ENERGY CONSUMPTION AND PERFORMANCE OF MANUFACTURING SECTOR IN KENYA

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DECLARATION

This project is my original work and has not been presented for an academic award in any University or any other award.

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DEDICATION

The project is devoted to my loving family and supportive friends for continuous encouragement during this time, for having faith in me and pushing me to succeed.

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LIST OF ACRONYMS AND ABBREVIATION

ARDL	Autoregressive Distributed Lag
CO2	Carbon Dioxide
GDP	Gross Domestic Product
IEA	International Energy Agency
KWH	Kilo Watt per Hour
MTP	Medium Term Plan
MW	Mega Watts
R & D	Research & Development
RES	Renewable Energy Sources
SVAR	Structural Vector Autoregressive
US	United States

OPERATIONAL DEFINITION OF TERMS

Energy prices: This is a parameter used to calculate the supply and demand side of the market's reaction to energy consumption since the rise in energy prices affects households' income, spending, and saving rates.

Non-Renewable Energy Consumption: Exhaustive resource that fails to adequately regenerate itself in meaningful time frames for sustainable economic extraction.

Performance: This is the general output of sector per year.

Renewable Energy Consumption: Non-fossil energy obtained from naturally replenished resources with low carbon emission and friendly to the environment.

Trade Openness: Trade enters the mode to measure impact of energy output in terms of efficiency.

ABSTRACT

Kenya's manufacturing sector contributes 70% of the industrial sector production with the combined contribution of construction, building and quarrying outputs to the remaining 30%. Energy plays critical role in manufacturing. The use of energy in industry affects every single citizen directly through the cost of goods and services, the quality of manufactured products, the strength of the economy, and the availability of jobs. It is utilized on production process thus efficient consumption of energy reduces the cost of doing business. Kenya Vision 2030 Economic Development Plan recognizes the manufacturing sector, as one of the fundamental pillars of sustainable annual GDP growth of 10%. Manufacturing stands tall as a key pillar in the Big Four Development Agenda by the National Government of Kenya, where manufacturing is seen to be the key to unlocking the success of the other development goals, namely: Universal Healthcare, Affordable Housing, and Food Security. The premises to increase the share of the manufacturing sector to GDP from an approximate existing 8.5% to a projected 15%according to the goals of the Big 4 Agenda. Numerous problems, however, hinder the results as shown by the decline in the sector from 9.6% in 2011 to 9.2% in 2012. The Kenyan manufacturing companies spent about 40% of the production overhead on energy leading to increased cost of operation thereby negatively affecting their overall performance. The purpose of this study therefore, was to investigate the effect of energy consumption on performance of manufacturing in Kenya. The study's specific objectives were to determine effect of renewable energy consumption on performance of manufacturing sector in Kenya and to determine effect of non-renewable energy consumption on performance of manufacturing sector in Kenya. The research project employed a non-experimental research design to evaluate economic models. The research utilized secondary data sources to gather relevant information to achieve our analysis aim and address the research gap while employing a multivariate time series regression model. The study used annual time-series data from the period 1980 to 2019. All relevant time-series tests were performed. The findings revealed that energy consumption had both bidirectional positive effects to manufacturing performance in Kenya. The findings also revealed that there was cointegration and therefore, existed a long run relationship between the manufacturing performance and energy consumption. The study therefore, concluded that in an energy efficiency nation and in a well-developed energy market, manufacturing form thrives and the country product competitiveness increases. In the long run, the speed of cointegration is divergence hence no equilibrium thus implying volatility and instability of the energy market affecting energy consumption. Based on the findings and the conclusions, the study recommends smoothening of energy consumption caused by renewable energy instability through deployment and investment of storage technology especially during excess energy supply and smart grid system to regulate supply and demand at point of metering.

CHAPTER ONE

INTRODUCTION

1.1 Background

Manufacturing sector is highly dependent on energy to produce the output, and if there are any weaknesses in the energy policy, this would give negative impact not only to the industrial development but the country's economic growth (Walther & Weigold, 2021). Energy consumption effects on performance of manufacturing firms has raised debates amongst researchers in the discipline of Energy Economics and Sustainable Development on Green Energy (Sarkodie & Adom, 2018). The role of energy consumption in modern policy strategies for economies towards efficient energy consumption is to expand and grow the economy.

Manufacturing sector is considered the backbone of development in general and economic development mainly because; manufacturing industries not only help in modernizing agriculture, but they also reduce the heavy dependence of people on agricultural income by providing jobs in secondary and tertiary sectors (Zheng, Ardolino, Bacchetti, Perona & Zanardini, 2019). Industrial development is a precondition for eradication of unemployment and poverty, and it is also aimed at bringing down regional disparities by setting up industries in backward areas (Adekoya, Ogunnusi, & Oliyide, 2021). Export of manufactured goods expands trade and commerce and brings in the much-needed foreign exchange (Zheng et al., 2019). Countries that transform their raw materials into a wide variety of furnished goods of higher value are usually prosperous.

According to Macharia, Gathiaka and Ngui (2022), adequate supply of energy is important for sustainable growth in an economy especially in the manufacturing sector. The rate of the growth of the Kenyan Energy Development is slow and not effective compared to other emerging economies; this on the other hands has discouraged production, most especially in the manufacturing sector (Sarkodie & Adom, 2018). According to Raza, Jawaid and Siddiqui (2016), energy plays a key role in production especially in the current industrial revolution and the manufacturing sector being the largest consumers of the green energy. Subsequently, increase in economic welfare and development may additionally induce the use of more electricity. Industrialization and urbanization may lead to extensive use of energy in different forms in the production set up, domestic level and huge national development projects (Zheng, Wang, Mak, Hsu & Tsang, 2021).

Empirical evidence supports the claim that manufacturing and the industrial sector both offer greater opportunities to exploit a variety of economic situations, promote financial investment and innovation, create formal employment, and facilitate global profession. (Zheng et al., 2021). This acknowledgment is based on its ability to drive the structural improvement of economies, which is key for understanding the financial development rates and respectable task possibilities needed to accomplish common and continual success (Lv, Chen & Cheng, 2020). Comprehensive and lasting automation relates to the growth of durable and varied manufacturing industries, including a durable industry-related services field and a strengthened tiny as well as medium-size business (SME) industry that prosper in giving possibilities accessible to all people, consisting of one of the most prone teams (Lv, Chen & Cheng, 2020).

The biggest opportunities for the Industrial Manufacturing industry to create shared value are grouped around developing renewable energy infrastructure and technologies that increase storage capacity, reliability, and reduce cost (Leng, Ruan, Jiang, Xu, Liu, Zhou & Liu, 2020). Creating agribusiness equipment, devices and industrial procedures that help with accuracy agriculture and reduce water strength, energy consumption as well as soil compaction and creating items which boost home and office energy effectiveness including illumination, air flow, heating, and cooling. The Sustainable Development Goals (SDGs) make up the core of the 2030 Program for Sustainable Development embraced by the international community as well as the new growth structure that aims at transforming our globe and will help all international, regional, and nationwide development undertakings for the following 15 years (Leng, et al., 2020).

In response to the challenges, the study endeavors to determine the effects of energy in terms of renewable and non-renewable energy consumption on Kenyan manufacturing sector performance. According to Wang, Zhou, Zhou and Wang (2011), they define energy as the flow or transfer of an object in terms of power to perform work on or to heat a substance, and converted in form, but not created or destroyed. Energy Consumption refers to the quantity of electricity or any other form of power utilized per given period.

Kenya energy sector heavily relies on hydroelectricity with geothermal and wind power currently being extracted to the national grid as the main source of renewable energy (Takase, Kipkoech & Essandoh, 2021). Fossil fuels were among the oldest source of energy consumed in the advent of the industrial development. An economy in a take off stage characterized with high-level mechanization and industrialization with energy and capital-intensive production leads to a derived demand for consumption of goods.

Energy has emerged as the essential component for the manufacturing sector and enhances the efficiency and output productivity of a particular economic sector. The intensive industrialization, urbanization and population growth has elevated use of power, especially inside the growing countries increasing demand (Korkmaz, 2022). Nevertheless, uncertain causal relationship and the direction of the causality among energy utilization along with sustainable development (Korkmaz, 2022). Further, the economic, social, and environmental dimensions of development economics underline that sustainable development strategies should focus primarily on structural changes in consumption and output with a view to boosting support for rational use of natural resources, reducing income polarization, and boosting economic competitiveness.

Renewable and non-renewable energy consumption on energy price per Kwh on average has been increasing which translates to increased total production cost within manufacturing sector (Onuonga, 008). In the Vision 2030, this sector is expected to continue contributing 10% per annum to Kenya's GDP (Republic of Kenya, 2007). In addition, under the Big 4 Agenda, MTP III targets the Government plans to increase the manufacturing contribution to GDP from current 8.4% to 15%. To acquire this, the manufacturing firms propose that the Government ought to provide enabling environment for renewable energy investments (Manyonge, & Kyalo, 2020).

Energy, a key determinant of achieving the objective of improving Kenyan economy welfare into an industrialized Country with middle income, yet energy is not covered in the Vision however mentioned as an enabler. The manufacturing sector will be critical in achieving the anticipated growth enshrined in Vision 2030 Blueprint. In order to achieve the Kenya Vision 2030, the factors that influence its energy utilization need to be known to improve all energy strategies of the Kenya Vision 2030, Blueprint.

The value of exports registered 50% growth during the ERS 2003-2007. The overall export quantum indices for the exports increased by 7.3% during the ERS period of 2003-2007. The manufacturing sector in Kenya performed well during ERS period, with the total value of output and value addition in the manufacturing sector increasing significantly in the year 2007(GoK, 2010).

According to Meijer, Huijben, Van Boxstael and Romme (2019), of all major fields consuming power, SMEs are the most difficult for plan makers. Energy usage per firm is typically small, and energy is not a top priority for most of the SMEs. Unlike larger power extensive companies, SMEs seldom have large adequate monetary rewards or possibilities in practice to make use of the firm's own sources to intend as well as implement power efficiency tasks. SMEs are not as homogenous an industry as families and targeting power efficiency policy actions is challenging, since business activities, location, and other problems can differ considerably in between SMEs (Meijer et al., 2019). In most countries, the energy consumption of SMEs is also not known for any adequate granularity.

1.1.1 Trend in Manufacturing Sector Performance in Kenya

Manufacturing has been described and accepted as a catalyst for economic growth and development all over the world. Industrialization under industrial sector is widely conceived as a critical tool for accelerating economic growth and development (Orella, Román-Leshkov & Brushett, 2018). Firm's performance measures achievement against the prescribed indicators of efficiency, productivity, and environmental obligations such as cycle time, output productivity, waste reduction, and regulatory compliance, according to (Orella, et al., 2018). The current study will focus on manufacturing sector performance which will be measured by the manufacturing sector contribution to GDP.

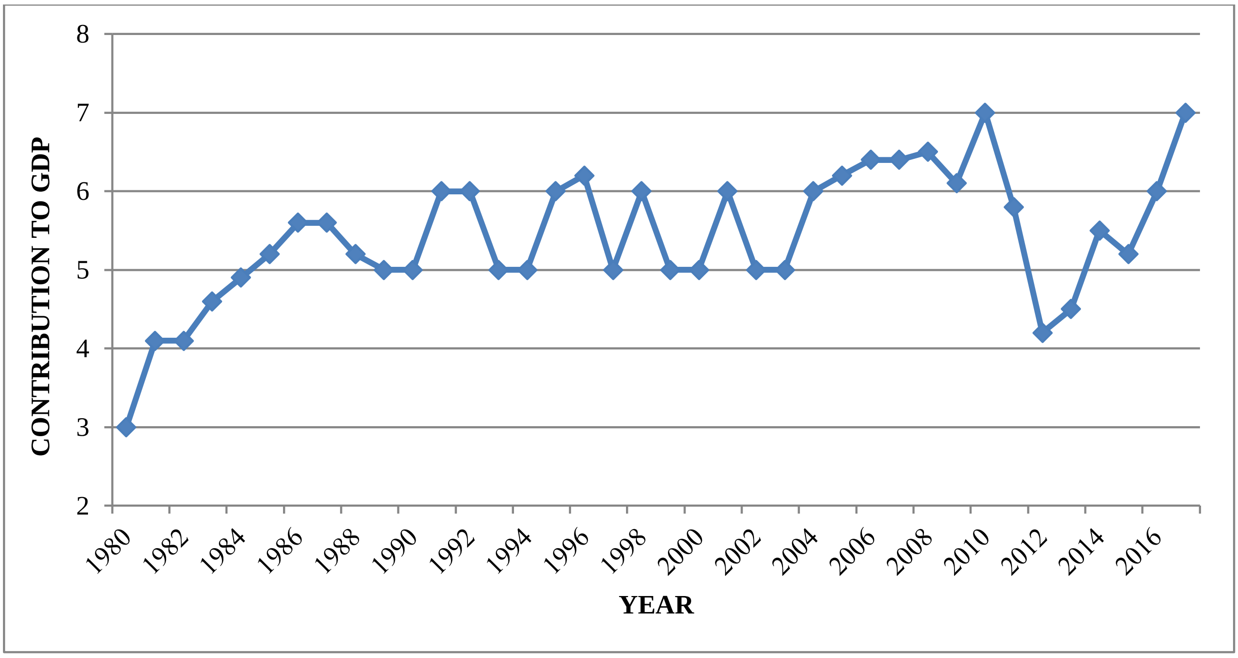
Keho (2018) Postulated that industrial growth deals with the application of modern equipment, makers, and technology in the manufacturing of products and solutions in addition to ease human suffering and ensure well-being renovation in a society. Hence, modern manufacturing procedures entail the advancement of managerial and entrepreneurial skills as well as high technological advancements that frequently promote huge scale efficiency as well as boosted living problems.

In Malaysia, Industrial Production Index (IPI) has been increasing consistently over the past decade and it increased to 50.1% in 2021 compared to the previous year. The increase was driven by strong performances in the manufacturing sector that rose by 68% (Sun & Tian, 2021). According to the Department of Statistics of Malaysia (2022), the major sub-sectors contributing to the growth in the manufacturing sector in the country are; transport, equipment, and other manufactures at 275.2%, non-metallic mineral products, basic metal, and fabricated metal products at 141.0% and electrical & electronics products at 70.1%. The performance of the manufacturing sector was also in line with the notable growth in exports and IPI for some of the main trading partners of Malaysia. The increase in the performance of the manufacturing sector in Malaysia has been attributed to the increase in natural gas index at 23.9%, and crude oil and condensate index at 2.7% (Department of Statistics of Malaysia, 2022). Additionally, the electricity sector output expanded 22.9% in 2021 as compared the previous years.

Since 2000, Africa has experienced high levels of economic growth. Between 2000 and 2015, Sub-Saharan Africa (SSA) grew at a rate of 5.04% per annum (World Bank, 2016). However, a substantial portion of the population has not benefitted from this growth. In 2012, 42.7% of SSA lived on less than US$1.90 a day (Beegle et al., 2016). Africa’s Gini coefficient in 2010 was 0.435 (Cornia, 2016). The number of poor people increased from 280 million to 330 million in 2012 (World Bank, 2016). A survey of 35 African Countries showed that there was little evidence for systemic reduction of lived poverty (Madzimure & Mbedzi, 2021). Despite strong economic growth over the past decade, the manufacturing sector in Africa has declined. Similarly, there has been minor changes in manufacturing employment (World Bank, 2020). Between 1981 and 1985, the average share of the manufacturing sector in Africa (excluding South Africa) was 14.7% of GDP (World Bank, 2016). This declined to an average of 10.%t of GDP between 2010 and 2014 (World Bank, 2016).

Investments in Manufacturing will serve as foundation for industrialization and economic engine for growth which will diversify growth from over reliance on agricultural sector for economic development. However, the sector is still grappling with challenges after three decades. These problems have contributed to the dismal performance of the sector especially during the 1980s. According to (Odhiambo, 2011) Kenya's industrial sector is representative of a less industrialized region, but it is excellent relative to majority Sub-Saharan African Countries.

