IMPACT OF OIL PRICE CHANGES AND ENERGY CONSUMPTION ON ECONOMIC GROWTH AND CO_2 EMISSIONS IN SUB-SAHARAN AFRICAN COUNTRIES

By

BABUGA UMAR TIJJANI

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in fulfilment of the requirement for the degree of Doctor of Philosophy

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Abstract of thesis presented to the senate of University Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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August 2021

Chairman : Associate Professor Mohd Naseem bin Niaz Ahmad, PhD
School : Business and Economics

This study is aimed at achieving three goals, firstly, to examine the long run relationship between the oil price change and economic growth for Sub-Saharan Africa (SSA) net oil exporters with the aim of finding the threshold level where an increase beyond that is no longer or even contributing negatively to the economic growth of these countries. The existence of cross-sectional dependence on the panel data of these countries is what prompted for the application of second-generation panel technique, Augmented Mean Group (AMG) method as proposed by (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010). The findings indicates that, oil price increase has stimulated the economic growth up to a certain level, then further increase in the price of oil beyond that is leading to negative economic growth. Therefore, the study concludes that a threshold level exists for oil price-economic growth of the SSA net exporters, Angola and Nigeria are the countries that are found to fall below the threshold level while Cameroon, Congo DR, Congo Republic, Equatorial Guinea and Gabon were the countries that are found to be above the threshold level. These countries should adopt policy measures to promote and diversify other economic sectors that are non-oil tradable so that countries that are above the threshold level can reduce the negative effect of the oil price increase on their economic growth. Thus, for those that fall below the threshold, diversification to other non-oil economic activities can prevent the occurrence of negative effect of oil price on their economic growth.

The second objective is aimed at investigating the long run effect of oil price change on inflation for the SSA countries. Similarly, the presence of cross-sectional dependence among the panel data units is what necessitated for the application of the second-generation panel technique, (AMG) method as proposed by (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010). The findings show that oil price changes had positively affected the price level, as oil price goes up the rate of inflation is also rising. For policy measure, the governments in these countries should adopt policy measures of reducing inflation by cutting the importation level and promoting the indigenous domestic manufacturers

to be producing different consumer goods so that they can meet up with the rising domestic demand.

The third objective is aimed at examining the long run relationship among the energy consumption and CO_2 emissions at both aggregate and disaggregate levels for the SSA countries. The study utilized a second-generation econometric panel technique AMG (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010) due to the presence of cross-sectional dependence on the panel data. Applying of first-generation panel technique in the event of cross-sectional dependence on the panel can lead to invalid and inconsistent results. The findings indicate that energy consumption at both aggregate and disaggregate level has positively affected the CO_2 emission. As consumption of energy increases, the rate of environmental pollution through the CO_2 emission also increases. For policy implication, some of the ways to cut down the rate of CO_2 emission from consumption of energy is by promoting and making the renewable energy sector attractive to investment so that efforts could be made in providing cleaner and efficient energy sources such as solar, wind and et cetera that are not harmful to the environment.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN PERUBAHAN HARGA MINYAK DAN PENGGUNAAN TENAGA KE ATAS PERTUMBUHAN EKONOMI DAN PELEPASAN KARBON DIOKSIDA CO_2 DI NEGARA AFRIKA SUB-SAHARA

