Indicators), the United Nations Conference on Trade and Development (UNCTAD) and the United Nations Statistics Database (UNdata) are the data sources for this study.

In the paper, net consumption of total electricity is expressed in terms of Megawatt hours (MWh), economic growth is proxied by Real GDP Per Capita (constant 2010 US$), Foreign direct investment, net inflows (BoP, current US$), Government Expenditure as percentage of GDP (US$); Broad money supply as percentage of GDP as a proxy for Financial Development and Population growth as a proxy for Market Size.

CHAPTER FOUR

4. DATA ANALYSIS AND DISCUSSION

4.1. Unit Root Test Results

After model specification, the first step, as shown above in the methodology section, was to investigate the presence of causality among electricity consumption, FDI and economic growth and to define the order of integration of the series under consideration.

Non-stationarity of time series data in empirical research has also been seen as a problem. Working with non-stationary variables leads to spurious effects of regression, from which it is useless to further conclude. Therefore, the first step in econometric analysis of time series is to perform unit root testing on the variables of interest. The test examines whether or not the data series is stationary. The conventional Augmented Dickey-Fuller (ADF) test is used execute the root test at the level and the first difference intercept. The null hypothesis in these tests is that the series under investigation has a root unit, otherwise it is stationary. The findings stated in table 1 below show that the null hypothesis for all variables at the levels is not rejected by the individual unit root test.

The study further applied the unit root test in the first differences of all the variables and the results reject the null hypothesis for all variables, implying that all the variables are stationary at first difference.

Table 1. Unit Root Tests of the Variables at Level

Variable	Augmented Dickey Fuller (ADF)			
	Intercept		Trend and intercept	
	Critical value	P value	Critical value	P value
lnRGDPPC	-2.967767	0.9958	-3.568379	0.4431
lnFDI	-2.963972	0.4308	-3.568379	0.1127
lnEC	-2.963972	1.0000	-3.568379	0.9590
GEXPGDP	-2.963972	0.2264	-3.568379	0.4405
POG	-2.971853	0.4223	-3.580623	0.8244
M2_GDP	-2.963972	0.1418	-3.568379	0.3846

Source: Own computation using EViews 10

Table 2. Unit Root Tests of the Variables at first difference

Variable	Augmented Dickey Fuller (ADF)			
	Intercept		Trend and intercept	
	Critical value	P value	Critical value	P value
lnRGDPPC	-2.967767*	0.0155	-3.580623*	0.0126
lnFDI	-2.971853*	0.0000	-3.580623*	0.0002
lnEC	-2.967767*	0.0232	-3.574244*	0.0004
GEXPGDP	-2.967767*	0.0001	-3.574244*	0.0005
POG	-2.971853*	0.0000	-3.587527*	0.0003
M2_GDP	-2.967767*	0.0000	-3.574244*	0.0001

Source: Own computation using EViews 10

Note: *** imply the rejection of null hypothesis at 5%, ** means the rejection of null hypothesis at 1% and 5% and * denotes rejection of the null hypothesis at 1%, 5% and 10% significance level.

The ADF test statistics as depicted in Table 2 illustrates that all variables are non - stationary at levels.

That is, it is not possible to reject the null hypothesis of unit root both with and without trend in the auxiliary regression of unit root. In other words, the null hypothesis of the unit root cannot be rejected, both with and without a trend in the unit root auxiliary regression.

Table 3 shows that the ADF test applied to the same variables becomes stationary at the conventional 1 percent, 5 percent and 10 percent level of significance in their first difference. Therefore, the variables are integrated with order one (I ~I (1)).

4.1.1 Determining the Optimal Lag Length (k) for the model

The Johansen co-integration test outcome is very sensitive to the number of lags incorporated in the VAR estimation for the endogenous variables. This requires the determination of an optimal lag order before the co-integration test. Hence, sequentially adjusted probability ratio test statistics [LR], the Final Prediction Error [FPE], the Akaike Information Criterion [AIC], the Schwarz Information Criterion [SIC], and the Hannan Quin Information Criterion [HQ]) are employed to determine the optimal lag order.

The optimal lag order is determined using the sequential adjusted Likelihood Ratio test statistics [LR], the Final Prediction Error [FPE], the Akaike Information Criterion [AIC], the Schwarz Information Criterion [SIC], and the Hannan Quinn Information Criterion [HQ]).

As shown in Table 3, an optimal lag of three, all at a 5 percent significance level, is suggested by LR, FPE, AIC, SC and HQ.

Table 3. Var lag order selection criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-151.9801	NA	0.002172	10.89518	11.17807	10.98378
1	23.21442	265.8124	1.56e-07	1.295557	3.275779	1.915738
2	97.66591	82.15337*	1.57e-08*	-1.356269*	2.321285*	-0.204505*

*indicates lag order selected by criterion

4.2. The Johanson Co-Integration Test Result

The stationarity test demonstrated that all variables are not stationary at level and it implies that any estimation using this level data will lead to wrong conclusion and policy implication. However, the Granger representation theorem states that it is possible for non-stationary variables to produce a stationary relationship if they are co-integrated. This would mean that the variables have a meaningful long-term relationship. Therefore, using the trace and the maximum Eigen value methods, the existence of and the number of such co-integrating relationships are verified.

Table 4. Johanson Co-Integration Test

Unrestricted co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.948971	225.1750	95.75366	0.0000
At most 1 *	0.876568	141.8650	69.81889	0.0000
At most 2 *	0.791270	83.28721	47.85613	0.0000
At most 3 *	0.612736	39.41927	29.79707	0.0029
At most 4	0.337756	12.85712	15.49471	0.1202
At most 5	0.045971	1.317708	3.841466	0.2510

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-Integration Rank Test (Maximum Eigen value)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.948971	83.31001	40.07757	0.0000
At most 1 *	0.876568	58.57775	33.87687	0.0000
At most 2 *	0.791270	43.86794	27.58434	0.0002
At most 3 *	0.612736	26.56215	21.13162	0.0078
At most 4	0.337756	11.53941	14.26460	0.1292
At most 5	0.045971	1.317708	3.841466	0.2510

The Max-eigenvalue test shows 4 eqn(s) cointegrating at the level of 0.05, * denotes rejection of the hypothesis at the level of 0.05, ** The p-values of MacKinnon-Haug-Michelis (1999)

The study has found number of co-integrated equations using trace statistics and maximum Eigen value statistics. According to probabilities given in tables 4, the analysis rejects the null hypothesis that there is no co-integrated vector (None), there are at most 4 co-integrated vectors (at most 4). It shows high association between explanatory and dependent variables used in current study. Since the objective of this paper is to see the relationship among RGDP growth, EC and FDI, and the impacts of government expenditure, money supply and population on RGDP, the unrestricted cointegrating vectors with ad-hoc normalization on RGDP growth has been estimated.

4.3. Vector Error Correction Model (VECM)

4.3.1 Post Estimation Diagnostic Test Results

A. Residual Normality Tests

The residual or error term are normally distributed when the probability value is greater than 5% significance level. As shown in the Jarque-Bera test (table 5), the probability value of this study is 89% which is far above the required criteria for normality test. Therefore, the error term of this study is normally distributed.

Table. 5. Jarque-Bera Histogram Normality Test Results

Component	Jarque-Bera	df	Prob.
1	1.169458	2	0.5573
2	2.070450	2	0.3551
3	0.511291	2	0.7744
4	0.284169	2	0.8675
5	1.660862	2	0.4359
6	0.730719	2	0.6939
Joint	6.426950	12	0.8931

Source: Own computation using EViews 10

B. Residual Autocorrelation Test

Concerning the Autocorrelation test, Breusch-Godfrey Serial Correlation LM test was used for the

analysis. Accordingly, the model is not suffering from autocorrelation problem. As shown in table 6 below, the P-value (0.4827) is by far greater than 5%. As a result, the study failed to refute the null hypothesis, which states that there is no serial association between residuals.