Figure 1.1: Manufacturing Sector Contribution to GDP



Data Source: KNBS 2020 Annual Report

Figure 1.1 presents the manufacturing sector contribution trend to GDP in Kenya. The manufacturing sector's contribution to GDP improved from 3.0% baseline in 1980 to 7.0% in 2018. However, the trend has been inconsistent in between the years with volatility within the manufacturing sector performance depicting inefficiency, shocks and challenges.

1.1.2 Trend in Renewable Energy consumption

Renewable energy is generated from non-fossil sources that is naturally substituted on a human scale, i.e., wind, sunlight, water, rain, and stream heat from geothermal wells. Devolved and distributed renewable energy systems provide enormous potential to achieve the instantaneous energy demands of remote organizations, companies, and households (Wanjiru & Ochieng, 2017). Despite government efforts under the rural electrification program, high costs and low-income disparities among the huge percentage of citizen, worsen low access to energy (Mbaka, 2021). The cost of connecting a household in the rural areas (rural electrification), for example, is estimated at an average of $ 40 US dollar per KWH as opposed to discounted useful life installation and maintenance cost of min grid solar generating systems of $5 per US dollar KWH (Kiplagat, Wang & Li, 2011).

The economy has extensive renewable resources endowment classified as best solar belt, highest velocity of wind intensity, biofuel, biogas, largest geothermal resource, and hydropower the utilization of the resources has been limited (Esmaeilion, Ahmadi, Hoseinzadeh, Aliehyaei, Makkeh & Astiaso Garcia, 2021). Renewable growth is characterized by rising demand, increased electricity prices, increasing global fossil fuel costs, and environmental activism. Oil and electricity accounts for about 22.0%t and 9.0%t, respectively (Esmaeilion et al., 2021). In Kenya, energy faces challenges of high reliance on biogas, inaccessibility to clean and sustainable source of power, intermittent supply, poor hydroelectric dependency as well as high dependence on imported fuel (Takase, Kipkoech & Essandoh, 2021). Exploitation of renewable sources to the overall energy mix is therefore a vital means of addressing the bottle necks of increasing demand with associated environmental strain.

The Kenya installed electricity capacity is 2,453MW with a projected peak demand of 5,000MW (Kimuyu, et al, 2012). Such generation capacity for power is less than effective demand hence could not meet demand. Thus, to bridge the gap, the initiative by the government to obtain additional auxiliary power to the system to satisfy the increasing demand and load-shedding reduction especially during peak moments. The leading source of hydroelectric power is 51.55% of the aggregate installed capacity. Thermal generators, geothermal sources, co-generation, and wind technologies contribute respectively 33.1% t, 13.39%, 1.83% p, and 0.37% respectively (KIPPRA, 2020). In total, renewable sources of energy accounts for about 67.1%, and Kenya's production of electricity is now predominantly' green'. In general, renewable energies accounted for about 72.7% of actual total consumption in 2016, which dropped to 72.1% in 2017(KIPPRA, 2020).

Kenya has experienced incredible economic growth over the previous years from the year 2003 to 2013. Average annual GDP growth rates is 5%, with agriculture, wholesale and retail trade and transportation accounting for 17.6%, 15.2%, and 10.8% respectively (Financial Survey, 2013). Throughout this period Kenya executed vibrant economic and structural reforms as clarified by the National Financial Plan called the Economic Recovery Strategy (ERS) covering the 2003-2007 period. Nonetheless, the high cost of energy stays among the biggest bottlenecks to economic task in the country (KIPPRA, 2020). Kenya is still to lose out on international direct financial investments partially due to this trouble, with significant fines on socio-economic growth. Available data shows that the cost of power in Kenya is four times that of South Africa, the country's main rival in the region, and three times that of China (KIPPRA, 2020).

On energy, the Kenya Vision 2030 noted that the energy prices in Kenya are more than those of her competitors. The Kenya Vision 2030 Blueprint, therefore, prioritizes the growth in investment of energy generation from cheaper sources to raise effectiveness in energy intake. This will be achieved through institutional reforms in the energy sector, consisting of a solid regulative structure, motivating private generators of power, and dividing generation from circulation, in addition to protecting brand-new resources of power via exploitation of geothermal power, coal, renewable resource resources, and attaching Kenya to energy-surplus nations in the area

Figure 1.2: Renewable energy Consumption (Kw/Capita)

Data Source: KNBS 2020 Annual Report

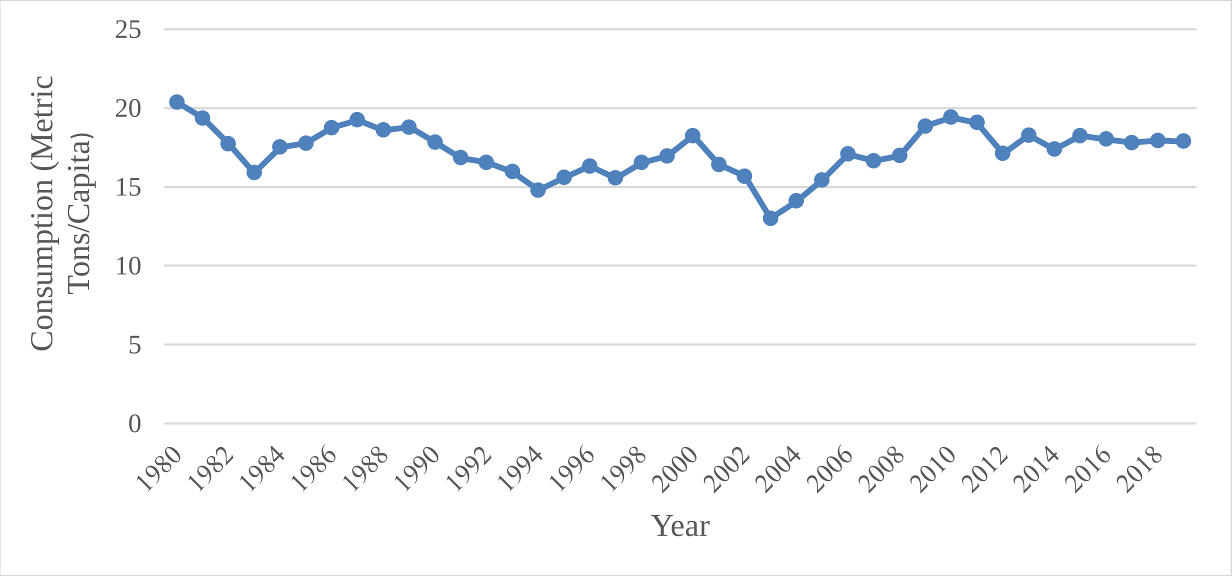
The trend line in Figure 1.2 depicts the consumption of renewable energy in kw/capita in Kenya between the years 1980 through 2018. The trend line demonstrates an erratic consumption of renewable energy in kw/capita over the period. The trend line shows that the lowest energy was consumed in the year 2015 when the manufacturing sector consumed 72.66275251Kw/Capita of renewable energy, particularly electricity. The highest consumption of renewable energy was in the year 2003, when the manufacturing sector consumed an average of 83.18299028 Kw/capita of renewable energy.

1.1.3 Trend in Non-renewable Energy consumption for Kenya

Non-renewable resource does not regenerate itself in meaningful human time frames at a reasonable pace for sustainable economic extraction. A case in point is carbon-based, renewable coal. In presence of heat and pressure, the initial organic material becomes a fuel i.e., oil or gas. According to the International Energy Agency (2018), gas and oil reserves (non-renewable energy) production will drop to about 40-60% by 2030. Wanjiru and Ochieng (2017) have estimated that by 2050 the supply of non-renewable energy will be exhausted.

Furthermore, Oluoch, Lal, Susaeta and Vedwan (2020) noted that this form of energy use was often susceptible to disturbances caused by major world events such as conflict, monopoly activities (e.g., OPEC3) and dependent on net oil producing countries ' political stability.

Figure 1.3: Nonrenewable Energy Consumption in Metric Tons/Capita



Data Source: KNBS 2020 Annual Report

Figure 1.3 shows the trend of consumption of non-renewable energy by the manufacturing sector in Kenya expressed in metric tons per capita between the year 1980 and the year 2018. The trend line shows that there were fluctuations in the level of consumption of non-renewable energy by the sector within the 40-year period. The highest consumption was recorded in the year 1980 when the sector consumed an average of 20.37791006 metric tons/capita of non-renewable energy. The lowest consumption was registered in the year 2003 when the manufacturing sector in Kenya consumed an average of 12.99901109 metric tons/capita of non-renewable energy.

1.2 The Statement of Problem

Kenya's manufacturing sector is the most developed in East and Central Africa accounting for 15% of Gross Domestic Product (GDP) of the region (Kenya Economic Outlook, 2020). Just like the global case, the leading sector in terms of energy consumption in Kenya is the manufacturing sector (Kenya Association of Manufacturers, 2019). Available data shows that the cost of mains electricity in Kenya is high compared to other countries resulting in high cost of production affecting the competitive advantage of locally produced goods (KAM, 2020). Further, power unreliability brought about by mains electricity fluctuations and rationing results in the use of diesel driven generators which increase the cost of production. The great disparities can be attributed to increased manufacturing sector that requires stable and cost-effective power supply to compete effectively at the global front in the highly developing economies.

In the past decade Kenya has grappled with the challenge of unreliable, expensive, and unsustainable energy use supporting a stagnating industrial and manufacturing base (Institute of Economic Affairs, 2020). This is due to aging energy infrastructure that can no longer meet the modern-day requirements as envisaged in the country's economic blueprint, the Kenya Vision 2030. The Vision 2030 notes that currently the energy costs in Kenya are higher than those of her competitors in the face of growing energy demand and this has had negative impact on the performance of the manufacturing sector (Institute of Economic Affairs, 2020). It therefore prioritizes the growth of energy generation and increased efficiency in energy consumption. The sector's contribution to GDP, however, dropped from 9.6% in 2011 to 9.2% in 2014, while the growth rate deteriorated from 3.4% (2015) to 3.1% (KIPPRA, 2017). The manufacturing sector is characterized with instability and volatility which the research project seeks to address.

There has been a general decline in contribution of renewable energy to manufacturing sector in Kenya. For example, the electricity accounted for approximately 74% of actual total consumption in 2014 but reduced to 72.3% in the year 2015. It later reduced to 71% in the year 2016.

In addition, there has been an inconsistent trend of contribution of non-renewable energy to manufacturing sector. For example, contribution of oil to manufacturing sector in the year 2015 was 9.54%. However, the value declined to 4.75% in 2016 but recorded an increase to 4.83% in 2017. The reduction in contribution of renewable as well as non-renewable energy to the manufacturing sector is said to be causing the inferior performance of the manufacturing sector (Kenya Association of Manufacturers, 2019).

According to Onuonga (2008), his study showed that the inter-fuel model in the Kenyan manufacturing sector demand for electricity and oil were substitutes also inelastic to price. Fuel cross price elasticity obtained was low but statistically significant. Few options for replacement between electricity and oil have been identified in the energy market providing a gap to consider other forms of energy that are consumed. The study didn't consider different technologies that is the renewable and non-renewable energy consumption.

In addition, Forkuoh and Li (2015) study examined cost of doing business, energy efficiency and firm growth. The scholar recommended that his study failed to show causality between the energy consumption and manufacturing sector performance at sector level.

Further, Kang, Islam, and Tiwari (2019) conducted a study on renewable and non-renewable energy sources ' comparative impact for European together with Eurasian Countries ' economic growth and CO_2 emissions. The study dealt with CO_2 emission causal relationship with different technologies and economic growth with European Countries. Therefore the current study is finding out the three conflicting school of thoughts causality about performance of manufacturing and consumption of energy, renewable vis –a vis non-renewable consumption to manufacturing performance, and bi-directional link between the three The current study will consider technology in the energy mix consumption on the performance of manufacturing sector.

1.3 Research Questions

The study seeks to answer:

i. What is the effect of renewable energy consumption on performance of manufacturing sector in Kenya`s economy?
ii. What is the effect of non-renewable energy consumption on performance of manufacturing sector in Kenya`s economy?

1.4 Research Objectives

1.4.1 Main objective

The main objective of this study is to investigate the effect of energy consumption on performance of manufacturing sector in Kenya.

1.4.2 Specific objectives:

The specific objectives of the study are:

i. To determine effect of renewable energy consumption on manufacturing sector in Kenya.
ii. To determine effect of non-renewable energy consumption on manufacturing sector in Kenya.

1.5 Significance/justification of the study

The research project aims in strengthening manufacturing firm’s policy intervention by providing information on energy efficiency relationship and how they can embrace them to gain a competitive edge both at a domestic and international level. Study of energy consumption in developing countries such as Kenya is a vital component of integrated energy planning and policy. Planners and policy makers gain insights into the factors that affect growth and energy trends before they can continue with future demand forecasts. Considering the capital intensity and long gestation periods of energy projects, supply difficulties and insufficient technologies for energy shortages, comprehensive energy demand studies need to be conducted at both aggregate and sectoral level.

The findings of the current study will be significantly important to the Government of Kenya through the Ministry of Energy and Petroleum together with private power producers, who have knowledge of areas where producers can be encouraged to embrace energy conservation. The research project also allows scholars to develop their literature on renewable energy, in addition to non-renewable energy use and its effect on the output of the manufacturing sector, by providing more guidance on filling gap in further studies. Finally, the findings of the study will be of immense help to the manufacturing companies in identifying areas where they can engage the government to ensure the cost of energy is properly regulated.

1.6 Scope of the study

The research project scrutinizes the effect of use of renewable as well as non-renewable energy on Kenya's performance for manufacturing sector. For several reasons, the study will limit to the period 1980-2020. First, time series data is available for this period and this period is believed to be long enough to capture the association among renewable and non-renewable energy utilization on manufacturing sector performance.

1.7 Organization of the study

This study only focused on the effect of energy consumption on the performance of manufacturing sector in Kenya. The study has five (5) chapters. Chapter one (1) of the study consists of the introduction and background of the study. Chapter two (2) is the literature review which evaluates the works of other researchers on the subject, their approaches, and the researcher’s criticisms. Chapter three (3) details the methodology and research design deployed. Chapter four (4) provided the empirical findings while chapter five (5) gives a summary of findings discusses and suggest policy implication.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains theories and research from other scholars reviewed in the study. It begins by reviewing theories supporting the study followed by empirical literature. Theoretical literature explores relevant theories that explain the consumption of production and energy. On the other hand, it concludes with discussion of literature examined.

2.2 Theoretical Literature Review

The study will examine relevant theories that are related to energy consumption as input and production output theories showing patterns of consumption relating to sectorial performance case study of manufacturing sector.

2.2.1 Theory of the Firm

The theory of the firm was created by Coase (1937). Firm's theory is the micro-economic concept based on neoclassical economics, which states that a business unit exists with a sole objective to maximize profits. Manufacturing sector in the economy exist to maximize their output and profit contribution to the GDP. In these theories the firm also is endogenous in microeconomics. In addition, there is claim that other factors will affect pricing, production, jobs, and all other supply side (MC) and demand side (MR) variables do not falsify the marginalized approach in this theory. Marginalist describes both an economical method of analysis and a theory of value and according to this theory, individuals make economic decisions on the margin, value is determined by how much additional utility an extra unit of a good or service provides (Demsetz, 1988). The theory of the firm consists of a number of economic theories that explain and predict the nature of the firm, company, or corporation, including its existence, behavior, structure, and relationship to the market (Holmstrom & Tirole, 1989).

Indeed, the performance of the firm will be depending on the technology employed for production to optimize the contribution to the economy depicted by the production function. Employed firm technology must assess the cost of production that creates demand. Firm seeks to follow this goal of balanced growth, subject to two major constraints: technological and financial.