Oleh

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Pengerusi : Profesor Madya Mohd Naseem bin Niaz Ahmad, PhD
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Kajian ini bertujuan untuk mencapai tiga matlamat, pertama, untuk mengkaji hubungan jangka panjang antara perubahan harga minyak dan pertumbuhan ekonomi bagi pengeksport bersih minyak Sub Sahara Afrika dengan tujuan untuk mengenal pasti paras ambang di mana peningkatan yang melebihi tidak lagi atau malah menyumbang secara negatif kepada pertumbuhan ekonomi di negara-negara tersebut. Kewujudan keratan rentas bersandarkan kepada data panel bagi negara-negara ini yang mendorong kepada penggunaan teknik panel generasi kedua, kaedah Kumpulan Min Terimbuh (AMG) (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010). Dapatan menunjukkan kenaikan harga minyak merangsang pertumbuhan ekonomi hingga ke tahap tertentu, manakala kenaikan harga minyak berterusan yang melebihi membawa kepada pertumbuhan ekonomi yang negatif. Oleh itu, kajian ini menyimpulkan bahawa kewujudan paras ambang bagi harga minyak-pertumbuhan ekonomi pengimport bersih di SSA; Angola dan Nigeria didapati jatuh di bawah paras ambang. Manakala Cameroon, Kongo DR, Republik Kongo, Guinea Khatulistiwa dan Gabon didapati berada di atas paras ambang. Negara-negara ini perlu mengamalkan langkah-langkah dasar untuk menggalakkan dan mempelbagaikan sektor ekonomi lain yang tidak melibatkan perdagangan minyak supaya negara yang berada di atas paras ambang boleh mengurangkan kesan negatif kenaikan harga minyak kepada pertumbuhan ekonomi negara. Dan bagi negara yang berada di bawah paras ambang, kepelbagaian kepada aktiviti ekonomi yang tidak melibatkan minyak dapat mengelakkan berlakunya kesan negatif harga minyak kepada pertumbuhan ekonomi negara.

Objektif kedua adalah bertujuan untuk mengkaji kesan jangka panjang perubahan harga minyak terhadap inflasi di negara-negara SSA. Begitu juga, kewujudan keratan rentas bersandar di antara unit data panel yang diperlukan bagi penggunaan teknik panel generasi kedua, kaedah AMG (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010). Dapatan menunjukkan perubahan harga minyak memberi kesan positif kepada paras harga. Ini kerana kenaikan harga minyak turut membawa kepada peningkatan kadar

inflasi. Bagi langkah dasar, kerajaan di negara-negara tersebut hendaklah mengamalkan langkah-langkah dasar pengurangan inflasi dengan mengurangkan tahap pengimportan dan menggalakkan pengilang domestik orang asli dalam menghasilkan pelbagai barangan pengguna supaya mereka dapat memenuhi peningkatan penggunaan domestik.

Objektif ketiga kajian ini mengkaji hubungan jangka panjang di antara penggunaan tenaga dan pelepasan karbon dioksida CO_2 pada kedua-dua tahap agregat dan tak agregat bagi negara-negara SSA. Kajian ini menggunakan teknik panel ekonometrik generasi kedua AMG (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010) disebabkan oleh kewujudan keratan rentas bersandar dalam data Panel. Penggunaan teknik panel generasi pertama bagi keratan rentas bersandarkan kepada panel boleh menyebabkan dapatan yang tidak sah dan konsisten. Apabila penggunaan tenaga meningkat, kadar pencemaran alam sekitar melalui CO_2 turut meningkat. Bagi kesan dasar pula, terdapat beberapa langkah untuk mengurangkan kadar pelepasan CO_2 dari penggunaan tenaga dengan menggalakan dan menjadikan sektor tenaga boleh baharu merangsang pelaburan dalam mewujudkan sumber tenaga yang lebih bersih dan efisien seperti solar, angin dan sebagainya yang merosakkan alam sekitar.

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Alhamdulillahi Bi Ni'matihi. All praises be to almighty Allah, the most gracious and most merciful, who gave me the ability and wisdom to accomplish this PhD thesis. I am so much grateful to Him for keeping me alive and healthy throughout my PhD journey.

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Finally, I will like to thank my friends in my home country for their prayers and well wishes.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the supervisory committee are as follows:

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Date: 11 August 2022

Declaration by Members of Supervisory Committee

This is to confirm that:

- The research conducted and the writing of this thesis was under our supervision;
- Supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
AMG	Augmented Mean Group and Development
ARDL	Autoregressive Distributed Lag
CAP	Capital formation
CCEMG	Common Correlated Mean Group
CIPS	Cross Sectional Im Pesaran Shin
CO_2	Carbon dioxide
CPI	Consumer Price Index
DFE	Dynamic Fixed Effect
EC	Energy Consumption
EIA	Energy Information Administration
EKC	Environmental Kuznet Curve
FE	Fixed Effect
FGLS	Feasible Generalized Least Squares
GAS	Liquefied petroleum gas
GCC	Gulf Countries Corporation
GDP	Gross Domestic Product
GDPC	Gross Domestic Product Per Capita
GMM	Generalized Method of Moments
IEA	International Energy Agency
KERO	Kerosene
LSDVC	Least Squares Dummy Variable Corrected
MG	Mean Group
NARDL	Nonlinear Autoregressive Distributed Lag

OECD	Organization for Economic Cooperation
OIL	Gasoline
OP	Oil Price
PSTR	Panel-Smooth Transition Regression
PTR	Panel Threshold
RC	Random Coefficients
REER	Real Effective Exchange Rate
RER	Real Exchange Rate
RGDPC	Real Gross Domestic Product per Capita
ROP	Real Oil Price
SSA	Sub-Saharan Africa
TO	Trade openness
VAR	Vector Autoregression
WDI	World Development Indicator
WTI	West Texas Intermediate

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Energy is an indispensable element that helps in running the economic activities all over the world. Treasures of some countries have changed because of crude oil. Crude oil is an important source of energy and in fact it is responsible for contributing to almost 2.5% of the world GDP (Daksh, Sai and Sundara, 2016). It is widely accepted that, most of the businesses and economic activities require energy as an important input in their production processes, and one of the major sources of that energy is crude oil. The importance of crude oil in the production process is enormous and that is what prompted many countries in the world to start giving attention on the issues related to oil price and its shocks over the past few decades due to the impressive impact it has on the real economy (Narayan, Sharma, Poon, and Westerlund, 2014).

In the case of oil exporting countries, oil price increase is an advantage, one important thing to them is the transfer of income channel. Consequently, an increase in oil price leads to transfer of wealth from oil importing to oil exporting countries which may cause a rise of national income via larger export earnings, that is also expected to boost consumer demand and purchasing power of the citizenry (Nusair, 2016). Similarly, Rotimi and Ngalawa (2017) found that an appreciation in the price of oil contributes to economic growth by providing the needed financial resources for the developmental activities in the oil exporting countries. Similar studies such as (Awartani, Maghyereh and Ayton, 2020; Mensah et al., 2019) found that there is a positive effect of oil price on economic growth.

Oil plays a key role in shaping the economies of the Sub-Saharan Africa (SSA) net oil exporting countries. It is obvious that these countries are heavily dependent on the revenues derived from oil. This over reliance is reflected in terms of the larger proportion that it has in the governmental revenue, Gross Domestic Products (GDP) and export earnings. For example, in Angola, the oil revenue accounts for almost 70 per cent of the government revenue, 50 percent of the GDP and more than 90 percent of the exports earning. As for Nigeria, oil revenue covers around 40 percent of the GDP contribution and about 80 percent of the government revenue. For the Republic of Congo, oil revenue takes around 65 percent of the GDP, around 92 percent of the export earnings and about 85 percent of the government revenue. Also, for the economy of Gabon, oil revenue accounts for roughly 46 percent of government revenue, 43 percent of the GDP contribution and 81 per cent of the export earnings. Similarly, in Cameroon oil revenue accounts for greater than 40 percent of the total export earnings (C.I.A., 2020). Figure 1.1 shows the correlation of nominal GDPC (current US$) and oil price of these SSA net oil exporting countries.

Figure 1.1 below indicates the relationship between SSA net oil exporting countries' GDPC (current US$) and WTI oil price. This figure indicates that the two variables are related to each other, with a very good positive correlation. This portrays that, changes in oil price have a very significant impact on their economies. Being that these countries are heavily dependent on oil resource as the main driver of economic growth and that makes them vulnerable to the fluctuation of that oil price in the global market. The explanation is that, due to the increase in oil price, the revenue for the oil SSA exporting countries increased, then the economy witnessed more economic progress which then lead to the increase in aggregate level of output.