Table 6. Serial Correlation LM Results

Null Hypothesis: no serial coorelation at lag order h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	37.08656	36	0.4187	0.922219	(36, 15.9)	0.5965
2	39.88843	36	0.3013	1.043414	(36, 15.9)	0.4827

Source: Own computation using EViews 10

C. Heteroscedasticity Test

To check the presence of Heteroscedasticity, this study employed White Test.
Accordingly, the result obtained from the White Test shows that there is no problem of Heteroscedasticity because the P-value (32%) is by far above the 5% significance level. Therefore, the study accepts the null hypothesis which says no Heteroscedasticity problem.

Table 7. Test for Residual Heteroscedastic

No Cross Terms (only levels and squares)

Joint test:

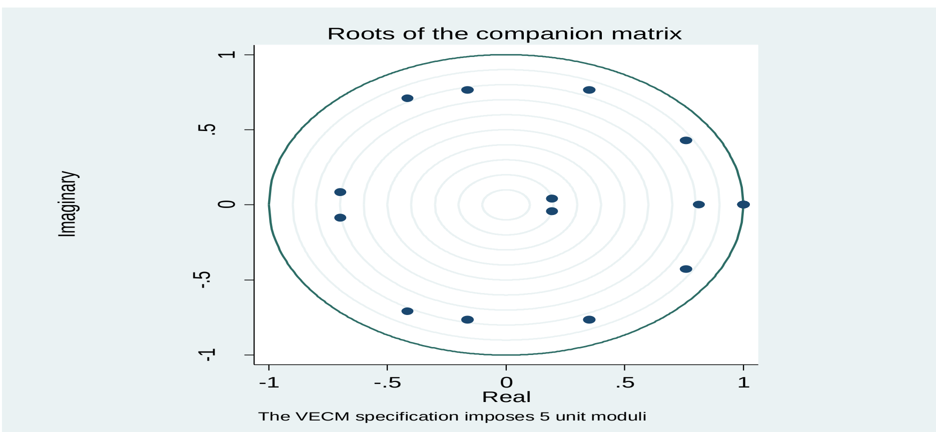
Chi-sq	df	Prob.
560.7995	546	0.3213

Source: Own computation using EViews 10

D. Model Stability Test

We should also evaluate the stability of the estimated VECM. For a K-variable model with r cointegrating relationships, the companion matrix will have K −r unit eigenvalues. For stability, the moduli of the remaining r eigenvalues should be strictly less than unity. Thus, the eigenvalues meet the stability condition.

Fig. 4. Roots of AR Characteristic Polynomial



```
. vecstable, graph
```

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
1	1
1	1
.7588641 + .429078*i*	.87177
.7588641 − .429078*i*	.87177
.3499454 + .7645409*i*	.840824
.3499454 − .7645409*i*	.840824
−.415031 + .7090796*i*	.821611
−.415031 − .7090796*i*	.821611
.812428	.812428
−.1630594 + .7643992*i*	.781597
−.1630594 − .7643992*i*	.781597
−.6982979 + .08508153*i*	.703462
−.6982979 − .08508153*i*	.703462
.194976 + .04273648*i*	.199605
.194976 − .04273648*i*	.199605

The VECM specification imposes 5 unit moduli.

Generally, a model which passes all the tests applied on the residuals, and is stable, could be used in analyses and forecasting.

4.3.2. VECM Long Run Estimate

The long run estimates of GDP Growth model are reported in table 8. First column is showing the names of variables, similarly, coefficients, standard errors and t-statistics are displayed in 2nd, 3rd and 4th columns, respectively. The 5th column indicates the significant and insignificant relationships of all the variables. As table 8 confirms, except for population growth, the null hypothesis of no significance for the variables included in the model namely Eclecricity Consumption, FDI, Government Expenditure and Money Supply been rejected. This suggests that the above mentioned variables are statistically significant in influencing real GDP percapita Growth.

As reported in table 8 below, the coefficients of FDI shows that foreign direct investment is statistically significant and positively correlated with real GDP per capita growth in the long run. The change in FDI affects economic growth positively in the long-run, which is a 1 percent increase in FDI will result in 0.124 percent rise in RGDP on average in the long run.

This study is in congruence with previous studies. A research on renewable electricity use, foreign direct investment and economic growth in Egypt was conducted by Ibrahiem (2015) and concluded that foreign direct investment has a long-term positive impact on economic growth. In his research on Multivariate Cointegration and Causality between Electricity Use, Economic Development, Foreign Direct Investment and Exports in Vietnam, Nguyen (2017) found that real GDP, EC, exports and FDI are cointegrated and a unidirectional causality of Granger that runs from real GDP to EC, EX and FDI.

In the same manner, Electricity Consumption is found to be significant and positively associated with Economic Growth. Accordingly, a 1 percent increase in Electric Consumption will result in 0.201 percent upsurge in real GDP per capita growth on average in the long run. However, this study is incontradiction with previous works. For instance, Tesfaye (2019) in his study on the interconnectedness of Electricity Consumption and Economic Growth, found negative effect of Electricity Consumption on Economic Growth. Okafor (2012) in his work on Energy Consumption and Economic Growth found different results. The estimated results reveal that economic growth causes total energy consumption in South Africa while energy consumption causes economic expansion in Nigeria.

Likewise, Money Supply (broad money) is positively associated with Economic Growth. The results reveal that Money Supply has significant positive coefficient. This implies that for the period under consideration, the role of financial development was positive in improving economic growth in Ethiopia. In the long run, a one percent rise in money supply results in an average increase of 0.04 percent in real GDP per capita. This finding is in line with the variety of works that have explored the relationship between economic growth and financial development. King and Levine (1993) looked at various financial development metrics, such as the ratio of liquid liabilities to GDP (M2/GDP) and the ratio of non-financial private sector claims to GDP, etc.

They concluded that the various indicators of financial development yielded similar conclusions, that is, there is a strong positive correlation between the extent of financial development and economic growth. Moreover, the same conclusion has been found by many authors like Roubini and Sala-i-Martin (1992), Gregorio and Guidotti (1995), and Arestis and Demetriades (1997).

Government spending, on the other hand, has a negative and statistically significant contribution to real GDP per capita growth. One percent increase in government spending leads to 0.001 percent decrease in real GDP per capita on average in the long run.

In addition to this results, similar findings were obtained by other researchers in the literature. Barro (1991), Fischer (1993) and Shahir (2014) found that government consumption expenditure has a negative effect on economic growth. The rationale behind for the findings is that government consumption expenditure is negatively related to private investment (Barro 1991). Besides, Martine Mariotti (2001) has undertaken a study on the impact of public policy on economic growth of South Africa and concluded that the increases in government consumption expenditure have a negative significant impact on GDP growth.

Conversely, population growth was found to have a negative association with real GDP per capita growth although it is not significant. As it has been reeled in the work of Asongu (2013), the sign goes with the concern related with the population projection. There has been growing concern over Africa's population growth and corresponding rising unemployment rate as the population projected to double by 2036.

Table 8. Vector Error Correction Long Run Relationship

Variables	Coefficient	Standard Error	T-Statistics	Prob.
LNEC(-1)	-0.200618	0.07576	-2.64808	0.0080
LNFDI(-1)	-0.123854	0.02819	-4.39363	0.0000
GEXPGDP(-1)	0.112665	0.00997	11.3051	0.0000
M2_GDP(-1)	-0.039012	0.00699	-5.58058	0.0000
POPG(-1)	0.000783	0.13390	0.00585	0.9950
C	-1.244232			

Source: Own computation using EViews 10

4.3.3 Pairwise Granger Causality Tests Results

After examining, in the earlier sections, the unit root and co-integration in the time series setting, the next step is to know the existence of causality between variables. And for this purpose, this study applied Pairwise Granger Causality test.