The technological constraint is set by the availability and efficiency of the affordable energy for production. Nonetheless, the theory has been discussed and broadened to think about whether a business' objective is to maximize revenues in the short-term or long-term. Modern tackles the theory of the firm sometimes compare long-run motivations, such as sustainability, as well as short-run inspirations, such as profit maximization. The concept of the company works side by side with the theory of the customer, which states that consumers seek to maximize their general energy. In this situation, energy refers to the viewed worth a customer position on an excellent or solution, sometimes described as the level of joy the consumer experiences from the great or solution.

2.2.1.1 Production Function

Production function express relationship of inputs technically combined give output provide in equation 2.1.

$$Y = f(K, L)^{\alpha} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 2.1$$

Where Y is production, K is capital and L is Labor.

The firm's goal aims at maximizing profit, either optimizing output i.e., Increasing Y produced or carrying out production at minimal cost-effective manner. The output function indicates the optimal output produced using inputs of labor (L), raw material (R) and capital (K) combinations. Y referred as the Total Physical Product (TPP). An input's Marginal Physical Product (MPP) defined as extra output produced by using additional input unit holding other inputs constant. The return to scale demonstrates production output reaction with changes in inputs level which may be constant, decreasing or increasing (Varian, 2006).

The relationship of output can be expressed in various forms for example linear, polynomial, and functional form of Cobb-Douglas. In 1928, Cobb and Douglas developed this feature to describe the relationship between output, labor, and capital. Douglas (1976) found that production was an equation of labor supply and linked capital.

$$Y = f(K, L, R)^{\alpha} \quad \text{……………………………………………………………} \quad 2.2$$

Where Y stands for Manufacturing firms' output, K refers to capital units used in the manufacturing process; this could be assets, machinery and stock, L stands for the amount of labor (people and skills), and R stands for the quantity of raw inputs in the production of the output (Y). The raw materials include the renewable as well as non-renewable energy being production factors. (Varian, 2006).

Current study examines the effect of consumption of renewable and non-renewable energy on manufacturing sector performance in Kenya. Therefore, renewable(R) and non-renewable (NR) energy will also be a function of manufacturing sector performance contribution to gross domestic product (GDP).

$$Y = f(K, L, R, NR)^{\alpha} \quad \text{……………………………………………………………} \quad 2.3$$

2.2.1.2 Isoquant

"An isoquant is a curve that displays all possible combinations of inputs that are physically capable of yield a given output level," says Ferguson. At the level of the manufacturing firm, renewable or non-renewable energy are used as energy input to maximize its level of production give a certain level of technology. Isoquant functions are shown as

$$\text{Max}(Q) = f(K, L) \quad \text{……………………………………………………………} \quad 2.4$$

Q: Quantity produced /output, K: Input capital quantity, L: Input labor quantity

The manufacturing sector makes a choice to consume any set of combination of renewable with non-renewable energy to produce output. The theory identifies isoquants in different forms, i.e., linear, convex, and concave. For convex and concave isoquants, the marginal rate of technological sustainability between inputs and technologies, i.e., renewable, and non-renewable, produces a declining return while linear isoquants have total replace ability in production inputs and constant scale returns.

In Kenya, environmental activist campaigns for the use of renewable energy despite the country being endowed with coal. The demand for renewable energy is high however the technology faces new challenges of the volatility and stability of the source of the energy. As the level of technological knowledge rises, efficiencies in inputs transformation and output changes as level of technological expertise increases. Because of increased technological progress in the energy sector, greater quantities or better quality of production can be generated for consumption (Kotze, 1970) .

2.2.2 The Keynesian Theory

Keynesian theory was proposed and popularized by Keynes in 1936. Keynesian theory states that the government should increase demand to boost growth. Keynesians believe consumer demand is the primary driving force in an economy. As a result, the theory supports the expansionary fiscal policy (Eichner & Kregel, 1975). Its main tools are government spending on infrastructure which includes energy, unemployment benefits, and education. The basic Keynesian theorem is.

$Y=C+I$……………………………………………………………………………………2.5

Where Y=output, C= consumption and I=Investment

Assuming that consumption C is a fraction of c of Y

$Y=cY+I$……………………………………………………………………………………2.6

Taking the incremental equation.

$\Delta Y=c\,\Delta Y+\Delta I,$ …………………………………………………………………………….………2.7

And thus,

$\Delta Y=\frac{\Delta I}{1-c}=k\Delta I$……………………………………………………………………….……………2.8

The k is the investment multiplier. This basic equation is only valid for small increments of the investment. For larger increments, the assumption that c is constant does not hold and a more complex expression would have to be derived.

Keynesians believe consumer demand is the primary driving force in an economy. As a result, the theory supports the expansionary fiscal policy. A drawback is that overdoing Keynesian policies increases inflation. Keynes advocated deficit spending during the contractionary phase of the business cycle (Knack & Keefer, 1995). Keynesians believe that, because prices are rigid, fluctuation in consumption, investment, or government expenditure cause output to change.

Keynesian theory is relevant in understanding the rigidity on electricity pricing tariffs, government investment allocation and expenditures to energy sector affecting the output at sector level. Keynesian theory states that the government should increase consumption to boost growth. As a result, the theory supports the expansionary policy on manufacturing sector. Spending on energy by government is meant to develop a vibrant manufacturing sector required to support the economy. Spending on energy is also aligned to support of research and development in economy in terms of technologies supporting renewable and non-renewable energy. In addition, government spending on energy ensures that the manufacturing companies can operate efficiently and improve their performances.

2.3 Empirical Literature

Onuonga (2008) conducted a study in Kenya's manufacturing sector on an econometric analysis of energy use. This research modelled the trans log function to evaluate total factor specifications with inter-fuel replacements. It was measured in two phases. The study finding indicated energy price, cross price, production, technology, capital price, and unexpected shocks had an impact on energy consumption. The results for the inter-fuel model showed that in the Kenyan manufacturing sector demand for electricity and oil were substitutes also inelastic to price. Fuel cross price elasticity obtained was low but statistically significant. Few options for replacement between electricity and oil have been identified in this market. Recommendation that totals cost shares of the factor illustrated that energy demand and labor was price inelastic on the other hand unitary elasticity for capital. However, those of resources, labor and capital were substitutes, but the degree of substitution was found to be small among the variables. Onuonga (2008) failed to link the energy utilization with manufacturing sector performance.

Onuonga, Etyang and Mwabu (2008) conducted a study on review of household energy choices in Nairobi areas in Kenya using descriptive statistics, data were analyzed. The research findings were that in the choice of household resources, income and education play a key role. The study recommended that the policy intervention on tax cuts and holiday for petroleum products, especially commonly utilized LPG for cooking and illuminating kerosene for lighting, to make it affordable to households. The study was conducted around Nairobi with a sampled data which might not be reflective of energy consumption at the nation level.

Kiplagat, Wang and Li (2011) conducted a study on Kenya's renewable energy: potential resource and exploitation status. Notable high reliance on traditional form of energy wood biomass hence leading to a supply and demand imbalance according to the study. Considerable strain on the remaining forest and plant stocks, speeding up land degradation processes. Amidst numerous challenges of rural connectivity to electricity grid, has made deliberate progress towards universe access to clean energy. With the new Energy Act 2019, Kenya partially liberalized energy sector at distribution level to enhance efficiency by opening to competition. Country’s energy mix comprise 80% renewable sources in electricity grid. Considerable proportion of renewable energy, however, the price per Kwh is expensive. For potential renewable sources, approximately 30% for country's reserve from hydropower is about 4% of geothermal production potential, and much smaller proportions of solar potential have been harnessed as well as wind. The study focused only on renewable sources of energy while the current study focuses on renewable and non-renewable sources of energy.

Research on effect of renewable energy on economic growth and CO_2 emissions was conducted by Silva, Soares, and Pinho (2012) using a SVAR approach. The study examined how a growing proportion of clean energy on Electricity Generation (RES-E) affects GDP and emissions from Carbon Dioxide (CO_2) using a 3-variable Structural Vector Autoregressive (SVAR) approach. Presence of unit roots has been checked to deduce the variables ' stationarity. The SVAR calculation showed that the growing RES-E share had per capita GDP costs for all countries in the study, apart from the USA. There was also a noticeable decline in per capita CO_2 emissions. It was the major contributor to Nigeria's Gross Domestic Product (GDP) as well as the main foreign-exchange source. Nevertheless, the nature of Nigeria's external trade changed dramatically from the mid-1970s (the oil boom period) and upwards when crude oil succeeded in taking the place of conventional agricultural produce as the key source of government revenue

Kasae (2014) conducted a study of Kenya's manufacturing companies ' energy efficiency and operational performance. Dataset analyzed with respect to baseline and current data. The baseline data been the data before implementation of EEMs by the companies while the current data been the data collected in after implementation of EEMs. The data was analyzed using regression model. To assess the relevance of the linear best-fit curve for energy consumption, production and SEEI, the Pearson correlation coefficient for both baseline and current data were examined. The study established a considerable use of EEMs by Kenya`s manufacturing firms with 92% t of the targeted firms having implemented EEMS. Finding depicted a positive link between the use of EEMs and the efficiency of the project. This finding was not definitive, however, as some companies showed low correction coefficients of the variables at both the baseline and the current level indicating further research.

Gitone (2014) evaluated renewable energy adoption determinants in Kenya. The study used bivariate probit model to account for interdependence in adoption decisions. However, the results indicated that decisions to adopt solar and biogas are independent. The research therefore used different probit equations to examine the effect on the adoption of both solar and biogas of household head characteristics, household characteristics and economic factors. The result revealed that household heads with secondary and post-secondary education and household size significantly influence adoption of solar energy while gender and the size of the family have a significant explanation on biogas adoption. Current study focused only on renewable sources of energy while the current study focuses on renewable and non-renewable energy

Forkuoh and Li (2015) evaluated the power insecurity and its impact on the growth of small manufacturing firms in Ghana. The theoretical approach investigated the electrical outages and the growth of small manufacturing firms in Ghana indicating a positive correlation between efficiency of electricity infrastructure to the growth of the firm’s productivity and the economy. Further, it discussed the electricity outages and cost of operations indicating high operational costs in developing countries. Finally, the study reviewed the alternative power supply and cost implications to the growth of small manufacturing firms in Ghana asserting the use of alternative power supplies like generators increases the cost of operations. Through a mixed method of study employing a questionnaire survey and interview, the study sampled 250 cold store operators in Asafo Market through purposive sampling. Data analysis was conducted using SPSS version 21.0 to establish the relationship that existed between the dependent and independent variables in the study. The research established that power outages negatively effect on the growth of small manufacturing firms in Ghana and the cost of operating businesses increase considerably. The significant increase in operation costs was also attributed to the use of alternative sources of power to counter power outages.

Kahia, Aïssa and Charfeddine (2016) studied on economic growth effect of use of renewable and non-renewable resources in MENA Net Oil Exporting Countries. Research project adopted a multivariate panel framework. Finding on panel error correction model exhibited short-run also long-run bidirectional and unidirectional causality from economic growth to renewable energy use, respectively. Furthermore, results demonstrate bidirectional causality between the consumption of non-renewable energy and economic growth both in the short and long run. In addition, there are several measures and policies that need to be implemented by the authorities to advocate usage of clean and sustainable energy, such as the establishment of several important regional institutions and cooperation, renewable energy generation tax credits and rebates. This study adopted panel data methodology while the current study will adopt time series.

Nevertheless, the Granger carbon emissions cause long-term energy consumption. The lack of long-term causality between income and carbon emissions from Granger provides evidence that carbon emissions are lowered by both the US and Turkey without ignoring economic growth. Applying the boundary checking to the protocol of co-integration in a multivariate model of carbon emissions, electricity usage, income, and international trade. The short-term viewpoint shows the transition to a new paradigm of energy (renewable), while the long-term view refers to the studied factors ' long-term equilibrium. Results show that the patterns of GDP and Renewable Energy Consumption (REC) are independent in the short term.

Research study on econometrics modeling of renewable energy sources with economic growth was performed by Ntanos, Skordoulis, Kyriakopoulos, Arabatzis, Chalikias, Galatsidas and Katsarou (2018) data from European Countries. Study used combination of descriptive statistics, cluster analysis and Autoregressive Distributed Lag (ARDL) resulting to variables being correlated; this indicates link of GDP as dependent variable with Renewable Energy (RES) and Non-RES energy consumption, gross fixed capital creation and long-term labor force. Addition, results showed a higher association between RES consumption and higher GDP countries ' economic growth than those of lower GDP. The study focused only on renewable sources of energy while the current study focuses on renewable and non-renewable sources of energy. The complex relationship between Foreign Direct Investment (FDI), non-oil exports and GDP using the principle of variance decomposition and stimulus response analysis showed that policy shocks to Foreign Direct Investment (FDI, non-oil exports and Economic growth did not react in the desired direction immediately.

Grainger and Zhang (2017) explored the impact of electricity shortages on the productivity of firms in Pakistan by evaluating 4,500 manufacturing firms between 2010 and 2011. Employing a critical empirical study survey, the shortage in electricity was determined in the form of hours per day when power fluctuations were experienced. The study found out that a 10% increase in the duration of power outage led to a 0.14% decrease in the firms’ total revenue and 0.36% decline in the value added. Thus, it is apparent that electricity fluctuation affects performance of manufacturing companies but, there lacks substantive studies on the Kenyan manufacturing sector. This study evaluated the extent of power fluctuations and its effect to the Kenyan manufacturing sector productivity and profitability.

Abeberese (2018) through a system review surveying Indian manufacturing companies utilized manufacturing firm-level panel data from the Indian Annual Survey of Industries (ASI) between the years 2001 and 2008. The study employed econometric analysis where simple regression of company performance with respect to electricity price was evaluated. The study outcome showed that increased costs of electricity results in companies lowering their electricity consumption and switching to less electricity-intensive production process. Such interventions eventually bring down the factor productivity affecting overall performance of a manufacturing company. Further, unreliable electricity forces manufacturers to have standby generators for back up increasing their cost of energy due to the high cost of thermal electricity. Thus, the study recommended manufacturing firms to produce coping strategies on negative outcomes while addressing unreliable electricity.

Kang, Islam, and Tiwari (2019) conducted a study on renewable and non-renewable energy sources ' comparative impact for European together with Eurasian Countries ' economic growth and CO_2 emissions: a PVAR approach. In a panel setting, the analysis examined RES and NRES ' relative performance on economic growth in European and Eurasian countries. In relation to CO_2 emissions, the dynamics of these variables were also studied. The research used the PVAR method to evaluate for the period 1965 to 2009 and found that NRES growth rate had a negatively affected on GDP growth rate as well as increased CO_2 emissions. RES ' relationship with GDP growth rate is found to be positive. The study recommended reducing NRES consumption to achieve higher economic growth, increase economic productivity and employment in Europe and Eurasian Countries with a safe and sustainable climate. The study was conducted in Europe and Eurasia, while the current study will be conducted in Kenya.

2.4 Overview of literature

Silva, et al. (2012) performed an impact analysis on economic growth and Carbon Oxide emissions from renewable energy sources a SVAR method. The study focused on only one type of energy renewable energy thus presenting a contextual gap. The current study will focus on renewable and non-renewable energy consumption. Tiwari (2011) conducted an analysis on the comparative effect of renewable and non-renewable energy sources on developed economies of Europe's and Eurasian Countries ' economic growth and Carbon Oxide emissions: A PVAR approach. The study was conducted in Europe and Eurasian Countries thus presenting a scope gap. The current study will be conducted in Kenya.

Ntanos et al (2018) conducted a study in European Countries on renewable energy and economic growth. The statistical analysis was based on analysis of cluster and a methodological gap was posed by Autoregressive Distributed Lag (ARDL). Onuonga (2008) study utilized trans log model in scrutinizing total factor demands and inter-fuel substitution thus presenting a methodological gap. The current study employs a non- experimental research design which will use economic models for analysis. Furthermore, empirical study had a research gap that links the consumption of energy to the manufacturing sectorial performance.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The chapter contains research methodology. It begins with describing research design employed; theoretical framework suggested and concludes with definition of variables and their measurement.