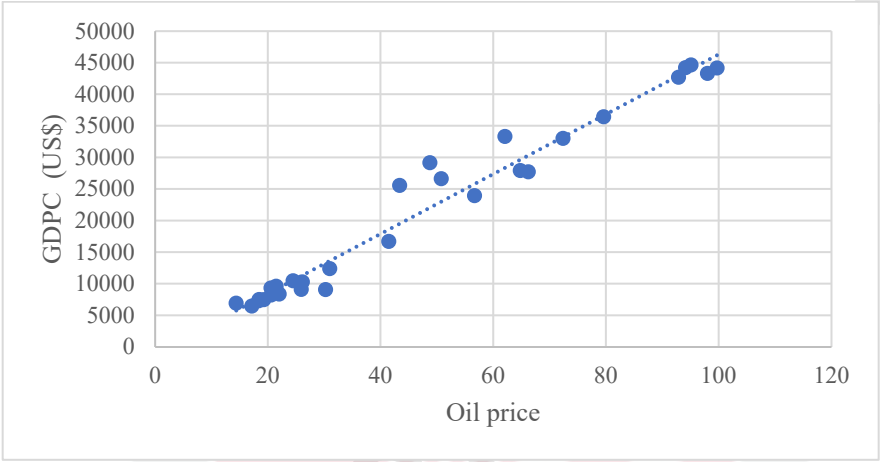

Figure 1.1: Scatter plot of oil price changes (US$) and total GDPC (current US$) for SSA net oil exporting countries
[Source: Computed from the data procured from WDI and EIA]

Notwithstanding, the issue of oil price increase is not always being good to oil exporting countries especially due to the effect of Dutch disease. The Dutch disease may ensue if the higher oil revenue to these countries frequently makes their exchange rate to be overvalued compared to the US$. In most cases if the exchange rate is overvalued, other non-oil sectors such as agriculture and manufacturing may likely be abandoned, which has implications for growth (Beverelli, Dell'Erba and Rocha, 2011). Apart from the effect of Dutch disease, these countries are also facing problem of mismanaging the extra money they generated from the sales of crude oil at higher prices in the global oil market. They spend substantial sums of money generated through paying of subsidies to the citizens especially on the importation of refined petroleum products and other consumer products. They also embark on big projects which might take a longer completion period and requiring huge amount of money out of the extra revenue they generated (Rotimi and Ngalawa, 2017).

Looking at oil price-inflation relationship, in the countries that import goods, an increase in the oil price always leads to an increase in the price of the imported goods thereby bringing-in inflation into the countries. Therefore, keeping inflation within a reasonable set target is one of the significant macroeconomic policy objectives that every economy

may wish to have as it is a reflection of healthy and stable economy. Price stability is what every economy is aiming to maintain as it can help in attaining growth and development, whereas price instability is what is not needed as it causes uncertainty by preventing the economic agents to make a right and well-informed decision about their consumptions and investments, hence leading to inefficiency in the nations' resource allocation. Price instability also increases the cost of doing business by raising the inflation risk premia (compensation to investor for the loss of value in the investment) in interest rates thereby leading to fall in investments and output (Nusair, 2019).

Dealing with oil price-inflation relationship is important as it indicates how the changes in oil price affect the price level of the domestic economy. Example of that is, a rise in the price level (inflation) of the 1970s was connected to the rise in oil price around that given time. Similarly, the drop in inflation in the recent years of (1980s and 1990s) were also related to the decrease in the oil price (Leblanc and Chinn, 2004). Increase in oil price causes difficulties to central banks. A rise in the price of oil increases the production costs of firms which finally shifts to the increase in the price of goods they produce. Thus, it is important to understand empirically the link between changes in oil price and inflation so that firms can fine-tune their pricing guidelines to go consistently with the prevailing inflationary condition. Similarly, policy makers can also fine-tune the macroeconomic policies to move in consistence with that (Leblanc and Chinn, 2004). These notions are also supported by some past empirical studies which established that oil price positively affected inflation (Choi et al., 2018; Nusair; 2019; Salisu et al., 2017; Sek et al., 2015). Similarly, studies such as (Adebayo, 2020; Balcilar, Uwilingiye, & Gupta, 2018; Sultan, Tawfik, Alkhateeb, & Fawaz, 2020) also prove that the effect of oil price changes on inflation is positive.