Table 9. Pairwise Granger Causality Tests Results

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision
GEXPGDP does not Granger Cause LNRGDPPC	29	0.57101	0.5724	Accepted*
LNRGDPPC does not Granger Cause GEXPGDP		2.97834	0.0699	Accepted
LNEC does not Granger Cause LNRGDPPC	29	9.13397	0.0011	Rejected*
LNRGDPPC does not Granger Cause LNEC		1.4151	0.2625	Accepted
LNFDI does not Granger Cause LNRGDPPC	29	2.74029	0.0847	Accepted
LNRGDPPC does not Granger Cause LNFDI		3.18497	0.0593	Accepted
M2_GDP does not Granger Cause LNRGDPPC	29	1.34731	0.2789	Accepted
LNRGDPPC does not Granger Cause M2_GDP		0.43567	0.6518	Accepted
POPG does not Granger Cause LNRGDPPC	29	1.394	0.2675	Accepted
LNRGDPPC does not Granger Cause POPG		3.10921	0.063	Accepted

*Accepted indicates the study failed to reject the null hypothesis Rejected

*Rejected indicates the study rejected the null hypothesis

Source: Own computation using EViews 10

As displayed in table 9 of Pairwise Granger Causality test results, only Electricity Consumption Granger Cause real GDP per capita growth. The Pairwise Granger Causality test results suggested a uni-directional causality flowing from Electricity Consumption to real GDP per capita growth. This supports the growth hypothesis implying an increase in Electricity consumption could cause an increase in GDP level.

However, there is no causality between FDI, government expenditure, Money supply and real GDP per capita growth in Ethiopia implying independent relationship between the variables and further studies need to be conducted to identify the possible reasons for this to happen.

4.3.4. VECM Short Run Model

Table 10 shows the short run relationship outcome of the error-correction model, from which the short-run impact of Electricity Consumption, FDI, Government Expenditure and Money Supply as percentage of GDP on economic growth (real GDP) can be analyzed. The coefficient of error correction of the equation is negative and important. This tells us that there is a fair change to the long-term steady state. This guarantees that although the actual real GDP per capita may temporarily deviate from its long-run equilibrium value, it would gradually converge to its equilibrium. The error correction term of -0.263 shows that about 26.3 percent of the deviation of the actual real per capita GDP from its equilibrium value is eliminated every year; hence, full adjustment would require a period of less than four years.

RGDP lag has insignificant positive impact; so, it does not explain the RGDP in the short run. Government expenditure has positive and significant impact on RGDP per capita. Accordingly, one percentage increase in government investment at lag one and lag two will result in 0.018 percent and 0.026 percent increase in RGDP per capita respectively.

Likewise, population growth at two period's lag affects economic growth positively in the short run. Hence, 1% increase in population growth will result in 0.931 percent upsurge in economic growth in the short run. Peter (2019) in his study titled the impact of population growth on economic growth found that population growth impacts economic growth positively although the impact of population growth on economic growth is still largely controversial at national and regional levels.

Conversely, economic growth is negatively affected by the past movements of FDI inflow in the short run; one and two period's lag of FDI are found to have statistically significant negative impact on real GDP Growth. Accordingly, 1% increase in FDI inflow at lag one and lag two respectively will result in 0.052 and 0.027 percent decline in economic growth in the short run. This is in line with Dinh's (2019) work that revealed the short run negative effect of FDI on economic growth. Similarly, the two-period lag in money supply has an impact on economic development in the short run.

Hence, 1% increase in money supply will lead to 0.013 percent fall in economic growth in the short run.

Whereas one and two period's lag of electric consumption has negative insignificant impact on RGDP in the short run. Similarly, population growth and money supply at one period's lag failed to explain RGDP Growth in the short run.

Table 10. Vector Error Correction Short-run Relationship

Variables	Coefficient	Standard Error	T-Statistics	Prob.
CointEq(-1)*	-0.262511	0.06212	-4.22615	0.000

D(LNRGDPPC(-1))	0.209672	0.19780	1.06003	0.289
D(LNRGDPPC(-2))	0.252335	0.16963	1.48757	0.137
D(GEXPGDP(-1))	0.018270	0.00459	3.98276	0.000
D(GEXPGDP(-2))	0.026070	0.00477	5.45985	0.000
D(LNEC(-1))	-0.049278	0.15566	-0.31658	0.752
D(LNEC(-2))	-0.148504	0.14051	-1.05693	0.291
D(LNFDI(-1))	-0.052403	0.00730	-7.1801	0.000
D(LNFDI(-2))	-0.026838	0.01033	-2.59764	0.009
D(POPG(-1))	-0.388222	0.26565	-1.46141	0.144
D(POPG(-2))	0.930587	0.24777	3.75587	0.000
D(M2_GDP(-1))	-0.004849	0.00357	-1.35952	0.174
D(M2_GDP(-2))	-0.012917	0.00307	-4.20266	0.000
Constant	0.075195	0.01796	4.18579	0.000

R- Squared 0.865 Durbin- Watson stat 1.785

Adjusted R-squared 0.740 F-statistic 6.919

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Although Ethiopia is endowed with abundant renewable energy resources and has a potential to generate over 60,000 Megawatts (MW) of electric power from hydroelectric, wind, solar and geothermal sources, currently it only has approximately 4,068 MW of installed generation capacity to serve a population of over 100 million.

Ethiopia's power system is large compared to its regional neighbors, dominated by large hydro plants. The country has more than 4500 MW of installed generation capacity, of which 90% is hydropower-based. This makes the sector particularly vulnerable to drought, resulting in Ethiopia being ranked 118th out of 144 countries for the quality of electricity supply.

Likewise, although the Ethiopian Electricity sector has shown improvement in recent years, the Energy consumption is still predominantly dominated by Traditional Biomass energy sources. On top of this, in 2018 only 45 per cent of the population has access to electricity which is far behind the global access rate of 87 percent but a little bit more than that of the African access rate of 43 percent.

The objective of this paper was to investigate the short-run and long-run causal relationships between Economic Growth/RGDPPC, FDI and Electricity Consumption as target variables and by considering additional variables such as FDI, Government Expenditure, Population and Financial Development in Ethiopia during the period 1988–2018, assuming other things remained constant.

At the beginning, Unit root test was employed to check the stationary properties of the collected time series data and accordingly, as a second step, the optimum lag that is 2 was selected for use in further system equation model. Thirdly, Johansen's Co-integration analysis was run to examine the long run relationship among the variables where it was found that taken variables have long run relationship.

To check the serial correlation problem of the model, Breusch-Godfrey Serial Correlation LM test was run where result shows that the model is free of serial correlation problem. Then, Jarque-Bera test has been run to check the residual normality. The result of Jarque-Bera test denotes that all models are normally distributed. The White Test was also employed to check the presence of Heteroscedasticity and the study accepts the null hypothesis which says no Heteroscedasticity problem. Finally, the Model Stability Test for the stability of the estimated VECM was run, and the eigenvalues meet the stability condition.

Then, with the help of statistical software EViews 10, VECM model was used to investigate the dynamic association between the variables. This study conducted the analyses taking five factors such as Economic Growth/RGDPPC, FDI and Electricity Consumption, FDI, Government Expenditure, Population growth and Financial Development. The regression results reveal that FDI, Electricity Consumption Government Expenditure as a percentage of GDP and Money Supply as a percentage of GDP proved to be significant at confidence level of one percent in influencing real GDP per capita. The researcher also found that in the short term, but not in the long term, population growth tends to have a positive effect on economic growth while the money supply, which is a proxy for financial development, has been found to have a negative impact on GDP both in the short and long term.

To verify the short-term relationship between the variables, the Granger causality test was also run. The short-term Granger causality test shows that there is a uni-directional causality that applies to economic growth from energy use, government expenditure, population growth and financial development. Moreover, the outcome also highlighted that there is a bidirectional linear short-run causality between FDI and GDP growth.