3.2 Research Design

The research used non-experimental research approach to examine with quantitative time series data using economic models. For the period 1980-2017, time series data set for the following variables will be analyzed: GDP, renewable, non-renewable, energy prices, debt, labor as well as trade accessibility. The design is advantageous in that researcher can deduce the casual and explanatory relation between consumption on renewable and non-renewal energy consumption on manufacturing performance.

3.3 Theoretical Model

According to theory of the firm, output is related to various inputs and may be expressed.

$$Y = f(A, K, L) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

Where Y is production, K is capital and L is Labor, A is efficiency parameter.

This study adopted Cobb-Douglas production function that guided the development of empirical model with a top-down analysis of energy demand. Cobb and Douglas introduced this function to clarify the relationship between production output, labor inputs and capital inputs with productivity of the technical factor (technology level) Cobb-Douglas production function is generally expressed as:

$$Y=AL^{\alpha}K^{\beta}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2$$

Where α and β are share of labor and capital with a constant return to scale.

$$\alpha + \beta = 1 \quad \ldots\ldots 3.3$$

3.4 Model specification

According to production function, exploring the role of labor growth as an input of production in terms of population growth, manufacturing performance measured as real GDP growth, with changes in relative fuel prices affected demand for energy. The production function will be derived from section (3.2) it will be used as the baseline function for our model specification.

$$Y=A* L^{\alpha} *K^{\beta} \quad \ldots\ldots 3.4$$

In model 3.4, Labor (population) enters the model tautological relationship between labor and aggregate demand for energy consumption. The study treats the outcomes of the Douglas equation similar to study variable. Therefore introducing E_t has the aggregate energy consumption demand, GDP real gross domestic product PE relative energy prices and A; total factor productivity yielding model 3.5

$$E_t = \mathrm{A}\, GDP_t^{\alpha} PE_t^{\beta} \quad \ldots\ldots 3.5$$

6

Where: E_t is the aggregate energy consumption demand, GDP real gross domestic product PE relative energy prices and A; total factor productivity.

The model fails in differentiating long term and short-term effects. Using process analysis, the relationship between energy consumption demand and aggregate capital stock is substitutional rather than imitational i.e., fixed proposition means there is a choice between more and less energy consumption. Thus, expressed as.

$$Y_t^{\alpha} = \frac{RE_t^{\gamma}}{\mathrm{A}*PE_t^{\beta}} \quad \ldots\ldots 3.6$$

RE_t^{γ} is the energy mix comprising of renewable (E_t^{γ}), non-renewable (nE_t^{τ}) substituted like a form of capital k, Price introduces to the model for demand as determinate of demand; linearize the equation logarithm are introduced.

$$Y_t = A, RE_t^{\gamma}, PE_t^{\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.7$$

$$Y_t = \alpha K_t^{\beta}, RE_t^{\gamma}, nE_t^{\tau}, O_t^{\varphi} Pe_t^{\gamma} \mu \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.8$$

Where:

Relative energy prices (Pe_t), Renewable energy consumption (RE_t), Non-renewable energy consumption (nE) at time t, Manufacturing performance output ($Y_{t,}$), K being capital, technology (A) and μ is white noise error term. Trade openness (O) will also be used as control variables and therefore will be added to the model. And taking the logarithms of equation (3.8) gives:

$$\text{Ln } Y_t = Ln\alpha + \beta \text{Ln } K_t + \gamma \text{Ln } RE_{\,t} + {}^{\eta}\text{Ln } nE_t + {}^{\varphi}\text{Ln } O_t + \gamma \text{Ln } Pe_t\ ) + \ \mu \ldots\ldots\ldots\ldots\ldots 3.9$$

3.5 Definitions and Measurement of Variables

Table 3.1: Definitions and measurement of variables

Variable	Definition	Measurement	Data source
Performance	General output of manufacturing sector per year.	Manufacturing sector contribution to Real GDP growth	World Bank data indicator
Renewable energy consumption	Energy obtained from renewable resources replenishing naturally such as sunlight, wind, rain, tides, waves, and geothermal heat.	per capita electricity consumption in Kwh per capita	Word Bank data indicator
Non-renewable energy consumption	Is a resource that does not adequately regenerate itself in meaningful human time frames for sustainable economic extraction	Per capita fossil fuel consumption to measure non-renewable energy in metric tons per capita	Word Bank data indicator

Energy prices	Measure the market disturbance reaction of energy consumption on both the supply and demand side.	Consumer prices Index was used as a proxy of Energy price.	Word Bank data indicator
Trade openness	Trade enters the mode to measure impact of energy output in terms of efficiency	Economic transparency, which is Import less export-divided to GDP as a percentage of GDP, OPEN was used.	World Bank data indicator
Capital	Measure capital as production factor	Measured items of real gross fixed capital (GFC)	World Bank data indicator

3.5 Data Analysis

Research project utilized in secondary information. The study's objective was to evaluate the degree and consequences of the relationship between renewable and non-renewable energy consumption and performance of manufacturing sector performance at country level. The time series dataset for the period 1980 to 2017 was used for analysis. Data on the variables was mined from Central Bank of Kenya (CBK), Energy Regulation Commission (ERC), Word Bank (WB) and Kenya National Bureau of Statistics (KNBS) Data Bank.

This research used a regression model of time series to study the effects of renewable and non-renewable energy on Kenya's manufacturing performance. Using standard OLS technique to non-stationary information arrangement will result 'spurious relapse'. In other words, the regression can provide high R-squared, low Durbin-Watson (DW) measurements with t-estimates of the coefficients evaluated showing significant causality between dependent and independent variables while reality they are disconnected. The Augmented Dickey-Fuller unit-root tests was utilized in testing stationarity and order of integrability of the dataset (Dickey and Fuller, 1981). The equilibrium relationship between the stationary model and non-stationary series was captured using co-integration technique to mitigate spurious and incorrect parameter estimates of the model coefficients, (Johnston & Dinardo, 1997).

With goal orientation to prepare for the likelihood of a spurious relationship while keeping up information/results, two primary methodologies provide sensible arrangements. Hendry and his co-researchers developed unrestricted error correction modeling (ECM) (Hendry, 1995). The Johansen's procedure was utilized to find cointegrating vector among the variables (Johansen, 1988). .Then again, Hendry's ECM methodology (1995) can be extended to combined data with different orders (Hendry, 1995)

3.6 Time Series Properties

3.6.1 Unit Roots

An Assumption of non-stationary time-series data is assumed, and it is therefore important to conduct root unit tests to assess the data's stationarity. The Augmented Dickey Fuller (ADF) test will check the data's time-series features. The ADF evaluated non-stationarity's null hypothesis against the alternative stationarity hypothesis. When checking the unit roots, the Phillips-Perron tests or the ADF test with below hypothesis:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{j=1}^{k} \lambda_j \Delta y_{t-j} + e_t \ldots\ldots 3.11$$

Ho: The variable is nonstationary (i.e., it has a unit root)

H_i: The variable is stationary (i.e., it has no unit root)

The lag length was selected by using the information selection criteria such as AIC, FPE, LR, SBIC and the Hannan-Quinn selection criterion and ensuring that the residuals are white noise. Preliminary test included normality test and tests for heteroskedasticity to meet the OLS assumptions. Shapiro-Wilk's test was used to assess normality of the data whereas the Breusch-Pagan or the Cook Weisberg test was used to test for heteroskedasticity.

3.6.2 Testing for Co-integration

The next stage will include checking the co-integrating equations ' existence. The Johansen co-integration method will be used. The unit root test result above indicates, if the series are integrated of the same order, the Johansen’s procedure is used to determine whether there exists a cointegrating vector among the variables (Johansen, 1988). The cointegrating test is used to determine the long-run relationship between two variables (Hwang, 1998). The cointegration test was based on equation 3.10:

$$\mathrm{Ln}\ Y_t = Ln\alpha + \beta \mathrm{Ln}\ K_t + \gamma \mathrm{Ln}\ RE_t + {}^{\eta}\mathrm{Ln}\ nE_t + {}^{\varphi}\mathrm{Ln}\ O_t + \gamma \mathrm{Ln}\ Pe_t\ ) + \mu \text{........................} 3.11$$

3.6.3 Error Correction Modelling

This research will use Hendry's (1995) method for Error Correction Modeling (ECM). This will be important in deciding the short-term relationships between variables. This technique will minimize the likelihood of evaluating spurious connections while holding long-run data without arbitrarily restricting the lag structure.

In addition, the ECM provided the assessment with significant t-values even in view of the endogenous explanatory variables (Inder, 1993). No variable is omitted from the self-regressive equation for all the variables in the scheme. In this analysis, we used the reduced form ECM, which modelled any endogenous variable in the system, in function of the lagged values of itself and of all the endogenic variables in the system (Engle and Granger, 1987).

3.6.4 Granger Causality Analysis

Relationships between variables do not imply causality or suggest causality direction. The Granger Causality test assumes that past events can influence future events (Gujarati, 2003) In this study, Granger Causality test was used to find presence and direction of causality linking energy consumption with performance of manufacturing sector.

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1 Introduction

In this chapter, the results of data analysis are presented. The characteristics of the data using visual aids and descriptive statistics. Before performing pilot result analysis of the data, diagnostic tests are conducted to evaluate for stationarity as well as cointegration, thereafter multivariate time series is used to discuss the empirical results. Finally, diagnose the data for variance stability.

4.2 Descriptive Statistics

In Table 4.1 shows averages, Standard deviation. Maximum and minimum observations of the study variable. Energy price has the highest variability with a standard deviation 56.481 with a min of 2.767 and Maximum of 180.515 indicating a wide spread of observation, followed by trade openness with a standard deviation of 14.724, minimum of -20.927 and a maximum of 71.303. The observation exhibits negative observation especially when term of trade is negative reliance on import is greater than exports showing adversity. Renewable energy consumption and non-renewable energy consumption have standard deviation of 2.016 and 1.546, respectively. The pattern in green energy illustrates the volatility in wind power generation technologies and the strength of the solar technology sources.

Table 4.1: Descriptive Statistics

Variable	Obs.	Mean	Std.Dev.	Min	Max
Log of Manufacturing Performance	40	3.143	2.538	-2.32	8.208
Log of Renewable Energy Consumption	40	78.696	2.016	72.663	83.183
Log of Nonrenewable Energy Consumption	40	17.262	1.546	12.999	20.378
Log of Energy Price	40	57.472	56.481	2.767	180.515
Log of Trade Openness	40	8.664	14.724	-20.927	71.303
Log of Real Gross Fixed Capital	40	18.658	1.864	15.388	22.88

Source: Author (2021)

In addition, histograms for the study are presented in annex 1 and 2 in Appendix 1. From the histograms, the distribution of manufacturing performance has a fat tail whereas energy prices, trade openness and capital are slightly skewed to the right. Annex 3 presents histogram plots to show normality of transformed series with aid of annex 4 which show the correlogram trends. The plots appear to deviate from the normal which is a sign that transformation yields a better distribution for time series analysis. The study adopted the third difference as a transformation to remedy the situation in preparation for the analysis.

4.3 Diagnostic Tests for VEC

The first step of preliminary analysis of the data is the selection of the optimal lag length, perform stationarity checks and thereafter identify the cointegrating rank before specifying the model and assessing it for adequacy. To check for stationarity, we use time series plots, correlogram plots and the Augmented Dickey Fuller (ADF) test. If the data is found to be non-stationary, we shall proceed to determine the order of integration, before deciding on the appropriate time series model to fit.

4.3.1 Lag Selection

The first step in the analysis is to select a suitable lag length. This ensures that the error term is correctly specified (Soytas & Sari, 2003). There are various selection criteria available including the Sequential modified Likelihood ratio (LR) criterion, the Final Prediction Error (FPE) criterion, the Akaike Information Criterion (AIC), the Schwarz Bayesian Information Criterion (SBIC) and the Hannan-Quinn Information Criterion (HQC). However, the decision rule is to choose the model with the lowest value of information criteria. In our case lag selection information criteria are shown in Table 4.2.

Table 4.2: Lag Selection-Order Criteria Results

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-662.098				1.5e+10	40.4908	40.5824	40.7629
1	-572.831	178.54	36	0.000	6.4e+8	37.2625	37.9033	39.1671
2	-499.271	147.12	36	0.000	8.3e+7	34.9861	36.1763	38.5233
3	-429.801	138.94	36	0.000	2.2e+7	32.9576	34.6971	38.1274
4	-251.96	355.68*	36	0.000	25060.3*	24.3612*	26.65*	31.1635*

Sample: 1980 – 2019 (number of obs = 40)

Source: Author (2021)

The lowest information criterion for LR is lag 3, while the lowest information criterion for FPE, AIC, HQIC and SBIC is lag 4. Therefore, we conclude the optimal lag 4.

4.3.2 Testing for Stationarity

When non-stationary time series data are used for analysis, we may end up with spurious results because estimates obtained from such data will possess non-constant mean and variance (Dimitrova, 2005). We begin by checking the stationarity of the data. Stationary time series imply its mean, variance and covariances are time invariant. The study utilized time series graphs to check for stationarity. The time series plots for the study variables are presented in Appendix 3, annex 3. The results indicate possible non stationarity since their movement exhibit a trend.

The correlograms in appendix 3: annex 4 also indicate that the variables may be non-stationary since they die away slowly. To confirm empirically the stationarity of the data used the Augmented Dickey Fuller (ADF) unit root tests whose results are shown in table 4.3 below. Data is stationary when ADF statistic is less than T-statistic critical value

Table 4.3: Unit Root Tests Results

Variable		ADF Test statistic Z(t)	T-statistic 5%	MacKinnon approximate p-value for Z(t)
Log of Manufacturing Performance	No Trend	-2.136	-2.972	0.2303
	Trend	-2.160	-3.560	0.5122
Log of Renewable Energy consumption	No Trend	-0.971	-2.972	0.7636
	Trend	-1.218	-3.560	0.9067
Log of Non-renewable energy consumption	No Trend	-2.125	-2.972	0.2347
	Trend	-2.057	-3.560	0.5699
Log of Energy Price	No Trend	-1.389	-2.972	0.5878
	Trend	-2.229	-3.560	0.4736
Log of Trade Openness	No Trend	-2.847	-2.972	0.0518
	Trend	-2.785	-3.560	0.2024
Log of Real Gross Fixed capital	No Trend	-1.569	-2.972	0.4991
	Trend	-1.661	-3.560	0.7677

Source: Author (2021)

The results indicated the variables were not stationary since ADF statistic > t-statistic. We therefore difference the data to achieve stationarity. Differencing detrends the value to achieve stationarity. After the first differencing the results are shown in the table 4.4

Table 4.4: Unit Root test after First differencing Results

Variable		ADF Test statistic Z(t)	T-statistic 5%	MacKinnon approximate p-value for Z(t)
Log of Manufacturing Performance	No Trend	-2.903	-2.975	0.0450
	Trend	-8.298	-2.964	0.0000*
Log of Renewable Energy consumption	No Trend	-1.895	-2.975	0.3343
	Trend	-6.375	-2.964	0.0000*
Log of Non-renewable energy consumption	No Trend	-3.080	-2.975	0.0281*
	Trend	-5.773	-2.964	0.0000*
Log of Energy Price	No Trend	-1.479	-2.975	0.5441
	Trend	-2.359	-2.964	0.1538
Log of Trade Openness	No Trend	-4.629	-2.975	0.0001*
	Trend	-11.709	-2.964	0.0000*
Log of Real Gross Fixed capital	No Trend	-3.441	-2.975	0.0096*
	Trend	-6.135	-2.964	0.0006*

Source: Author (2021)

Manufacturing performance, renewable energy consumption and energy prices are non-stationary after the 1st differencing while non-renewable energy consumption, trade openness and real gross fixed capital are stationary. To achieve stationary, we proceed to difference further until all variables are stationary.