In this context, one of the regions that is affected by the issue of oil price-inflation relationship is Sub-Saharan Africa (SSA) region. Basically, all the countries in the SSA region import various consumer goods and oil for their domestic consumption. Even though there are some among the SSA countries that are net oil exporters, still they import majority of the fuel they need for domestic consumption. The limited refining capacity is the main problem that prompted the oil exporting countries to go along with the non-oil exporting ones in importing the refined petroleum products in order to meet up with the rising domestic needs. Despite the existence of numerous refineries in various SSA countries, still their refining capacities are very much underutilized and subsequently, the huge of the continent's oil resources are being transported overseas to have value added and then returned to the countries as refined petroleum products (Rettig, Kimenyi, and Routman, 2013). The decayed infrastructures, lack of investments and poor performing capacity are the reasons why many countries across Africa and SSA in particular rely on oil importation to meet up with the increasing need of domestic fuel consumption.

According to Energy Information Administration- EIA (2019) report, the SSA region fuel consumption is expected to increase by about 16.3 percent from around 4.3 million barrel per day (mbd) in the year 2017 to almost 5 mbd by 2023. The refining capacity for SSA region is also expected to remain at its low level until the rate of investment in the sector become fruitful to yield reasonable profit so that investors could be attracted. Regrettably, that might be a difficult task to achieve because authorities in these countries

choose giving subsidies on fuel products, and at the same time they prefer giving attention to programs and projects that bring leadership with political capital (Oirere, 2018). Figure 1.2 below, illustrates the correlation plot of oil price (WTI) and CPI for the SSA countries. This shows that there is good positive correlation between these two variables.

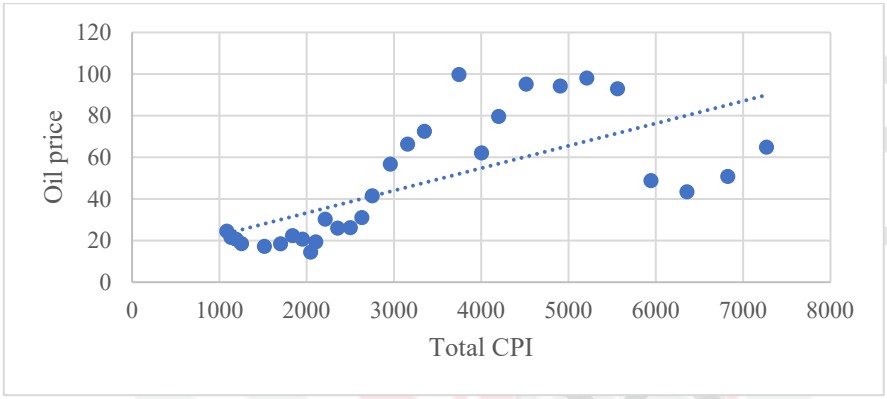

Figure 1.2: Scatter plot of oil price changes (US$) and total CPI (2010=100 US$) for 42 SSA countries
[Source: Computed from the data procured from WDI and EIA]

In the case of CO_2 emission, it is likely that increase in economic activities may give rise to increase in energy consumption at various levels thereby leading to increase in Carbon dioxide (CO_2) emission. CO_2 emissions is a worldwide phenomenon that raises public concerns internationally. This is largely due to the potential dangers it causes to the humans and their environments through the emission of harmful gasses. Greenhouse gasses emissions which mostly contain CO_2 emissions is a typical example of that. In fact, more than 60 percent of greenhouse gasses is CO_2 (Ozturk & Acaravci, 2010). These emissions from CO_2 and other harmful gasses are everyday growing and that is considered as one of the biggest threats to the environment and mankind (Sirag, Matemilola, Law and Bany-Ariffin, 2017). Studies such as (Andjarwati et al., 2020; Mensah et al., 2019; Mohsin, Abbas, Zhang, Ikram, & Iqbal, 2019; Nathaniel & Iheonu, 2019) prove that energy consumption is a strong factor in determining the rate of CO_2 emissions.