The Pairwise Granger causality test was also run to check the long run relationship between the variables. Accordingly, the long run Pairwise Granger Causality test results revealed that only Electricity Consumption Granger Cause real GDP per capita growth suggesting a uni-directional causality flowing from Electricity Consumption to real GDP per capita growth. The results support growth hypothesis implying an increase in Electricity consumption could causes an increase in GDP level. Therefore, EC has a vital role in production process of GDP that confirm the importance of heavy hand of the government in the energy sector.

This paper is believed to contribute to Ethiopia's rising literature on electricity use, foreign direct investment and the nexus of economic growth.

5.2. Recommendations

In general, the results of this study show that in the long-run FDI, Electricity Consumption and Financial Development are found to have a positive effect on economic growth in Ethiopia while Government expenditure has negative impact on GDP; Moreover, although population growth positively affects GDP in the short run, it negatively impacts GDP in the long run but not significant.

The results can show that foreign direct investments are important drivers of GDP growth in Ethiopia. Therefore, policy makers should enhance policies that encourage and attract FDI as this in turn creates employment and improve the livelihood of the societies. This can be made possible if the country gives due attention to investing on energy and finalizing energy related projects so that the country will have competitive advantage over others in providing cheap electricity which is critical in attracting foreign direct investments.

Moreover, the following policy implications can be taken from the conclusions found in this report. The uni-directional causality that flows from the use of electricity to economic growth indicates that electricity demand boosts the economic growth of Ethiopia. And the findings support the growth hypothesis that an increase in electricity usage will lead to an increase in GDP levels.

The study results further reveal that there is statistically significant positive relationship between money supply and economic growth in the long run. These results have a paramount policy implication for Ethiopia. The author of the paper made recommendations that would be of great importance to monetary policy makers. The Ethiopian government should maintain consistency and follow “the Taylor[1] rule” to allow money supply to increase at a steady rate keeping pace with the economic growth. In respect to such rule will help Ethiopian Reserve Bank to avoid the inefficiencies that caused by execution of discretionary policy.

On the other hand, expenditure to per capita GDP ratio is negatively related with GDP in the long run although it has positive relationship in the short run. Thus, fiscal policy instruments like increasing expenditure on infrastructure need to be applied with great care so as to attract FDI which in turn help alleviate unemployment and improve the wellbeing of the socity. Population growth has been found to have a significant positive effect on GDP in the short run. Thus, the cheap labor that Ethiopia has shall be supported by reforming the educational and training policies in a way that it fits to the demand of labor market and create job opportunities to the population at large.

Further study

To make future empirical results as robust and as representative as possible, this research proposes further investigation and recommends that future research to incorporate longer time series and additional data sets over and above the one considered in the analysis, more relevant variables such as: export, carbon dioxide emissions, real exchange rate, Number of telephones per 1000 persons, Total labor force, and inflation which are excluded. It may also be interesting to investigate causality between FDI, electricity consumption and GDP by using more

[1] Taylor rule is a reduced form approximation of the responsiveness of the nominal interest rate, as set by central bank, to changes in inflation, output, or other economic condition

disaggregated and sectorial micro level data. Moreover, a sector-wise flow of FDI in Ethiopia needs to be studied.

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APPENDICES

APPENDIX A: SUMMARY OF LITERATURE REVIEW

Table 12: Summary of literature review for electricity consumption and economic growth for some selected countries

Study	Country	Period	Methodology	Results
Tesfaye (2019)	Ethiopia	1988-2017	ARDL approach , ECM	No causality
Belloumi (2009)	Tunisia	1971-2004	Johansen Co-integration; VECM	GDP↔EC
Khobai (2018)	Argentina	1970-2016	ARDL approach; VECM	GDP↔EC
Nguyen (2017)	Vietnam	1980-2013	VECM	GDP→EC
Stern (2010)	Croatia	1993-2006	ECM	EC→GDP
Alam (2013)	India	1975-2008	ECM	EC→GDP & EC →FDI

APPENDIX B: ANALYSIS RESULTS

Vector Error Correction Model

Cointegrating Eq:	CointEq1
LNRGDPPC(-1)	1.000000
GEXPGDP(-1)	0.112665
	(0.00997)
	[11.3051]
LNEC(-1)	-0.200618
	(0.07576)
	[-2.64808]
LNFDI(-1)	-0.123854
	(0.02819)
	[-4.39363]
POPG(-1)	0.000783
	(0.13390)
	[0.00585]
M2_GDP(-1)	-0.039012
	(0.00699)
	[-5.58058]
C	-1.244232

Error Correction:	D(LNRGDPPC)	D(GEXPGDP)	D(LNEC)	D(LNFDI)	D(POPG)	D(M2_GDP)

CointEq1	-0.262511	-8.451069	-0.190425	2.440287	0.038610	1.691409
	(0.06212)	(4.48882)	(0.13918)	(1.96919)	(0.02419)	(7.61589)
	[-4.22615]	[-1.88269]	[-1.36822]	[1.23923]	[1.59616]	[0.22209]
D(LNRGDPPC(-1))	0.209672	20.87046	0.370003	8.349642	-0.004246	-4.009922
	(0.19780)	(14.2939)	(0.44319)	(6.27055)	(0.07703)	(24.2515)
	[1.06003]	[1.46010]	[0.83487]	[1.33157]	[-0.05513]	[-0.16535]
D(LNRGDPPC(-2))	0.252335	-15.23129	0.657880	-5.146262	0.045273	-7.730742
	(0.16963)	(12.2583)	(0.38007)	(5.37756)	(0.06606)	(20.7978)
	[1.48757]	[-1.24253]	[1.73093]	[-0.95699]	[0.68536]	[-0.37171]
D(GEXPGDP(-1))	0.018270	0.479502	-0.001630	-0.027706	-0.000350	0.057256
	(0.00459)	(0.33149)	(0.01028)	(0.14542)	(0.00179)	(0.56242)
	[3.98276]	[1.44649]	[-0.15856]	[-0.19052]	[-0.19605]	[0.10180]
D(GEXPGDP(-2))	0.026070	-0.573254	0.010944	-0.192676	-0.000950	-0.587189
	(0.00477)	(0.34505)	(0.01070)	(0.15137)	(0.00186)	(0.58543)
	[5.45985]	[-1.66135]	[1.02295]	[-1.27287]	[-0.51089]	[-1.00301]
D(LNEC(-1))	-0.049278	-10.50515	-0.179547	0.575224	0.008555	5.556752
	(0.15566)	(11.2486)	(0.34877)	(4.93463)	(0.06062)	(19.0848)
	[-0.31658]	[-0.93390]	[-0.51480]	[0.11657]	[0.14114]	[0.29116]
D(LNEC(-2))	-0.148504	-1.805665	0.044005	1.536234	0.052860	-0.423073
	(0.14051)	(10.1537)	(0.31482)	(4.45429)	(0.05472)	(17.2271)
	[-1.05693]	[-0.17783]	[0.13978]	[0.34489]	[0.96607]	[-0.02456]
D(LNFDI(-1))	-0.052403	0.942891	-0.041357	-0.400338	0.001149	2.843002
	(0.00730)	(0.52742)	(0.01635)	(0.23137)	(0.00284)	(0.89484)
	[-7.18010]	[1.78775]	[-2.52904]	[-1.73028]	[0.40442]	[3.17712]
D(LNFDI(-2))	-0.026838	0.364014	-0.048955	-0.569801	0.005771	0.338609
	(0.01033)	(0.74662)	(0.02315)	(0.32753)	(0.00402)	(1.26674)
	[-2.59764]	[0.48755]	[-2.11478]	[-1.73968]	[1.43424]	[0.26731]
D(POPG(-1))	-0.388222	36.11373	0.112429	-20.55944	1.530642	34.22497
	(0.26565)	(19.1972)	(0.59521)	(8.42156)	(0.10345)	(32.5706)
	[-1.46141]	[1.88120]	[0.18889]	[-2.44129]	[14.7959]	[1.05079]
D(POPG(-2))	0.930587	-24.47135	0.154363	6.288036	-0.801113	-27.01566