Table 4.5: Unit Root test after third differencing Results

Variable		**ADF Test statistic Z(t)**	**T-statistic 5%**	**MacKinnon approximate p-value for Z(t)**
Log of Manufacturing Performance	No Trend	-4.396	-2.980	0.0003*
	Trend	-4.311	-3.572	0.0030*
Log of Renewable Energy consumption	No Trend	-7.396	-2.980	0.0000*
	Trend	-7.331	-3.572	0.0000*
Log of Non-renewable energy consumption	No Trend	-4.806	-2.980	0.0001*
	Trend	-4.749	-3.572	0.0006*
Log of Energy Price	No Trend	-3.062	-2.972	0.0295*
	Trend	-3.702	-2.894	0.0460*
Log of Trade Openness	No Trend	-5.899	-2.980	0.0000*
	Trend	-5.785	-3.572	0.0000*
Log of Real Gross Fixed capital	No Trend	-4.806	-2.980	0.0001*
	Trend	-4.724	-3.572	0.0006*

Source: Author (2021)

Table 4.5 displays the results of the ADF test after the data is differenced three times. The data is stationary if the ADF test statistic is less than the critical value. All variables become stationary after the third difference indicating that the variables are integrated to order three, I (3). Appendix 3 and 4 also indicates stationarity of data after the third difference since there is no indication of trending and the correlograms do not die away.

4.3.3 Cointegration Test

To investigate long run relationship between the manufacturing performance and energy consumption, we assess the series for cointegration. Cointegration is applied to establish the long run relationship between variables. If the series is cointegrated, we use the error correction model to analyses the causality and the short-run equilibrium between the variables. The Granger representation theorem states that there is a corresponding error correction term, and an error correction model must be constructed. However, if the series are not cointegrated, then the VEC model is reduced to a basic VAR. Depending on the cointegrating relationship, we perform the Granger causality test to investigate the causal linkage between the variables (Bhunia & Das, 2012).

In this study, the series are I (3) so cointegration was then assessed using the Johansen cointegration test. Johansen and Juselius (1990), computes the trace (λ trace) and maximum eigenvalue (λ max) statistics. The null hypothesis was assessed that there is r=0 cointegrating vectors against the alternate that there is at least one cointegrating vectors. Having established earlier the appropriate lag length to be four, we proceed to determine the number of cointegrating equations.

Table 4.6: Johansen Cointegration test results

Johansen tests for cointegration
Trend: none Number of observations=33
Sample: 1987 – 2019 Lag=4

Maximum Ranks	**Parms**	**LL**	**eigenvalue**	**trace statistic**	**5% critical value**	**1% critical value**
0	108	-474.05623		435.8647	82.49	90.45
1	119	-393.30651	0.99251	274.3653	59.46	66.52
2	128	-329.09202	0.97959	145.9363	39.89	45.58
3	135	-293.96811	0.88101	75.6885	24.31	29.75
4	140	-269.6454	0.77102	27.0431	12.53	16.31
5	143	-257.61935	0.51754	2.9910*1*5	3.84	6.51
6	144	-256.12385	0.08665			
Maximum Ranks	**Parms**	**LL**	**eigenvalue**	**max statistic**	**5% critical value**	**1% critical value**
0	108	-474.05623		161.4994	36.36	41.00
1	119	-393.30651	0.99251	128.4290	30.04	35.17
2	128	-329.09202	0.97959	70.2478	23.80	28.82
3	135	-293.96811	0.88101	48.6454	17.89	22.99
4	140	-269.6454	0.77102	24.0521	11.44	15.69
5	143	-257.61935	0.51754	2.9910	3.84	6.51
6	144	-256.12385	0.08665			

Source: Author (2021)

When the trace statistic is smaller than the critical value, we accept the null hypothesis of no cointegration. From the table of Cointegration above we determine our series to have a cointegration rank of order five that is they are cointegrating equations since the trace statistics at r=5 of 2.9910 is less than its critical value of 3.84 at 5% critical value and 6.51 at 1% critical value we reject the null hypothesis. The results show that there is cointegrating vector and eventually there exist a long run relationship between the manufacturing performance and energy consumption. Hence a vector error correction model needs to be estimated.

4.3.4 Test for Adequacy of the Model

Pilot Ordinary least square model is estimated as adequacy of the model without factoring in time series and discuss the aptness of using such models which previous studies have used to draw conclusion. The results are Table 4.6.

Table 4.7: Ordinary least square analysis results

Manufacturing sector performance	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Renewable Energy Consumption	0.336	0.339	0.99	0.329	-0.353	1.025	
Non-renewable energy consumption	0.223	0.335	0.67	0.510	-0.458	0.905	
Energy Price	-0.009	0.009	-0.93	0.358	-0.028	0.010	
Trade Openness	-0.041	0.026	-1.58	0.123	-0.093	0.012	
Real Gross Fixed capital	0.676	0.238	2.83	0.008	0.191	1.160	***
Constant	-38.882	31.818	-1.22	0.230	-103.543	25.779	

Mean dependent var	3.143	SD dependent var	2.538
R-squared	0.306	Number of obs	40.000
F-test	2.991	Prob > F	0.024
Akaike crit. (AIC)	184.423	Bayesian crit. (BIC)	194.557

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Author (2021)

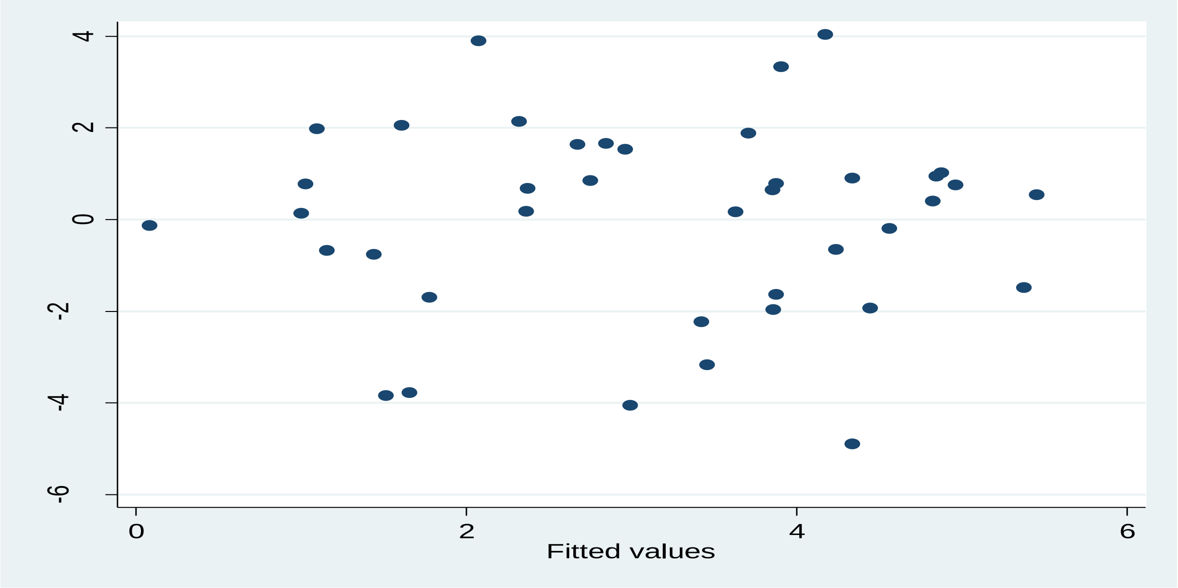
The results of the regression model coefficients were inconsistent with the theoretical expectation except for real gross fixed capital in term of the significancy of the coefficients resulting to model specification problem. Consequently, we sought to investigate the adequacy of the fitted regression model using model diagnostic tests.

To test for adequacy of the model, we checked whether the assumptions of OLS estimates have been met through use of residual analysis. The OLS assumption estimates that the predicted residuals are random, linear relationship between dependent and independent variables, no serial correlation among the residuals and homoscedasticity of residuals.

4.3.4.1 Normality test

The test of multivariate normality (mvtest normality residuals) reveals that there is violation of normality test with chi square (2) of 3.086 and P-value of 0.02137. Further histograms for the residuals were used to examine normality while scatter plots were used to check the linearity assumption. In addition, the residual plot for the residual value over fitted values to inspect the randomness of the residuals. If the model is a good fit, the residual plot should not have any apparent pattern. The residual plot shown in figure 4.1 indicates lack of fit.

Figure 4.1: Residual plots graph for test of normality



Source: Author (2021)

4.3.4.2 Test for Serial Correlation and Heteroscedasticity

Durbin Watson test is used to check for serial correlation of the residuals after differencing and before differencing the variable values. Durbin Watson test was conducted to examine for serial correlation of the regression residuals. Null hypothesis no differencing autocorrelation, under null no serial correlation d=2. The d statistic after differencing is 3.181462 within the 5% level of significant bound. Testing before differencing under null d=2. Given 40 observations and 5 regressors, the 5% bound is at 0.9343. The Durbin Watson d statistic of 1.9707 and 3.181464 was far from center of distribution and hence concluded there is a problem of serial correlation. This was mitigated by differencing the variables to third difference.

Next Breusch-Pagan test investigated the data for residual variance stability. When variance of residuals is not constant, there is a problem of heteroscedasticity. We used the Breusch-Pagan test to assess the null hypothesis that residuals have constant variance. The results of the homoscedasticity and autocorrelation tests are presented in table 4.7. From the results, we rejected the null hypothesis since $p<0.05$ and concluded that the residuals were homoscedastic.

Table 4.8: Result of serial correlation and heteroscedasticity

Durbin Watson d-Statistic	Breusch-Pagan Test
(4.72) = 3.181462	Chi2(1) = 14.645 Prob > chi2 = 0.0001
H_0: No autocorrelation.	H_0: No Heteroscedasticity.

Source: Author (2021)

4.3.4.3 Model specification tests.

The ordinary least square method will result to specification error indicted in the result of Ramsey RESET test where Ho: model has no omitted variable. The P-value of the Ramsey test is 0.9918 with an F-statistic (3, 31) of 0.03. Thus, reject null hypothesis since P-Value is greater than 5% level of significance.

The regression output in Table 4.5 indicates the data was normally distributed, it is evident that the residual plots indicate instability in the variance and autocorrelation of errors. This compromises the aptness of fitting a regression model to data of this nature. Moreover, we observe that the data is time series, and a regression model fails to capture the dynamic variability of such data. Additionally, non-stationarity problems may cause spurious regression. Given these inadequacies, we decided to fit time series models that are more robust in capturing the dynamic structure of time series data.

4.4 Empirical Results

The result of vector error correction model was used to discuss the result for both the short run and long run. Having determined that series are of order three I (3) and the rank of five, in such a case the suitable action is to fit VEC models which will be able to capture both short-term and long-term relationships of the variables. At the long term we will examine the speed of convergence of each variable.

Table 4.9: Short Run VEC model results

Vector error-correction model
Sample: 1984-2019 Number of observations = 36
AIC =26.18362
Log likelihood =-322.3051 HQIC =28.47114
Det(sigma_ml) =2.407472 SBIC =32.73763

Equation	Parms	RMSE	R-sq	Chi2	P>chi2
D_Manufacturing	24	2.42067	0.7526	36.49642	0.0491
D_Renewable energy	24	1.02878	0.7877	44.5246	0.0066
D_Nonrenewable energy	24	1.01211	0.6954	27.40172	0.2861
D_Energy prices	24	4.3519	0.8836	91.05818	0.0000
D_Trade openness	24	16.7723	0.8341	60.32069	0.0001
D_Real Gross Fixed Capital	24	1.0693	0.8681	78.96018	0.0000

Source: Author (2021)

In long run the dependent and independent variables are endogenous in the model; manufacturing sector also explains performance of itself through the lagged differences. The results in Table 4.7 indicate eventually the speed of cointegration and convergence toward equilibrium in the long run energy price will not converge in the future with a P value of 0.0760 against the 1% significant level but at 5% significant level it will converge showing causality between the manufacturing sector and energy prices.

Table 4.10: Johansen normalization restriction Results

Beta	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
D2LogManfuacturingperformance	1	.	.	.	.	
D2LogRenewableEnergy	7.3033	1.4703	4.9700	0.0000	31.2234	21.611
D2LogNonrenewableenergy	1.9938	0.9098	2.1900	0.0340	5.27925	1.2897
D2LogEnergyPrice	-0.1114	0.0612	-1.8200	0.0760	-0.94723	1.2251
D2LogTradeOpennes	0.7164	0.4561	1.5700	0.1240	1.43207	0.3124
D2LogRealGrossFixedcapital	0.3829	0.1564	2.4500	0.0190	13.70686	16.0558
Cons	0.67112	.	.	.	.	

Source: Author (2021)

Table 4.11: Speed of Cointegrating equations

Beta	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
L._ce1	-5.084	0.786	-6.47	0.000	-6.624	-3.544	***
L._ce2	4.550	1.965	2.32	0.021	0.699	8.401	**
L._ce3	-2.299	2.023	-1.14	0.256	-6.265	1.667	
L._ce4	1.679	0.465	3.61	0.000	0.767	2.590	***
L._ce5	-0.421	0.111	-3.78	0.000	-0.640	-0.203	***

Source: Author (2021)

4.4.1 Effect of Renewable energy consumption on manufacturing

Examining the individual variable on the VECM model with lag (4) the result at the short run, the lag of manufacturing performance, renewable energy and energy prices Trade openness and capital stock are statistically significant in explaining the relationship of manufacturing performance. This means that a change in renewable energy leads to a significant change in the manufacturing performance as shown by the significant t-values and p-values at 5% critical value.

The theoretical expectation of the model Root Mean Square Error (RMSE) presented in Figure 4.3 implies that the renewable energy residual spread concentrated near the line of fit indicating causal relationship between the renewable energy and manufacturing. The direction of the relationship in short run is positive. The result is consistent with Silva, Soares, and Pinho (2012) findings using SVAR calculation showed that the growing RES-E share had per capita GDP costs for all countries in the study, apart from the USA. There was also a noticeable decline in per capita CO2 emissions implying a positive externality from renewable energy consumption in the short run.

A unit change in renewable energy will result into an increase in the manufacturing sector by 7.3033 margins showing a statistically significant, explaining the casualty with a P- Value of 0.000 while nonrenewable energy was found to be positive and statistically significant with a P- Value of 0.0340. Energy price was found to have a negative and insignificant effect on the performance of manufacturing sector with a p-value of 0.0760, trade openness has a positive statistically insignificant with a p-value of 0.1240. Further trade openness coefficient indicates that there will be less reliance of external commodities due to well performing manufacturing sector with a 0.7164 value. Finally, the results show that there existed a positive and significant relationship between real gross fixed capital and performance of manufacturing sector with a p-value of 0.0190. The result on gross fixed capital implies that a unit improvement in gross fixed capital results in an increase in the performance of the manufacturing sector by 0.3829 units.

4.4.2 Effect of Non-renewable energy consumption on manufacturing

The short run results from the VEC estimation are that present values of manufacturing performance, renewable energy, energy prices, trade openness and capital are important in explain the relationship with their lagged values and performance of manufacturing sector performance. All the variables are statistically significant with a P-Value of 0.0000 except for non-renewable energy consumption indicating statistically insignificant with a P-Value of 0.2861 in figure 4.3. Which implies Non-renewable energy sources diminish over time, are non-replenishable which are finite and exhaustible. In addition, they produce $C0_2$ which are climatic unfriendly, increased advocacy of green climate and consumption of clean energy. The result is consistent with Kang, Islam, and Tiwari (2019) findings that NRES growth rate had a negatively affected on GDP growth rate as well as increased CO2 emissions. RES ' relationship with GDP growth rate is found to be positive.