According to a report by International Energy Agency (I.E.A), 2018 on Global Energy and CO_2 emission Status Report of 2018, energy-related CO_2 emissions rose by 1.7 percent gaining a historic high of 33.1 Gigaton (Gt) CO_2. That is the maximum since 2013, and it is 70 percent greater than the average increase since 2010. The growth in the rate of CO_2 emissions was generally caused by the increase in the global energy consumption and other conditions such as changes in weather which led to the growth in energy demand for heating and cooling. In the region of SSA, the rate of CO_2 emissions rose by more than 20 percent from 2000–2012 (Odugbesan and Murad, 2019). As at 2014, the rate of CO_2 stood around 822,819.03 kiloton in the region, an increase of 4.94 percent compared to the previous year 2013. These comprises of CO_2 emission coming

out from the process of burning of fossil fuels, manufacturing of cements, (consumption of liquid, solid and gas fuels) and gasses flaring (macrotrend, 2019).

Figure 1.3 represents the plot showing the relationship between energy consumption and CO_2 emission for 40 SSA countries based on the available data. This figure indicates that, the two variables are related to each other, with an excellent positive correlation. This indicates that, changes in energy consumption have effects on their CO2 emissions.

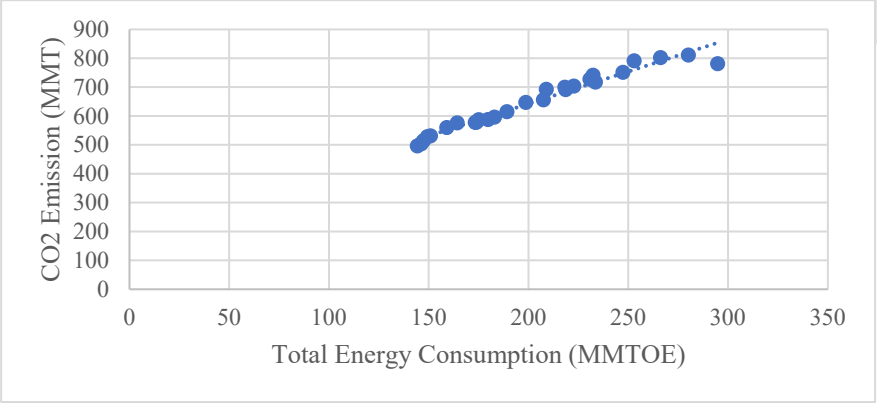

Figure 1.3: Scatter plot of Energy consumption and CO_2 emission for 40 SSA countries
[Source: Computed from the data procured from WDI and EIA]

Environmental pollution due to the energy use is a challenge that faces the SSA region just like other parts of the world. Global warming and climate change are the two most important environmental issues confronting the planet and they are largely caused by greenhouse gasses emission with 60 percent of it coming from CO_2 emission. Thus, increase in CO_2 emission is due to the increase in various energy use as a result of a rise in economic activities. This prompted for the need of a thorough study on the relationship among the energy consumption, economic growth and CO_2 emission and some studies in the past have established that the three components are related, for instance, (Al-mulali, 2012; AlZgool, Shah & Ahmed 2020; Andjarwati et al., 2020; Khan, Khan & Rehan, 2020). Increase in energy consumption-CO_2 emission relationship is taking place as a result of increase in economic growth which requires more energy use by increasing economic activities such as manufacturing, increase in service rendering and so on (Khan, Khan & Rehan, 2020).