	(0.24777)	(17.9051)	(0.55515)	(7.85474)	(0.09649)	(30.3784)
	[3.75587]	[-1.36673]	[0.27806]	[0.80054]	[-8.30273]	[-0.88931]
D(M2_GDP(-1))	-0.004849	-0.197583	0.013626	0.109690	-0.001411	-0.228064
	(0.00357)	(0.25773)	(0.00799)	(0.11306)	(0.00139)	(0.43727)
	[-1.35952]	[-0.76664]	[1.70521]	[0.97018]	[-1.01587]	[-0.52157]
D(M2_GDP(-2))	-0.012917	0.402366	-0.001146	0.044734	0.000278	0.382355
	(0.00307)	(0.22210)	(0.00689)	(0.09743)	(0.00120)	(0.37683)
	[-4.20266]	[1.81162]	[-0.16648]	[0.45912]	[0.23263]	[1.01467]
C	0.075195	0.522126	0.093939	-0.271184	-0.014903	-0.429948
	(0.01796)	(1.29819)	(0.04025)	(0.56950)	(0.00700)	(2.20255)
	[4.18579]	[0.40220]	[2.33384]	[-0.47618]	[-2.13026]	[-0.19520]
R-squared	0.865311	0.705211	0.516222	0.678085	0.978453	0.563016
Adj. R-squared	0.740243	0.431477	0.067000	0.379164	0.958444	0.157245
Sum sq. resids	0.013223	69.05594	0.066385	13.28960	0.002005	198.7821
S.E. equation	0.030733	2.220938	0.068861	0.974298	0.011968	3.768119
F-statistic	6.918726	2.576271	1.149146	2.268443	48.90246	1.387521
Log likelihood	67.48138	-52.36825	44.89246	-29.29716	93.88759	-67.17034
Akaike AIC	-3.820098	4.740589	-2.206604	3.092654	-5.706256	5.797882
Schwarz SC	-3.153996	5.406692	-1.540502	3.758756	-5.040154	6.463984
Mean dependent	0.036009	-0.293168	0.089286	0.200711	-0.028929	0.123579
S.D. dependent	0.060301	2.945524	0.071291	1.236527	0.058711	4.104629

Johansen Cointegration

Date: 08/30/20 Time: 14:20

Sample (adjusted): 1991 2018

Included observations: 28 after adjustments

Trend assumption: Linear deterministic trend

Series: LNRGDPPC GEXPGDP LNEC LNFDI POPG M2_GDP

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.948971	225.1750	95.75366	0.0000

At most 1 *	0.876568	141.8650	69.81889	0.0000
At most 2 *	0.791270	83.28721	47.85613	0.0000
At most 3 *	0.612736	39.41927	29.79707	0.0029
At most 4	0.337756	12.85712	15.49471	0.1202
At most 5	0.045971	1.317708	3.841466	0.2510

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.948971	83.31001	40.07757	0.0000
At most 1 *	0.876568	58.57775	33.87687	0.0000
At most 2 *	0.791270	43.86794	27.58434	0.0002
At most 3 *	0.612736	26.56215	21.13162	0.0078
At most 4	0.337756	11.53941	14.26460	0.1292
At most 5	0.045971	1.317708	3.841466	0.2510

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

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

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
-10.69485	-1.204933	2.145585	1.324600	-0.008374	0.417228
36.82109	-1.576355	-14.37579	-1.619210	2.536947	1.712237
-90.35381	2.066520	53.04510	1.802711	35.92870	-1.768697
4.964381	0.436353	2.045250	-1.443734	-10.62234	0.024825
-35.41180	0.911838	27.69259	-3.535814	-2.806797	-0.408577
-31.66117	0.617202	24.03840	-1.385743	8.795606	-0.501624

Unrestricted Adjustment Coefficients (alpha):

D(LNRGDPPC)	0.024546	-0.000289	-0.000764	0.012571	0.004560	0.002344
D(GEXPGDP)	0.790200	-0.904695	-0.455989	-0.784781	-0.262869	0.034896
D(LNEC)	0.017805	0.009898	-0.016905	0.017661	-0.019731	0.003175
D(LNFDI)	-0.228174	-0.295435	-0.408141	0.078719	0.048981	0.081509

D(POPG)	-0.003610	-0.000112	-0.002909	0.003950	0.000735	-0.001234
D(M2_GDP)	-0.158152	-1.532319	-0.318715	-0.483357	-1.149009	0.006471

1 Cointegrating Equation(s): Log likelihood 108.5718

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
1.000000	0.112665	-0.200618	-0.123854	0.000783	-0.039012
	(0.00997)	(0.07576)	(0.02819)	(0.13390)	(0.00699)

Adjustment coefficients (standard error in parentheses)

D(LNRGDPPC)	-0.262511
	(0.06212)
D(GEXPGDP)	-8.451069
	(4.48882)
D(LNEC)	-0.190425
	(0.13918)
D(LNFDI)	2.440287
	(1.96919)
D(POPG)	0.038610
	(0.02419)
D(M2_GDP)	1.691409
	(7.61589)

2 Cointegrating Equation(s): Log likelihood 137.8607

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
1.000000	0.000000	-0.338159	-0.065970	0.050143	0.022955
		(0.03279)	(0.01206)	(0.05615)	(0.00186)
0.000000	1.000000	1.220795	-0.513770	-0.438115	-0.550012
		(0.53200)	(0.19568)	(0.91105)	(0.03019)

Adjustment coefficients (standard error in parentheses)

D(LNRGDPPC)	-0.273159	-0.029120
	(0.22268)	(0.01152)
D(GEXPGDP)	-41.76291	0.473982
	(13.1545)	(0.68071)
D(LNEC)	0.174038	-0.037057
	(0.48856)	(0.02528)

D(LNFDI)	-8.437949	0.740645
	(6.37779)	(0.33003)
D(POPG)	0.034480	0.004527
	(0.08672)	(0.00449)
D(M2_GDP)	-54.73025	2.606041
	(22.3372)	(1.15588)

3 Cointegrating Equation(s): Log likelihood 159.7947

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
1.000000	0.000000	0.000000	-0.118404	0.750644	0.047374
			(0.01431)	(0.14704)	(0.00170)
0.000000	1.000000	0.000000	-0.324477	-2.967006	-0.638169
			(0.09874)	(1.01441)	(0.01174)
0.000000	0.000000	1.000000	-0.155057	2.071512	0.072213
			(0.02836)	(0.29137)	(0.00337)

Adjustment coefficients (standard error in parentheses)

D(LNRGDPPC)	-0.204089	-0.030700	0.016272
	(0.56967)	(0.01663)	(0.31922)
D(GEXPGDP)	-0.562564	-0.468329	-9.486848
	(31.4777)	(0.91875)	(17.6387)
D(LNEC)	1.701453	-0.071991	-1.000810
	(1.16938)	(0.03413)	(0.65527)
D(LNFDI)	28.43912	-0.102786	-17.89232
	(12.3256)	(0.35975)	(6.90669)
D(POPG)	0.297347	-0.001485	-0.160458
	(0.20845)	(0.00608)	(0.11681)
D(M2_GDP)	-25.93311	1.947409	4.782681
	(56.5659)	(1.65102)	(31.6970)

4 Cointegrating Equation(s): Log likelihood 173.0758

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
1.000000	0.000000	0.000000	0.000000	5.904826	0.071098
				(0.77912)	(0.01638)
0.000000	1.000000	0.000000	0.000000	11.15764	-0.573157
				(2.13428)	(0.04487)

0.000000	0.000000	1.000000	0.000000	8.821209	0.103280
				(1.03687)	(0.02180)
0.000000	0.000000	0.000000	1.000000	43.53045	0.200360
				(6.39365)	(0.13441)