In long term, the cointegrating equation beta of non-renewable consumption and trade openness on the manufacturing sector performance decreases or converges, implying a negative interaction with the manufacturing sector, which means that a rise in non-renewable energy consumption would result in a shift in the cost of production technology, thereby decreasing production output performance. Further trade openness is not statistically significant in the short run but significant eventually in the long run. Non-renewable consumption on performance of manufacturing sector exhibits a bi-directional causality. Kahia, Aïssa and Charfeddine (2016) results demonstrate bidirectional causality between the consumption of non-renewable energy and economic growth both in the short and long run. This study adopted panel data methodology while the current study adopted time series.

4.5 Post estimation analysis

Post estimation test to verify the robustness of the model in the modelling of the relationship between manufacturing performance and energy consumption is conducted. First, we check for autocorrelation in residuals of VECM using the Langrage multiplier test.

4.5.1 Autocorrelation test

Table 4.12: Lagrange multiplier Autocorrelation test results

Lag	**Chi2**	**Df**	**Prob>Chi2**
1	95.8674	36	0.00000
2	91.5159	36	0.00000

H_0: No autocorrelation at lag order.

Source: Author (2021)

The p-value at lag one and two is less than 0.05. Therefore, the null hypothesis was rejected, and the alternative hypothesis adopted that there is no autocorrelation at lag order 1 and 2.

4.5.2 Normality test

Table 4.13 Jarque-Bera Normality test

Equation	**Chi2**	**Df**	**Prob>Chi2**
D_D2Manfuacturingperformance	2.968	2	0.22677
D_D2RenewableEnergy	5.248	2	0.07252
D_D2Nonrenewableenergy	5.345	2	0.06909
D_D2EnergyPrice	3.435	2	0.17953
D_D2TradeOpennes	0.911	2	0.63410
D_D2RealGrossFixedcapital	1.152	2	0.56228
ALL	19.057	12	0.08716

Source: Author (2021)

All probabilities are above 5% significant level hence we reject Ho and conclude that all the series all the equations are normally distributed.

4.5.3 Eigen Stability Condition

The stability status of the VECM estimates is then examined. After fitting the VECM, the variables are expected to be stationary covariance. The VECM does not meet the stability criterion. Although the module with each own value is not explicitly less than one, the approximate model is unstable as seen in the table below. The non-stationary model associated to the VECM should have unstable roots, but its companion stationary representation should have stable roots. If we say that this companion model has unstable roots, then we make invalid assumptions about the stationarity of at least one of variable's transformations (say its first difference or its second difference).

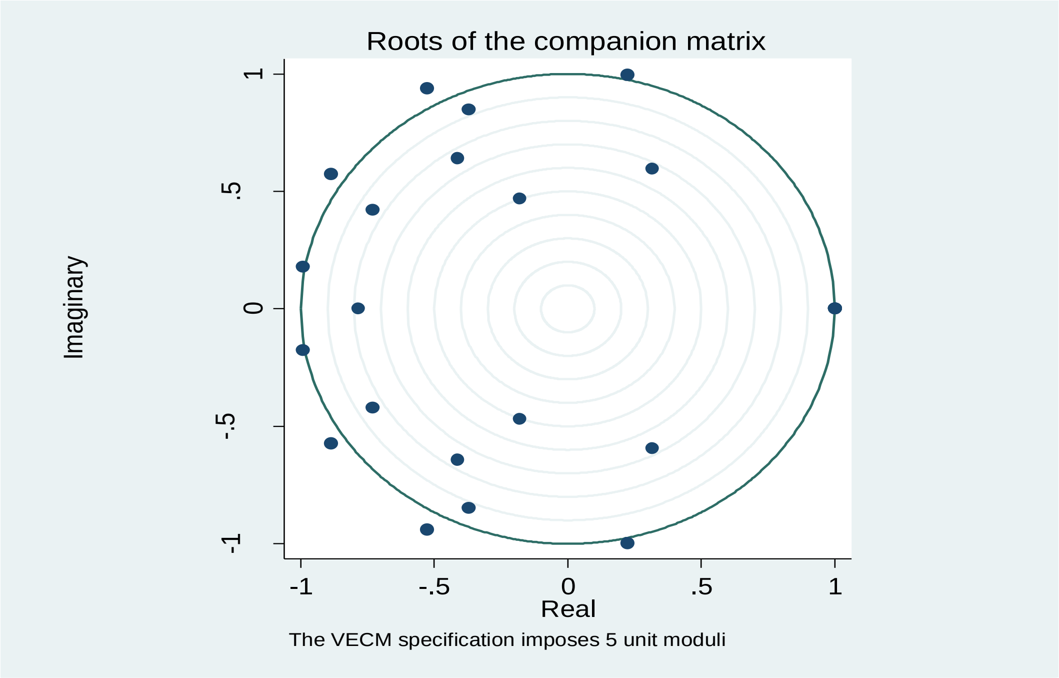
Table 4.14: Check Stability of Variance

Eigen value	Modulus
-.5269968, + .9391426i	1.0769
-.5269968, - .9391426i	1.0769
-.8881017, + .5735724i	1.05722
-.8881017, - .5735724i	1.05722
.2244707, + .9969588i	1.02192
.2244707, - .9969588i	1.02192
-.9933965, + .1776803i	1.00916
-.9933965, - .1776803i	1.00916
1	1
1	1
1	1
1	1
1	1
-.3708267, + .8483937i	0.925896
-.3708267, - .8483937i	0.925896
-.7311275, + .4210312i	0.843691
-.7311275, - .4210312i	0.843691
-0.7837139	0.783714
-.4123421, + .6410742i	0.762235
-.4123421, - .6410742i	0.762235

.3176481, + .5949094i	0.674402
.3176481, - .5949094i	0.674402
-.1793372, + .4688247i	0.501955

Source: Author (2021)

Figure 4.2: Root of the companion matrix stability of the model



Source: Author (2021)

5-unit moduli and eigen values lie inside the unit circle thus VECM is unstable. The impulse response functions cannot be estimated since the model is unstable which will result to unknown interpretations.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

The chapter addresses discussions and conclusions based on the study findings, recommendations, and areas for further research.

5.2 Summary

This study was motivated by the fact that there is a common belief that manufacturing firm's performance are affected by the energy consumption which is vital in the production process and competing advantage especially for energy and capital-intensive firm. The main objective of this was to study the effect of energy consumption on performance of manufacturing sector in Kenya. To achieve this objective, time series data were collected from 1980 to 2019. Data were evaluated for stationarity and then analyzed using inferential statistics. The specific objectives of the study were to determine the long run or short run relationship between the energy consumption and the performance of manufacturing and to determine the causal linkage between the two variables.

The study employed Vector Auto-regression model. The rationale for using VECM is that it is possible to simulate the reaction over time of the own disturbance of the variable and the disturbance of the other variables in a system of equations. To establish the long run relationship, the study employed the Johansen cointegration test and the Granger causality was used to determine the cause-and-effect relationship between the two variables. The findings revealed that there was cointegrating vector and eventually there existed a long run relationship between the manufacturing performance and energy consumption.

The findings of the analysis revealed that a unit change in renewable energy will result into an increase in the manufacturing sector by 7.3033 margins showing a statistically significant, explaining the casualty with a P- Value of 0.000 while nonrenewable energy was found to be positive and statistically significant with a P- Value of 0.0340. Energy price was found to have a negative and insignificant effect on the performance of manufacturing sector with a p-value of 0.0760, trade openness has a positive statistically insignificant with a p-value of 0.1240. Further trade openness coefficient indicates that there will be less reliance of external commodities due to well performing manufacturing sector with a 0.7164 value. Finally, the results show that there existed a positive and significant relationship between real gross fixed capital and performance of manufacturing sector with a p-value of 0.0190. The result on gross fixed capital implies that a unit improvement in gross fixed capital results in an increase in the performance of the manufacturing sector by 0.3829 units.

5.3 Conclusions

A Vector Error Correction Model (VECM) with four lags was estimated and results analyzed. The empirical results established that for manufacturing firm utilize more of renewable energy than non-renewable. This is backed by the production process is capital intensive and efficiency which increases but the incremental energy consumption decreases for both renewable energy and non-renewable energy in the short run. However, the energy price is statistically insignificant in short term and long run implying inefficient energy market characterized by may distortions which include international fuel prices, imports and exports regimes policy for energy, immobility of energy resources such as hydro, solar, and tidal waves. This is contrary to common knowledge that energy consumption increases with increase in production as opposed to technological efficiency.

The positive response of renewable energy to a shock on the manufacturing sector performance could be because of the advocacy on the green energy debates and current international clean energy subsidies. Kenya was awarded 100million energy credit incentive program by United Nations because if the renewable energy mix being higher than non-renewable thus reduction of pollution. Such environmentally friendly generation have positive impact directly to the manufacturing sector performance on the sustainability reporting on the individual financial statement. The trend of renewable energy has been incremental over time but very stable

(Mwakubo et al., 2007) renewable growth is characterized by rising demand, increased electricity prices, increasing global fossil fuel costs, and environmental activism.

The study established a weak positive linkage between trade openness and manufacturing performance of firms. Imports destroy domestic firms while increased competitiveness is harnessed by increased exports. Such that in energy efficiency nation and well-developed energy market, manufacturing form thrives and the country product competitiveness increases. The find was also supported by Kahia, Aïssa and Charfeddine (2016) showed short-run also long-run bidirectional and unidirectional causality from economic growth to renewable energy use, respectively.

Energy price trends are incremental over time and series is recursive. Further analysis of the model result to instability as indicated by the unit circle and a module of more than one. In depth insight still reveals at long run the speed of cointegration is divergence hence no equilibrium thus implying volatility and instability of the energy market. This problem will be addressed by policy change in electricity pricing tariff in Kenyan energy sector and liberalization of the sector form monopoly to perfect competition model with supply and demand determining the energy tariffs.

5.4 Policy Recommendations.

The key policy intervention to alleviate the challenges facing energy markets in term of fluctuation of supply as shown in the trends. Renewable energy instability needs investment and deployment of storage technology especially during excess energy supply and smart grid system to regulate supply and demand at point of metering.

In addition, the findings depict a bi-directional relationship between the non-renewable energy consumption and output efficiency in short and long term. Further, there are measures and policies that need to be implemented by the authorities to advocate usage of clean and sustainable energy, such as the establishment of several important regional institutions and cooperation, renewable energy generation tax credits and rebates.

5.5 Contribution to Knowledge

In this analysis, we examined the energy consumption relationship and production efficiency in Kenya using time series data. First, we used the root test unit to ascertain the stationarity of the data set. Results indicate that the data of the variables are non-stationary and integrated of order four. Then we applied the Johansen Cointegration test to determine the long run relationship between the two variables. Results indicate that there is a cointegrating interaction, that there is a long-term co-movement between research variables. In the presence of a long-term relationship, we used the VECM test to assess the causal relationship between energy use and output in the manufacturing sector.

Results indicate that renewable energy had bidirectional relationship with manufacturing performance in short and long run. This implies that their performance of manufacturing sector can be determined by the efficiency technology deployed that utilized the renewable energy. Lastly, we sought to investigate the response of non-renewable energy to a standard deviation shock on the manufacturing sector performance using the VECM model. Results indicate a weak positive relationship between energy prices and trade openness in the model depicting energy and commodity markets inefficiency, while a strong long run relationship between renewable and capital with manufacturing performance sector.

5.6 Areas for Further Research

However, based on the results of this analysis, variables are stable based on historical values for other variables. Therefore, there is a chance of improving the manufacturing performance by consumption of renewable energy in a more efficiency manager using a capital-intensive technology. The study makes recommendations to researchers to look at firm level to investigate the implication of renewable energy on total output productivity factor. In addition, suggested areas for further research include identification of other factors such as energy storage influence on demand and supply of renewable energy for future generation. Also changing tends on investment models deployed in energy sector.

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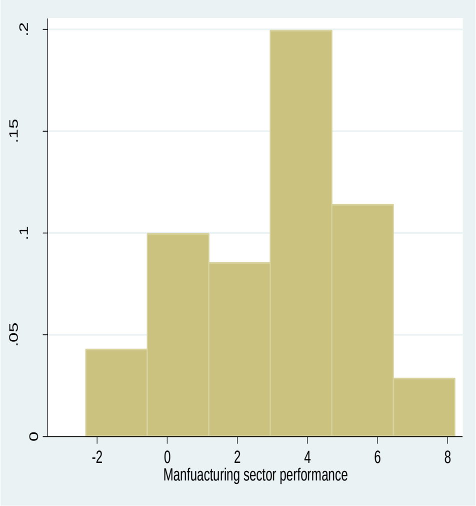
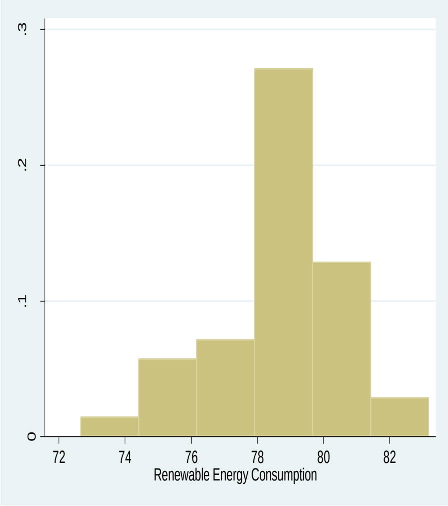
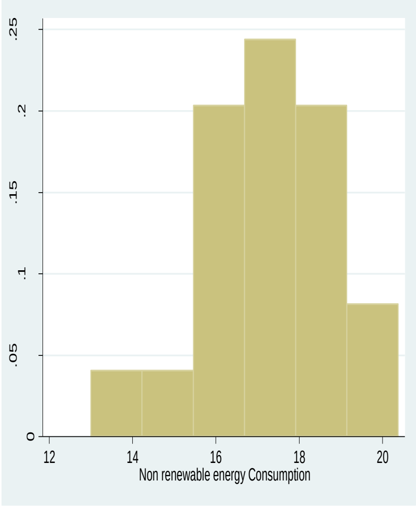
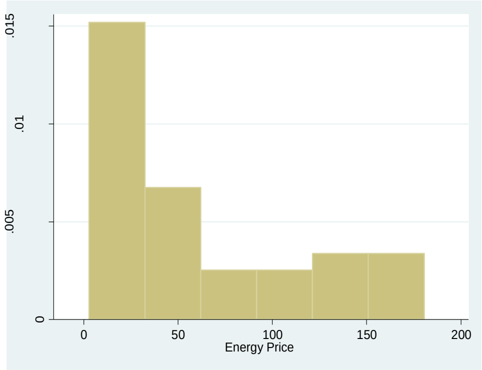
APPENDICES