Adjustment coefficients (standard error in parentheses)

D(LNRGDPPC)	-0.141680	-0.025214	0.041983	0.013454
	(0.46511)	(0.01371)	(0.26047)	(0.01475)
D(GEXPGDP)	-4.458513	-0.810770	-11.09192	2.822587
	(23.8429)	(0.70304)	(13.3526)	(0.75600)
D(LNEC)	1.789128	-0.064285	-0.964689	-0.048415
	(1.07506)	(0.03170)	(0.60206)	(0.03409)
D(LNFDI)	28.82991	-0.068437	-17.73132	-0.673277
	(12.1669)	(0.35876)	(6.81378)	(0.38578)
D(POPG)	0.316958	0.000238	-0.152379	-0.015548
	(0.18110)	(0.00534)	(0.10142)	(0.00574)
D(M2_GDP)	-28.33268	1.736495	3.794095	2.394947
	(55.1970)	(1.62756)	(30.9118)	(1.75017)

5 Cointegrating Equation(s): Log likelihood 178.8455

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDPPC	GEXPGDP	LNEC	LNFDI	POPG	M2_GDP
1.000000	0.000000	0.000000	0.000000	0.000000	0.044291
					(0.00863)
0.000000	1.000000	0.000000	0.000000	0.000000	-0.623809
					(0.01341)
0.000000	0.000000	1.000000	0.000000	0.000000	0.063234
					(0.01525)
0.000000	0.000000	0.000000	1.000000	0.000000	0.002744
					(0.05096)
0.000000	0.000000	0.000000	0.000000	1.000000	0.004540
					(0.00382)

Adjustment coefficients (standard error in parentheses)

D(LNRGDPPC)	-0.303148	-0.021056	0.168254	-0.002669	-0.174739
	(0.47771)	(0.01389)	(0.28175)	(0.02155)	(0.17220)
D(GEXPGDP)	4.850157	-1.050465	-18.37145	3.752044	-9.610851
	(24.2575)	(0.70544)	(14.3071)	(1.09441)	(8.74426)
D(LNEC)	2.487827	-0.082276	-1.511082	0.021349	-0.714626
	(1.00118)	(0.02912)	(0.59050)	(0.04517)	(0.36090)

D(LNFDI)	27.09542	-0.023775	-16.37492	-0.846463	-16.38522
	(12.8601)	(0.37399)	(7.58490)	(0.58020)	(4.63576)
D(POPG)	0.290933	0.000909	-0.132027	-0.018147	-0.148805
	(0.19140)	(0.00557)	(0.11289)	(0.00864)	(0.06900)
D(M2_GDP)	12.35581	0.688784	-28.02495	6.457630	-6.977698
	(49.1242)	(1.42860)	(28.9735)	(2.21631)	(17.7081)

Postestimation Tests

VEC Residual Serial Correlation LM Tests

Date: 08/30/20 Time: 15:23

Sample: 1988 2018

Included observations: 28

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	37.08656	36	0.4187	0.922219	(36, 15.9)	0.5965
2	39.88843	36	0.3013	1.043414	(36, 15.9)	0.4827

```
. veclmar

   Lagrange-multiplier test

  +--------------------------------------+
  | lag |      chi2    df   Prob > chi2  |
  |-----+--------------------------------|
  |   1 |   37.0868    36     0.41868    |
  |   2 |   39.8885    36     0.30128    |
  +--------------------------------------+

   H0: no autocorrelation at lag order
```

1. **Residual Heteroskedasticity Tests (Levels and Squares)**

Date: 08/30/20 Time: 14:32

Sample: 1988 2018

Included observations: 28

Joint test:

Chi-sq	df	Prob.
560.7995	546	0.3213

Individual components:

Dependent	R-squared	F(26,1)	Prob.	Chi-sq(26)	Prob.
res1*res1	0.999501	77.02749	0.0898	27.98603	0.3591
res2*res2	0.987697	3.087803	0.4258	27.65552	0.3756
res3*res3	0.741890	0.110551	0.9942	20.77292	0.7536
res4*res4	0.928208	0.497277	0.8320	25.98984	0.4637
res5*res5	0.999996	9999.680	0.0079	27.99989	0.3585
res6*res6	0.992672	5.209835	0.3351	27.79481	0.3686
res2*res1	0.998719	29.98513	0.1435	27.96413	0.3602
res3*res1	0.998092	20.11954	0.1747	27.94658	0.3611
res3*res2	0.999751	154.4173	0.0635	27.99303	0.3588
res4*res1	0.978052	1.713919	0.5482	27.38545	0.3893
res4*res2	0.967191	1.133842	0.6437	27.08136	0.4051
res4*res3	0.779762	0.136175	0.9882	21.83334	0.6978
res5*res1	0.992914	5.389382	0.3298	27.80159	0.3683
res5*res2	0.994756	7.296057	0.2858	27.85317	0.3657
res5*res3	0.996877	12.27729	0.2224	27.91256	0.3628
res5*res4	0.986991	2.918048	0.4367	27.63575	0.3766

res6*res1	0.998740	30.49251	0.1423	27.96473	0.3602
res6*res2	0.986209	2.750518	0.4482	27.61386	0.3777
res6*res3	0.990186	3.880662	0.3840	27.72521	0.3721
res6*res4	0.856504	0.229571	0.9532	23.98212	0.5770
res6*res5	0.993428	5.813536	0.3183	27.81597	0.3676

1. **Residual Normality Tests**

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: Residuals are multivariate normal

Date: 08/30/20 Time: 14:37

Sample: 1988 2018

Included observations: 28

Component	Skewness	Chi-sq	df	Prob.*
1	0.500561	1.169287	1	0.2795
2	0.662999	2.051314	1	0.1521
3	0.052911	0.013065	1	0.9090
4	0.142997	0.095425	1	0.7574
5	0.503871	1.184800	1	0.2764
6	-0.075410	0.026538	1	0.8706

Joint		4.540427	6	0.6040

Component	Kurtosis	Chi-sq	df	Prob.
1	3.012126	0.000172	1	0.9896
2	2.871927	0.019137	1	0.8900
3	3.653491	0.498226	1	0.4803
4	2.597780	0.188745	1	0.6640
5	3.321415	0.120525	1	0.7285
6	1.887596	1.443684	1	0.2295
Joint		2.270488	6	0.8932

Component	Jarque-Bera	df	Prob.
1	1.169458	2	0.5573
2	2.070450	2	0.3551
3	0.511291	2	0.7744
4	0.284169	2	0.8675
5	1.305325	2	0.5207
6	1.470222	2	0.4795
Joint	6.810915	12	0.8699

*Approximate p-values do not account for coefficient estimation

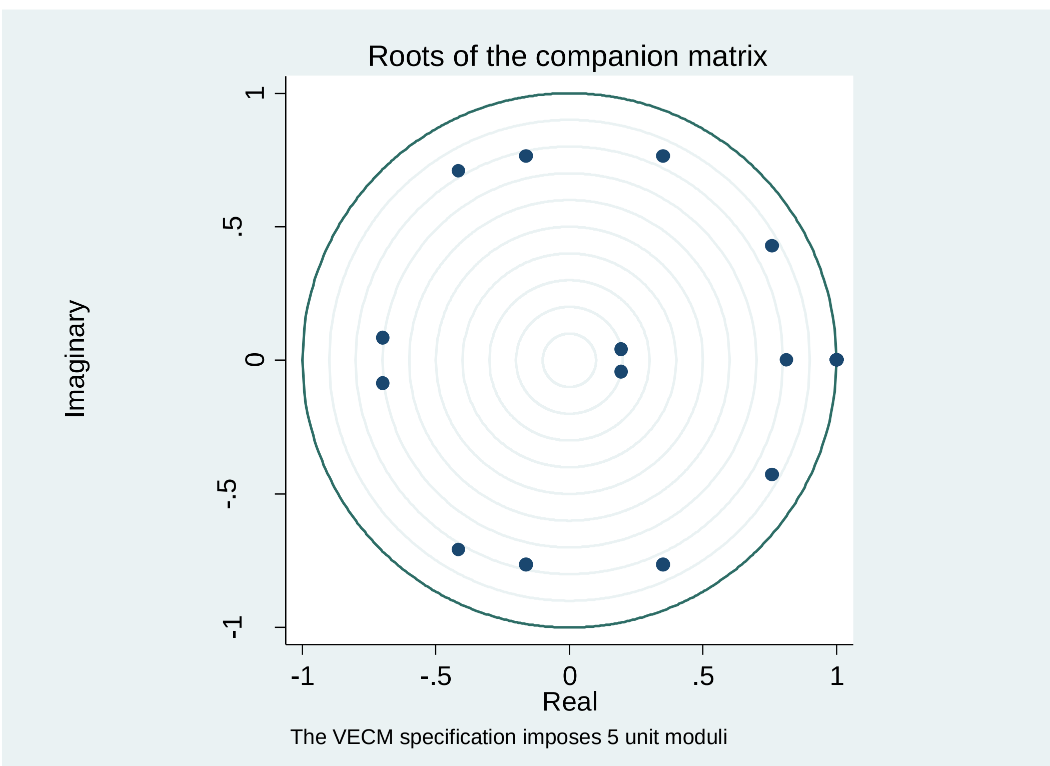
2. Stability Test

```
. vecstable, graph
```

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
1	1
1	1
.7588641 + .429078*i*	.87177
.7588641 - .429078*i*	.87177
.3499454 + .7645409*i*	.840824
.3499454 - .7645409*i*	.840824
-.415031 + .7090796*i*	.821611
-.415031 - .7090796*i*	.821611
.812428	.812428
-.1630594 + .7643992*i*	.781597
-.1630594 - .7643992*i*	.781597
-.6982979 + .08508153*i*	.703462
-.6982979 - .08508153*i*	.703462
.194976 + .04273648*i*	.199605
.194976 - .04273648*i*	.199605

The VECM specification imposes 5 unit moduli.



Annex- with P-value

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.262511	0.062116	-4.226151	0.0001
C(2)	0.209672	0.197797	1.060033	0.2922
C(3)	0.252335	0.169629	1.487571	0.1406
C(4)	0.018270	0.004587	3.982764	0.0001
C(5)	0.026070	0.004775	5.459850	0.0000
C(6)	-0.049278	0.155657	-0.316581	0.7523
C(7)	-0.148504	0.140506	-1.056926	0.2936
C(8)	-0.052403	0.007298	-7.180102	0.0000
C(9)	-0.026838	0.010332	-2.597638	0.0111
C(10)	-0.004849	0.003566	-1.359520	0.1776
C(11)	-0.012917	0.003073	-4.202662	0.0001
C(12)	-0.388222	0.265649	-1.461411	0.1476
C(13)	0.930587	0.247769	3.755868	0.0003
C(14)	0.075195	0.017964	4.185792	0.0001
C(15)	-8.451069	4.488822	-1.882692	0.0632
C(16)	20.87046	14.29388	1.460098	0.1480
C(17)	-15.23129	12.25830	-1.242529	0.2175
C(18)	0.479502	0.331494	1.446487	0.1518
C(19)	-0.573254	0.345054	-1.661347	0.1004
C(20)	-10.50515	11.24863	-0.933905	0.3530
C(21)	-1.805665	10.15368	-0.177834	0.8593
C(22)	0.942891	0.527419	1.787746	0.0774
C(23)	0.364014	0.746619	0.487550	0.6271
C(24)	-0.197583	0.257726	-0.766642	0.4454
C(25)	0.402366	0.222103	1.811621	0.0736
C(26)	36.11373	19.19717	1.881200	0.0634
C(27)	-24.47135	17.90509	-1.366726	0.1754
C(28)	0.522126	1.298190	0.402195	0.6886
C(29)	-0.190425	0.139177	-1.368219	0.1749
C(30)	0.370003	0.443186	0.834871	0.4062
C(31)	0.657880	0.380072	1.730934	0.0871
C(32)	-0.001630	0.010278	-0.158556	0.8744
C(33)	0.010944	0.010699	1.022948	0.3093
C(34)	-0.179547	0.348767	-0.514805	0.6080
C(35)	0.044005	0.314818	0.139779	0.8892
C(36)	-0.041357	0.016353	-2.529044	0.0133
C(37)	-0.048955	0.023149	-2.114784	0.0374
C(38)	0.013626	0.007991	1.705210	0.0919
C(39)	-0.001146	0.006886	-0.166475	0.8682

C(40)	0.112429	0.595214	0.188888	0.8506
C(41)	0.154363	0.555153	0.278055	0.7817
C(42)	0.093939	0.040251	2.333836	0.0220
C(43)	2.440287	1.969191	1.239233	0.2187
C(44)	8.349642	6.270547	1.331565	0.1866
C(45)	-5.146262	5.377564	-0.956988	0.3413
C(46)	-0.027706	0.145422	-0.190524	0.8494
C(47)	-0.192676	0.151371	-1.272872	0.2066
C(48)	0.575224	4.934633	0.116569	0.9075
C(49)	1.536234	4.454294	0.344888	0.7310
C(50)	-0.400338	0.231372	-1.730277	0.0873
C(51)	-0.569801	0.327532	-1.739678	0.0856
C(52)	0.109690	0.113061	0.970180	0.3347
C(53)	0.044734	0.097434	0.459121	0.6473
C(54)	-20.55944	8.421563	-2.441286	0.0167
C(55)	6.288036	7.854742	0.800540	0.4257
C(56)	-0.271184	0.569500	-0.476178	0.6352
C(57)	1.691409	7.615887	0.222090	0.8248
C(58)	-4.009922	24.25147	-0.165348	0.8691
C(59)	-7.730742	20.79784	-0.371709	0.7110
C(60)	0.057256	0.562424	0.101802	0.9192
C(61)	-0.587189	0.585430	-1.003005	0.3187
C(62)	5.556752	19.08480	0.291161	0.7716
C(63)	-0.423073	17.22708	-0.024559	0.9805
C(64)	2.843002	0.894837	3.177118	0.0021
C(65)	0.338609	1.266738	0.267308	0.7899
C(66)	-0.228064	0.437266	-0.521567	0.6033
C(67)	0.382355	0.376827	1.014670	0.3132
C(68)	34.22497	32.57057	1.050794	0.2964
C(69)	-27.01566	30.37838	-0.889306	0.3764
C(70)	-0.429948	2.202554	-0.195204	0.8457
C(71)	0.038610	0.024190	1.596157	0.1142
C(72)	-0.004246	0.077028	-0.055126	0.9562
C(73)	0.045273	0.066058	0.685358	0.4950
C(74)	-0.000350	0.001786	-0.196054	0.8450
C(75)	-0.000950	0.001859	-0.510892	0.6108
C(76)	0.008555	0.060617	0.141137	0.8881
C(77)	0.052860	0.054717	0.966069	0.3368
C(78)	0.001149	0.002842	0.404418	0.6869
C(79)	0.005771	0.004023	1.434244	0.1552
C(80)	-0.001411	0.001389	-1.015870	0.3126

C(81)	0.000278	0.001197	0.232632	0.8166
C(82)	1.530642	0.103451	14.79586	0.0000
C(83)	-0.801113	0.096488	-8.302733	0.0000
C(84)	-0.014903	0.006996	-2.130261	0.0361