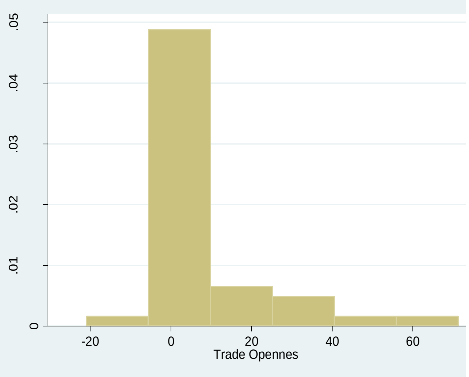
Appendix 1: Histograms Raw Data

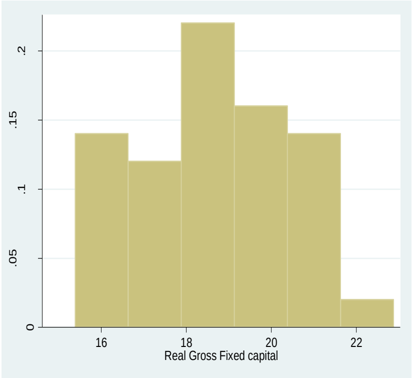












Appendix 2: Transformed Series Histogram Plots to Show Normality

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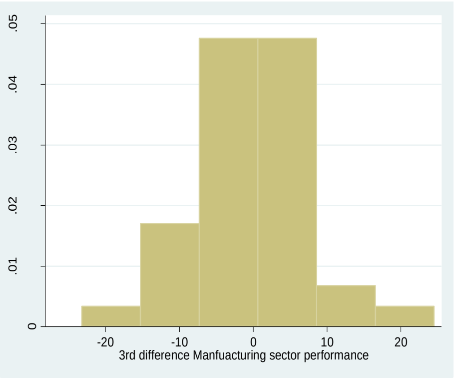
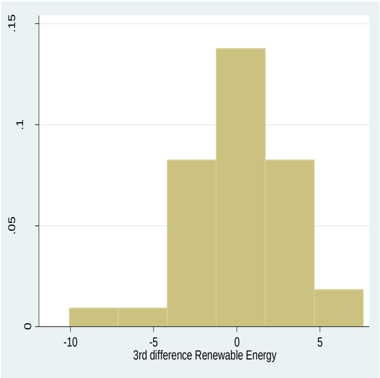
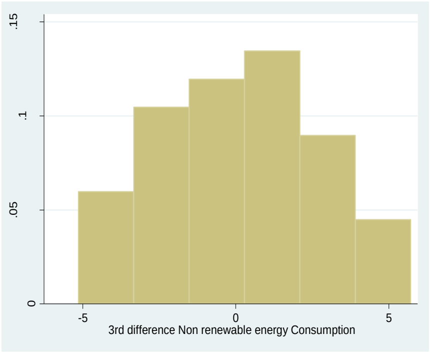
<td> </td>
<td> </td>
<td> </td>
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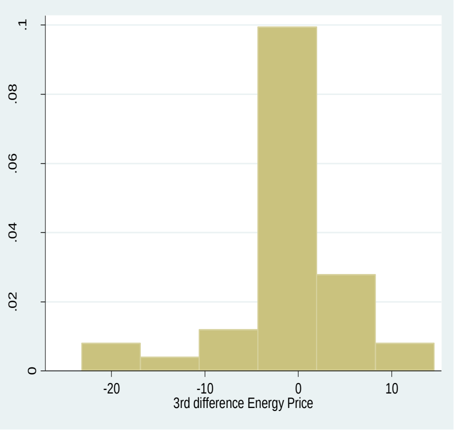
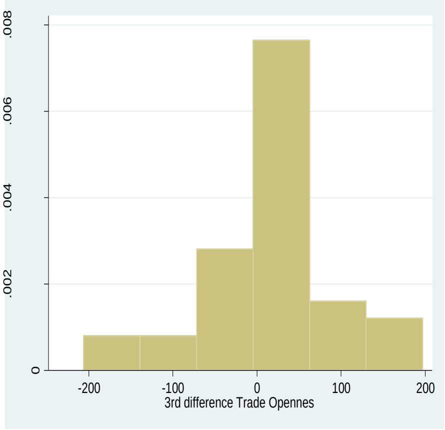
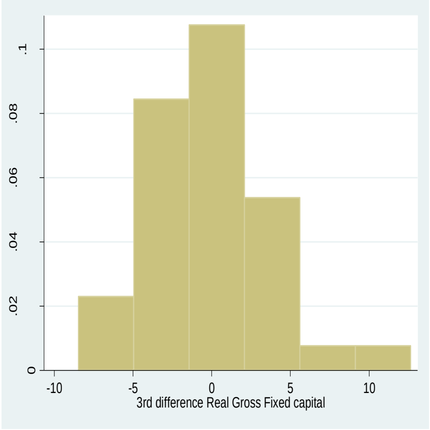
<td> </td>
<td> </td>
<td> </td>
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Appendix 3: Time series graphs before and After Differencing

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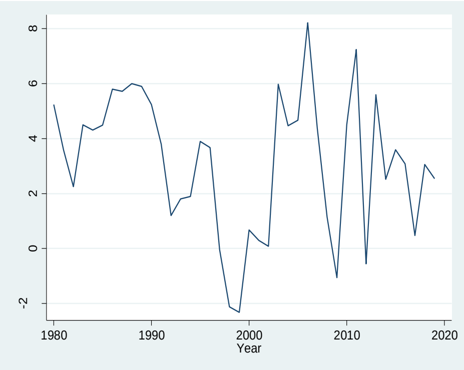

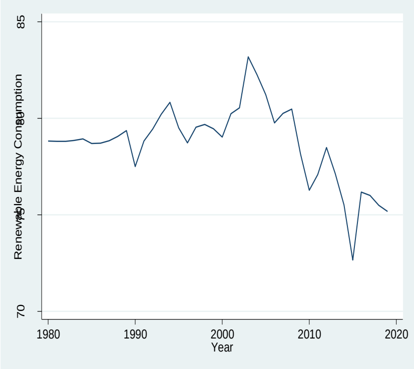

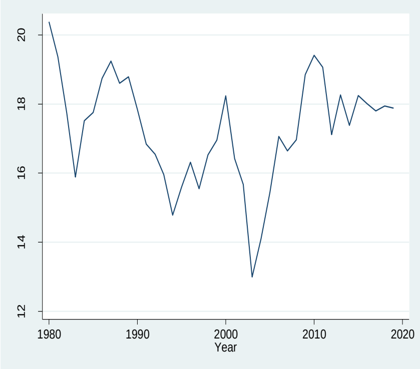

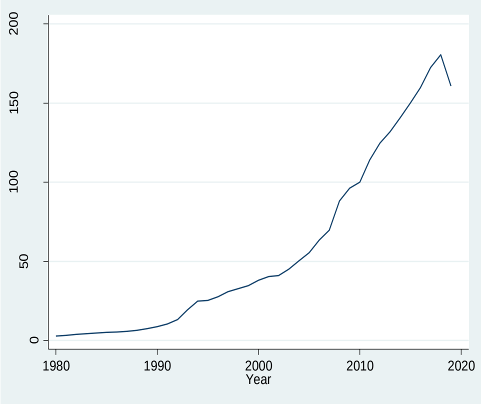

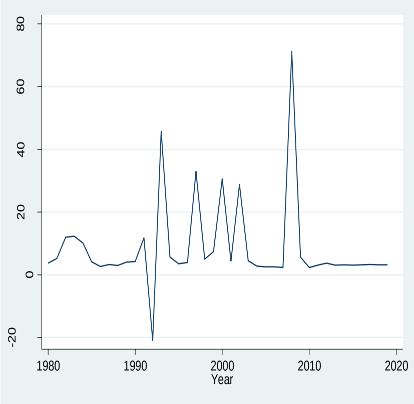

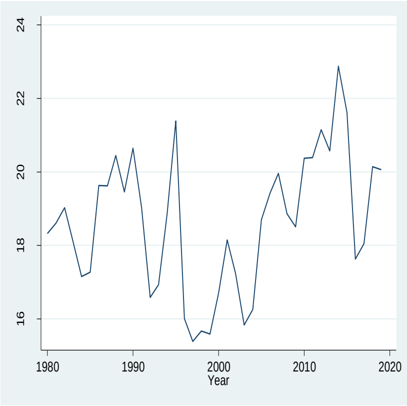

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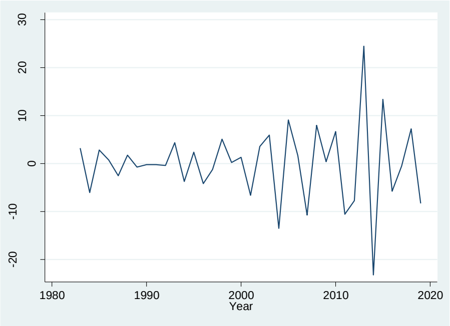
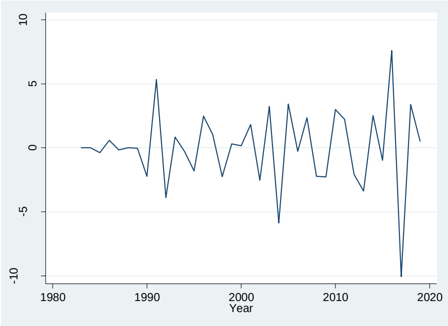
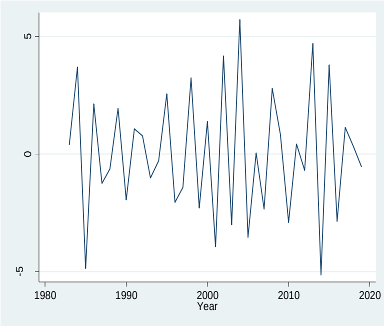
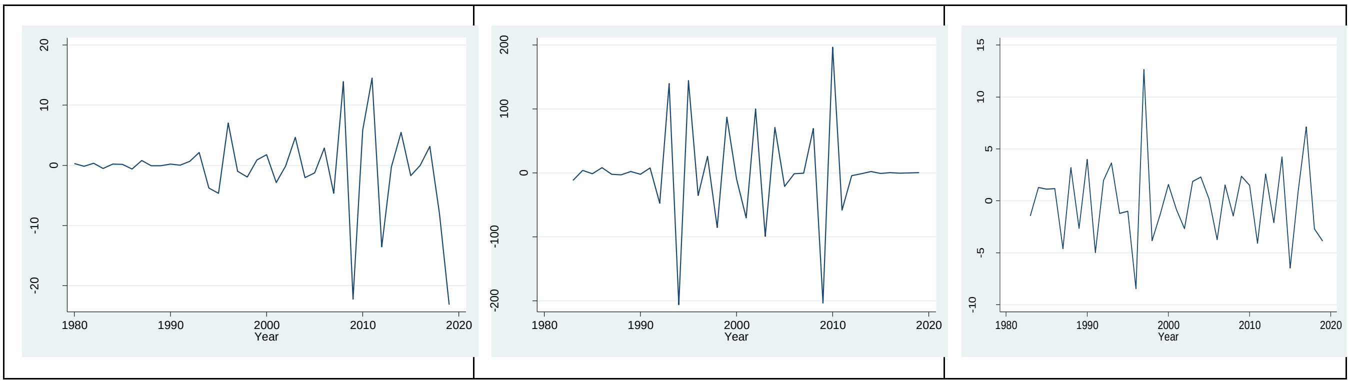