Determinant residual covariance	1.73E-11

Equation: D(LNRGDPPC) = C(1)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(2)*D(LNRGDPPC(-1)) + C(3)*D(LNRGDPPC(
-2)) + C(4)*D(GEXPGDP(-1)) + C(5)*D(GEXPGDP(-2)) + C(6)*D(LNEC(
-1)) + C(7)*D(LNEC(-2)) + C(8)*D(LNFDI(-1)) + C(9)*D(LNFDI(-2)) +
C(10)*D(M2_GDP(-1)) + C(11)*D(M2_GDP(-2)) + C(12)*D(POPG(-1)) +
C(13)*D(POPG(-2)) + C(14)

Observations: 28

R-squared	0.865311	Mean dependent var	0.036009
Adjusted R-squared	0.740243	S.D. dependent var	0.060301
S.E. of regression	0.030733	Sum squared resid	0.013223
Durbin-Watson stat	1.800878		

Equation: D(GEXPGDP) = C(15)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(16)*D(LNRGDPPC(-1)) + C(17)*D(LNRGDPPC(
-2)) + C(18)*D(GEXPGDP(-1)) + C(19)*D(GEXPGDP(-2)) + C(20)
*D(LNEC(-1)) + C(21)*D(LNEC(-2)) + C(22)*D(LNFDI(-1)) + C(23)
*D(LNFDI(-2)) + C(24)*D(M2_GDP(-1)) + C(25)*D(M2_GDP(-2)) + C(26)
*D(POPG(-1)) + C(27)*D(POPG(-2)) + C(28)

Observations: 28

R-squared	0.705211	Mean dependent var	-0.293168
Adjusted R-squared	0.431477	S.D. dependent var	2.945524
S.E. of regression	2.220938	Sum squared resid	69.05594
Durbin-Watson stat	1.785424		

Equation: D(LNEC) = C(29)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(30)*D(LNRGDPPC(-1)) + C(31)*D(LNRGDPPC(
-2)) + C(32)*D(GEXPGDP(-1)) + C(33)*D(GEXPGDP(-2)) + C(34)
*D(LNEC(-1)) + C(35)*D(LNEC(-2)) + C(36)*D(LNFDI(-1)) + C(37)

*D(LNFDI(-2)) + C(38)*D(M2_GDP(-1)) + C(39)*D(M2_GDP(-2)) + C(40)
*D(POPG(-1)) + C(41)*D(POPG(-2)) + C(42)

Observations: 28

R-squared	0.516222	Mean dependent var	0.089286
Adjusted R-squared	0.067000	S.D. dependent var	0.071291
S.E. of regression	0.068861	Sum squared resid	0.066385
Durbin-Watson stat	1.929721		

Equation: D(LNFDI) = C(43)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(44)*D(LNRGDPPC(-1)) + C(45)*D(LNRGDPPC(
-2)) + C(46)*D(GEXPGDP(-1)) + C(47)*D(GEXPGDP(-2)) + C(48)
*D(LNEC(-1)) + C(49)*D(LNEC(-2)) + C(50)*D(LNFDI(-1)) + C(51)
*D(LNFDI(-2)) + C(52)*D(M2_GDP(-1)) + C(53)*D(M2_GDP(-2)) + C(54)
*D(POPG(-1)) + C(55)*D(POPG(-2)) + C(56)

Observations: 28

R-squared	0.678085	Mean dependent var	0.200711
Adjusted R-squared	0.379164	S.D. dependent var	1.236527
S.E. of regression	0.974298	Sum squared resid	13.28960
Durbin-Watson stat	1.960791		

Equation: D(M2_GDP) = C(57)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(58)*D(LNRGDPPC(-1)) + C(59)*D(LNRGDPPC(
-2)) + C(60)*D(GEXPGDP(-1)) + C(61)*D(GEXPGDP(-2)) + C(62)
*D(LNEC(-1)) + C(63)*D(LNEC(-2)) + C(64)*D(LNFDI(-1)) + C(65)
*D(LNFDI(-2)) + C(66)*D(M2_GDP(-1)) + C(67)*D(M2_GDP(-2)) + C(68)
*D(POPG(-1)) + C(69)*D(POPG(-2)) + C(70)

Observations: 28

R-squared	0.563016	Mean dependent var	0.123579
Adjusted R-squared	0.157245	S.D. dependent var	4.104629
S.E. of regression	3.768119	Sum squared resid	198.7821
Durbin-Watson stat	1.954375		

Equation: D(POPG) = C(71)*(LNRGDPPC(-1) + 0.112664774615
*GEXPGDP(-1) - 0.200618393004*LNEC(-1) - 0.12385396001*LNFDI(
-1) - 0.0390120747807*M2_GDP(-1) + 0.000783007151642*POPG(-1)
- 1.24423161602) + C(72)*D(LNRGDPPC(-1)) + C(73)*D(LNRGDPPC(
-2)) + C(74)*D(GEXPGDP(-1)) + C(75)*D(GEXPGDP(-2)) + C(76)

*D(LNEC(-1)) + C(77)*D(LNEC(-2)) + C(78)*D(LNFDI(-1)) + C(79) *D(LNFDI(-2)) + C(80)*D(M2_GDP(-1)) + C(81)*D(M2_GDP(-2)) + C(82) *D(POPG(-1)) + C(83)*D(POPG(-2)) + C(84)

Observations: 28

R-squared	0.978453	Mean dependent var	-0.028929
Adjusted R-squared	0.958444	S.D. dependent var	0.058711
S.E. of regression	0.011968	Sum squared resid	0.002005
Durbin-Watson stat	2.754938		

Short Run Causality Test

VEC Granger Causality/Block Exogeneity Wald Tests

Date: 09/04/20 Time: 23:28

Sample: 1988 2018

Included observations: 28

Dependent variable: D(LNRGDPPC)

Excluded	Chi-sq	df	Prob.
D(GEXPGDP)	36.79808	2	0.0000
D(LNEC)	1.128750	2	0.5687
D(LNFDI)	52.01338	2	0.0000
D(M2_GDP)	17.68023	2	0.0001
D(POPG)	16.89376	2	0.0002
All	71.64955	10	0.0000

Dependent variable: D(GEXPGDP)

Excluded	Chi-sq	df	Prob.
D(LNRGDPPC)	3.726436	2	0.1552
D(LNEC)	0.872252	2	0.6465
D(LNFDI)	3.316242	2	0.1905
D(M2_GDP)	5.542509	2	0.0626
D(POPG)	3.542307	2	0.1701
All	14.89193	10	0.1361

Dependent variable: D(LNEC)

Excluded	Chi-sq	df	Prob.
D(LNRGDPPC)	3.654035	2	0.1609
D(GEXPGDP)	1.242041	2	0.5374
D(LNFDI)	7.610391	2	0.0223
D(M2_GDP)	3.583103	2	0.1667
D(POPG)	0.371317	2	0.8306
All	9.869216	10	0.4520

Dependent variable: D(LNFDI)

Excluded	Chi-sq	df	Prob.
D(LNRGDPPC)	2.724504	2	0.2561
D(GEXPGDP)	1.642245	2	0.4399
D(LNEC)	0.121326	2	0.9411
D(M2_GDP)	0.956734	2	0.6198
D(POPG)	7.638550	2	0.0219
All	20.45050	10	0.0253

Dependent variable: D(M2_GDP)

Excluded	Chi-sq	df	Prob.
D(LNRGDPPC)	0.163846	2	0.9213
D(GEXPGDP)	1.148947	2	0.5630
D(LNEC)	0.091885	2	0.9551
D(LNFDI)	11.74703	2	0.0028
D(POPG)	1.148236	2	0.5632
All	15.51327	10	0.1144

Dependent variable: D(POPG)

Excluded	Chi-sq	df	Prob.
D(LNRGDPPC)	0.473885	2	0.7890
D(GEXPGDP)	0.265149	2	0.8758

D(LNEC)	0.936054	2	0.6262
D(LNFDI)	2.126393	2	0.3454
D(M2_GDP)	1.431717	2	0.4888
All	12.15281	10	0.2750