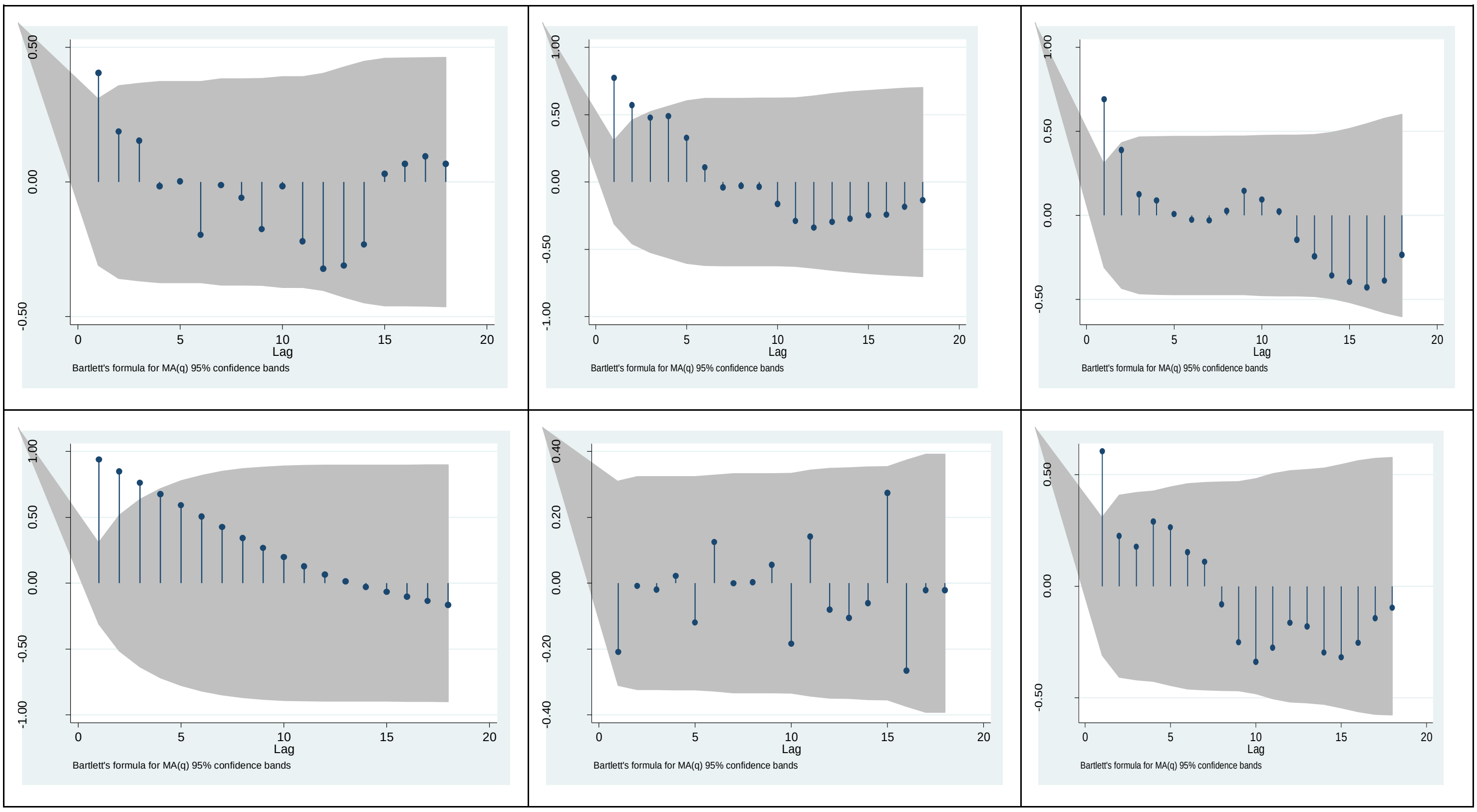




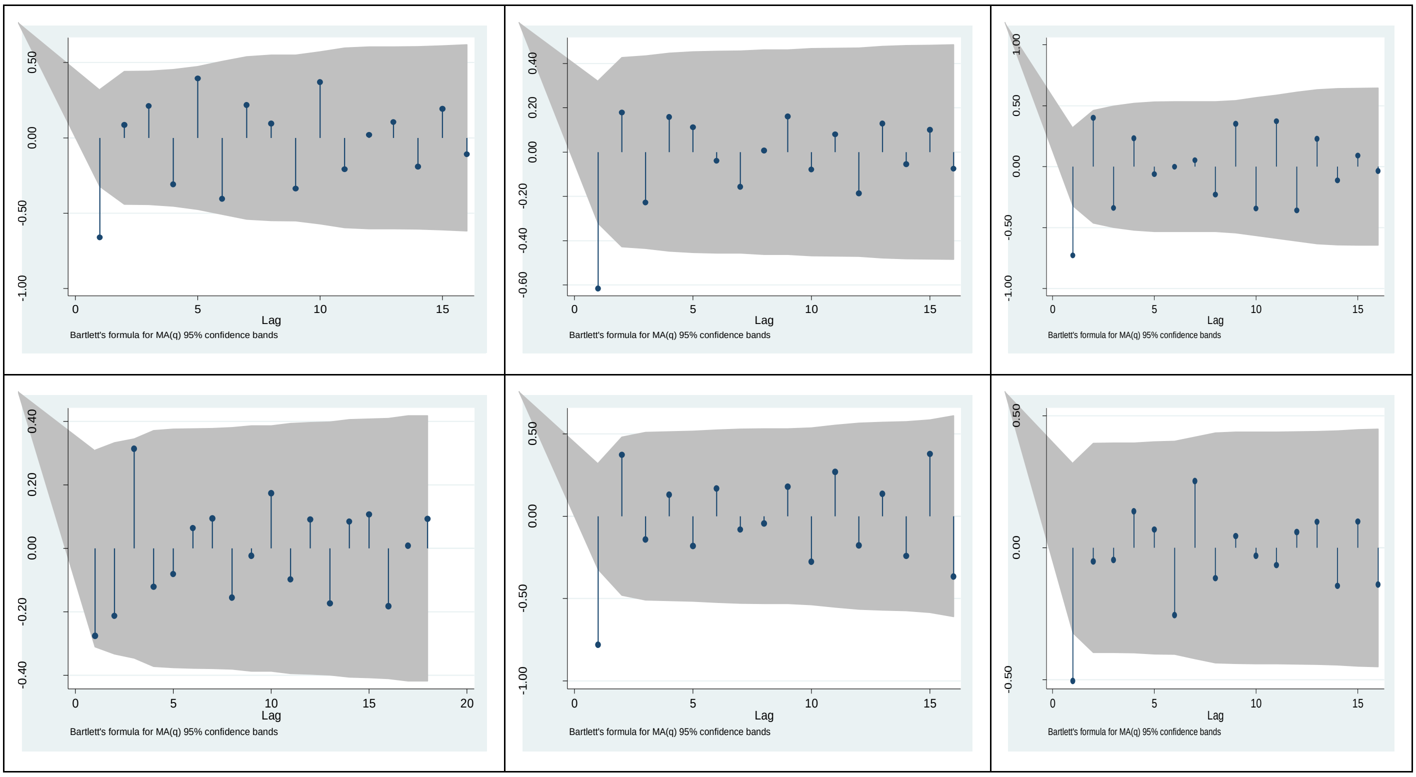


Appendix 4: Correlograms Before and After Differencing

Before



After



Appendix 5: Output of Vector error Correction model result

Vector error-correction model

	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
L._ce1	-5.084	0.786	-6.47	0.000	-6.624	-3.544	***
L._ce2	4.550	1.965	2.32	0.021	0.699	8.401	**
L._ce3	-2.299	2.023	-1.14	0.256	-6.265	1.667	
L._ce4	1.679	0.465	3.61	0.000	0.767	2.590	***
L._ce5	-0.421	0.111	-3.78	0.000	-0.640	-0.203	***
LD. D2Manfuacturing~e	2.611	0.650	4.02	0.000	1.338	3.884	***
L2D.D2Manfuacturin~e	0.781	0.423	1.85	0.064	-0.047	1.610	*
L3D.D2Manfuacturin~e	-0.137	0.203	-0.68	0.498	-0.535	0.260	
LD. D2RenewableEnergy	-4.259	1.834	-2.32	0.020	-7.853	-0.665	**
L2D.D2RenewableEne~y	-3.762	1.539	-2.44	0.014	-6.777	-0.746	**
L3D.D2RenewableEne~y	-3.910	1.002	-3.90	0.000	-5.875	-1.945	***
LD. D2Nonrenewablee~y	-0.344	2.010	-0.17	0.864	-4.284	3.596	
L2D.D2Nonrenewable~y	-0.765	1.531	-0.50	0.618	-3.766	2.236	
L3D.D2Nonrenewable~y	-0.997	0.716	-1.39	0.163	-2.400	0.405	
LD. D2EnergyPrice	-1.456	0.393	-3.71	0.000	-2.225	-0.687	***
L2D.D2EnergyPrice	0.509	0.450	1.13	0.259	-0.374	1.391	

L3D.D2EnergyPrice	0.245	0.206	1.19	0.234	-0.158	0.649	
LD. D2TradeOpennes	0.349	0.092	3.79	0.000	0.168	0.529	***
L2D.D2TradeOpennes	0.053	0.073	0.72	0.473	-0.091	0.197	
L3D.D2TradeOpennes	-0.082	0.042	-1.94	0.052	-0.165	0.001	*
LD. D2RealGrossFixe~l	-1.146	0.689	-1.66	0.096	-2.495	0.204	*
L2D.D2RealGrossFix~l	-0.676	0.482	-1.40	0.160	-1.620	0.268	
L3D.D2RealGrossFix~l	-0.665	0.296	-2.25	0.025	-1.245	-0.085	**
Constant	0.089	0.392	0.23	0.820	-0.678	0.857	
L._ce1	0.462	0.400	1.16	0.248	-0.321	1.246	
L._ce2	-5.238	1.000	-5.24	0.000	-7.197	-3.279	***
L._ce3	-1.176	1.030	-1.14	0.253	-3.194	0.842	
L._ce4	-1.070	0.237	-4.52	0.000	-1.534	-0.607	***
L._ce5	0.131	0.057	2.31	0.021	0.020	0.242	**
LD. D2Manfuacturing~e	-0.228	0.331	-0.69	0.490	-0.876	0.420	
L2D.D2Manfuacturin~e	-0.033	0.215	-0.15	0.878	-0.454	0.389	
L3D.D2Manfuacturin~e	0.011	0.103	0.10	0.918	-0.192	0.213	
LD. D2RenewableEnergy	2.990	0.933	3.21	0.001	1.162	4.819	***
L2D.D2RenewableEne~y	2.161	0.783	2.76	0.006	0.627	3.695	***
L3D.D2RenewableEne~y	0.818	0.510	1.60	0.109	-0.181	1.818	
LD. D2Nonrenewablee~y	0.689	1.023	0.67	0.501	-1.316	2.694	
L2D.D2Nonrenewable~y	0.473	0.779	0.61	0.544	-1.054	2.000	
L3D.D2Nonrenewable~y	0.339	0.364	0.93	0.351	-0.374	1.053	
LD. D2EnergyPrice	0.709	0.200	3.55	0.000	0.318	1.101	***
L2D.D2EnergyPrice	0.518	0.229	2.26	0.024	0.069	0.967	**
L3D.D2EnergyPrice	0.243	0.105	2.32	0.021	0.037	0.448	**
LD. D2TradeOpennes	-0.086	0.047	-1.85	0.065	-0.178	0.005	*
L2D.D2TradeOpennes	-0.040	0.037	-1.06	0.290	-0.113	0.034	
L3D.D2TradeOpennes	-0.019	0.022	-0.89	0.373	-0.061	0.023	
LD. D2RealGrossFixe~l	0.394	0.350	1.12	0.261	-0.293	1.080	
L2D.D2RealGrossFix~l	0.391	0.245	1.60	0.110	-0.089	0.871	
L3D.D2RealGrossFix~l	0.296	0.150	1.97	0.049	0.001	0.591	**
Constant	0.270	0.199	1.36	0.175	-0.120	0.661	
L._ce1	-0.473	0.294	-1.61	0.107	-1.049	0.102	
L._ce2	1.288	0.734	1.75	0.080	-0.152	2.727	*
L._ce3	-1.789	0.756	-2.37	0.018	-3.271	-0.306	**
L._ce4	0.181	0.174	1.04	0.298	-0.160	0.522	
L._ce5	-0.059	0.042	-1.42	0.155	-0.141	0.022	
LD. D2Manfuacturing~e	0.312	0.243	1.28	0.199	-0.164	0.788	
L2D.D2Manfuacturin~e	0.147	0.158	0.93	0.352	-0.163	0.457	

L3D.D2Manfuacturin~e	0.119	0.076	1.56	0.118	-0.030	0.267	
LD. D2RenewableEnergy	-0.882	0.685	-1.29	0.198	-2.226	0.461	
L2D.D2RenewableEne~y	-0.899	0.575	-1.56	0.118	-2.026	0.228	
L3D.D2RenewableEne~y	-0.130	0.375	-0.35	0.728	-0.865	0.604	
LD. D2Nonrenewablee~y	0.558	0.751	0.74	0.457	-0.914	2.031	
L2D.D2Nonrenewable~y	0.370	0.572	0.65	0.518	-0.752	1.492	
L3D.D2Nonrenewable~y	0.264	0.267	0.99	0.323	-0.260	0.788	
LD. D2EnergyPrice	0.217	0.147	1.48	0.140	-0.071	0.504	
L2D.D2EnergyPrice	0.124	0.168	0.74	0.462	-0.206	0.454	
L3D.D2EnergyPrice	0.075	0.077	0.97	0.333	-0.076	0.225	
LD. D2TradeOpennes	0.013	0.034	0.37	0.708	-0.055	0.080	
L2D.D2TradeOpennes	-0.008	0.027	-0.28	0.777	-0.062	0.046	
L3D.D2TradeOpennes	0.005	0.016	0.32	0.749	-0.026	0.036	
LD. D2RealGrossFixe~l	-0.204	0.257	-0.79	0.427	-0.709	0.300	
L2D.D2RealGrossFix~l	-0.233	0.180	-1.29	0.196	-0.586	0.120	
L3D.D2RealGrossFix~l	-0.043	0.111	-0.39	0.694	-0.260	0.173	
Constant	-0.045	0.146	-0.31	0.758	-0.332	0.242	
L._ce1	-1.721	1.431	-1.20	0.229	-4.525	1.083	
L._ce2	-5.785	3.577	-1.62	0.106	-12.796	1.226	
L._ce3	-2.593	3.684	-0.70	0.482	-9.813	4.628	
L._ce4	-0.768	0.847	-0.91	0.364	-2.428	0.891	
L._ce5	0.046	0.203	0.23	0.822	-0.352	0.443	
LD. D2Manfuacturing~e	1.619	1.183	1.37	0.171	-0.699	3.938	
L2D.D2Manfuacturin~e	1.551	0.770	2.02	0.044	0.043	3.060	**
L3D.D2Manfuacturin~e	0.962	0.370	2.60	0.009	0.238	1.686	***
LD. D2RenewableEnergy	6.838	3.339	2.05	0.041	0.294	13.382	**
L2D.D2RenewableEne~y	6.536	2.801	2.33	0.020	1.046	12.026	**
L3D.D2RenewableEne~y	3.643	1.825	2.00	0.046	0.065	7.220	**
LD. D2Nonrenewablee~y	3.407	3.660	0.93	0.352	-3.767	10.580	
L2D.D2Nonrenewable~y	3.118	2.788	1.12	0.263	-2.346	8.582	
L3D.D2Nonrenewable~y	1.729	1.303	1.33	0.184	-0.824	4.282	
LD. D2EnergyPrice	-0.980	0.715	-1.37	0.170	-2.380	0.421	
L2D.D2EnergyPrice	-1.271	0.820	-1.55	0.121	-2.877	0.336	
L3D.D2EnergyPrice	-0.187	0.375	-0.50	0.618	-0.922	0.548	
LD. D2TradeOpennes	-0.008	0.168	-0.05	0.960	-0.337	0.320	
L2D.D2TradeOpennes	0.045	0.134	0.34	0.737	-0.217	0.307	
L3D.D2TradeOpennes	0.014	0.077	0.18	0.856	-0.137	0.165	
LD. D2RealGrossFixe~l	0.448	1.254	0.36	0.721	-2.009	2.905	
L2D.D2RealGrossFix~l	0.311	0.877	0.35	0.723	-1.408	2.029	

L3D.D2RealGrossFix~l	0.430	0.539	0.80	0.424	-0.625	1.486	
Constant	-0.169	0.713	-0.24	0.812	-1.567	1.228	
L._ce1	6.440	8.032	0.80	0.423	-9.303	22.183	
L._ce2	14.357	20.084	0.71	0.475	-25.007	53.720	
L._ce3	62.568	20.685	3.02	0.002	22.027	103.109	***
L._ce4	-20.385	4.753	-4.29	0.000	-29.700	-11.069	***
L._ce5	-3.212	1.139	-2.82	0.005	-5.445	-0.979	***
LD. D2Manfuacturing~e	-5.914	6.642	-0.89	0.373	-18.932	7.104	
L2D.D2Manfuacturin~e	-1.201	4.321	-0.28	0.781	-9.669	7.268	
L3D.D2Manfuacturin~e	1.385	2.075	0.67	0.505	-2.683	5.452	
LD. D2RenewableEnergy	-19.183	18.745	-1.02	0.306	-55.923	17.558	
L2D.D2RenewableEne~y	-10.832	15.728	-0.69	0.491	-41.658	19.994	
L3D.D2RenewableEne~y	8.245	10.248	0.81	0.421	-11.841	28.330	
LD. D2Nonrenewablee~y	-51.913	20.550	-2.53	0.012	-92.191	-11.636	**
L2D.D2Nonrenewable~y	-35.109	15.653	-2.24	0.025	-65.788	-4.430	**
L3D.D2Nonrenewable~y	-10.924	7.315	-1.49	0.135	-25.261	3.412	
LD. D2EnergyPrice	19.788	4.013	4.93	0.000	11.923	27.652	***
L2D.D2EnergyPrice	8.197	4.602	1.78	0.075	-0.824	17.217	*
L3D.D2EnergyPrice	4.393	2.106	2.09	0.037	0.266	8.520	**
LD. D2TradeOpennes	0.626	0.941	0.67	0.506	-1.218	2.470	
L2D.D2TradeOpennes	0.184	0.751	0.25	0.806	-1.287	1.656	
L3D.D2TradeOpennes	0.179	0.433	0.41	0.679	-0.669	1.027	
LD. D2RealGrossFixe~l	5.862	7.039	0.83	0.405	-7.933	19.658	
L2D.D2RealGrossFix~l	-0.311	4.923	-0.06	0.950	-9.959	9.337	
L3D.D2RealGrossFix~l	3.063	3.024	1.01	0.311	-2.863	8.989	
Constant	-0.001	4.004	0.00	1.000	-7.849	7.847	
L._ce1	1.189	0.297	4.00	0.000	0.607	1.770	***
L._ce2	5.119	0.742	6.90	0.000	3.665	6.574	***
L._ce3	4.023	0.764	5.26	0.000	2.525	5.521	***
L._ce4	-0.423	0.176	-2.41	0.016	-0.767	-0.078	**
L._ce5	0.149	0.042	3.55	0.000	0.067	0.232	***
LD. D2Manfuacturing~e	-0.830	0.245	-3.38	0.001	-1.311	-0.349	***
L2D.D2Manfuacturin~e	-0.271	0.160	-1.70	0.090	-0.584	0.042	*
L3D.D2Manfuacturin~e	0.021	0.077	0.27	0.787	-0.130	0.171	
LD. D2RenewableEnergy	-4.190	0.693	-6.05	0.000	-5.547	-2.832	***
L2D.D2RenewableEne~y	-2.233	0.581	-3.84	0.000	-3.372	-1.094	***
L3D.D2RenewableEne~y	-0.893	0.379	-2.36	0.018	-1.635	-0.150	**
LD. D2Nonrenewablee~y	-3.038	0.759	-4.00	0.000	-4.526	-1.550	***
L2D.D2Nonrenewable~y	-1.364	0.578	-2.36	0.018	-2.497	-0.230	**

L3D.D2Nonrenewable~y	-0.342	0.270	-1.27	0.206	-0.872	0.188	
LD. D2EnergyPrice	0.048	0.148	0.32	0.747	-0.243	0.338	
L2D.D2EnergyPrice	0.006	0.170	0.04	0.972	-0.327	0.339	
L3D.D2EnergyPrice	0.058	0.078	0.74	0.459	-0.095	0.210	
LD. D2TradeOpennes	-0.092	0.035	-2.65	0.008	-0.160	-0.024	***
L2D.D2TradeOpennes	-0.017	0.028	-0.60	0.548	-0.071	0.038	
L3D.D2TradeOpennes	0.001	0.016	0.07	0.944	-0.030	0.032	
LD. D2RealGrossFixe~l	2.794	0.260	10.74	0.000	2.285	3.304	***
L2D.D2RealGrossFix~l	1.666	0.182	9.16	0.000	1.309	2.022	***
L3D.D2RealGrossFix~l	0.703	0.112	6.29	0.000	0.484	0.922	***
Constant	0.021	0.148	0.14	0.889	-0.269	0.311	

Mean dependent var	-0.134	SD dependent var	4.157
Number of Observation	33.000	Akaike crit. (AIC)	.

*** *p<0.01*, ** *p<0.05*, * *p<0.1*