Furthermore, the economic growth-pollution nexus is among the notable empirical relationships on which numerous researches were conducted. This had started gathering momentum since the beginning of the 20th century when the issue of global warming became a public concern due to the deteriorating effect that air pollution causes to the environmental quality, however, substantial discharge of CO_2 emission is seen as a major contributor to the global warming. Extensive literature were documented on that, and the

aim of those literature were mostly examining the role of income on pollution (Narayan and Narayan, 2010). The theoretical proposition is that, during the early stage of economic development the pressure on the environment used to be higher and the concern of the society is not much on protecting the environmental quality, but later, as the economy grows the pressure on the environment will fall and the concern of the society on the environmental quality will rise (Kais & Sami, 2016). The Environmental Kuznet Curve (EKC) hypothesis assumes that, an inversed U shape relationship exists between environmental pollution and economic development, for instance, (Heidari et al., 2015; Kais & Sami, 2016; Zaghdoudi, 2017) have all found that Kuznet hypothesis exists between income and CO_2 emission.

1.2 General Background of the Sub-Saharan African Region

The region of Sub-Saharan Africa is situated at the southern part of the African continent. It covers all the African countries except only the northern part (see figure 1.4), and economic wise, the countries are categorically falling under the class of either middle- or low-income ones, examples on figure 1.5. The population of all the countries in the region as at 2019, according to the estimate of (WDI, 2020) stood at around 1.1 billion, and the aggregated gross domestic product (GDP) of the region is estimated to be $1.755 trillion (current US$). As at 2018, the gross national income (GNI) per capita of the region is estimated to be $ 1,595.41 (current US$) and the average life expectancy at birth for a Sub-Saharan African is 61 years. The division of the region's population between the urban and the rural areas are 37% and 63%, respectively.

Figure 1.4: Countries in SSA Region

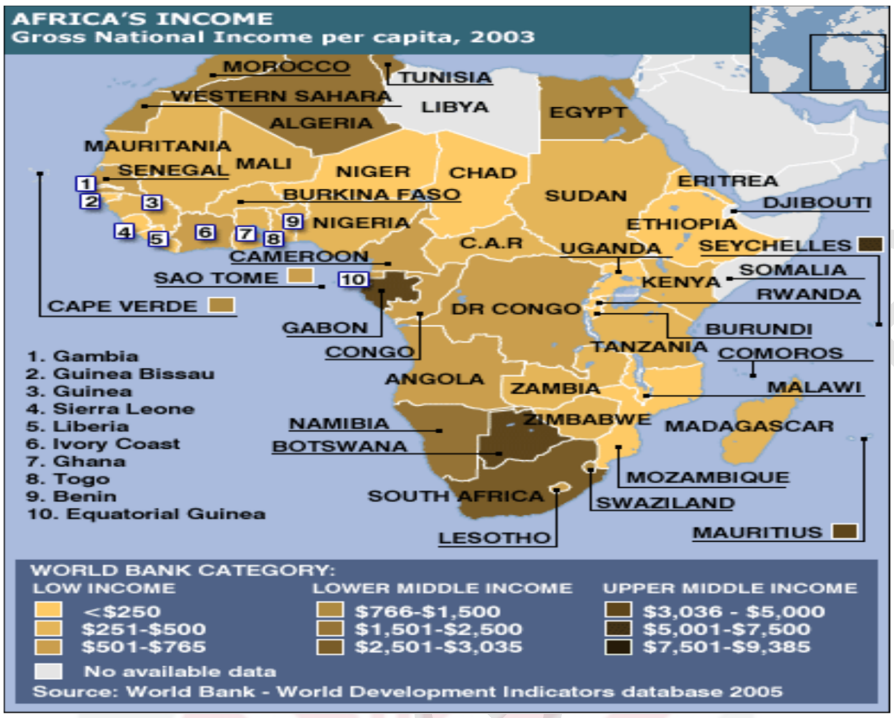

Figure 1.5: Map Showing Low-Income and Middle-Income Countries in Africa

1.2.1 Oil production in Sub-Saharan Africa

The production of oil started in the region of Sub-Saharan Africa (SSA) since 1960s, and it has been growing gradually since that time, except for a small period of disruption in the early 1980s due to the then collapse of oil prices. Currently, more than 500 oil companies participate in the activities of hydrocarbon exploration in the whole African region (OPEC (1), 2017). The continent has large deposits of oil laid down under its various countries. According to the figures, Africa's proven oil reserves have increased by almost 120 percent in the last 30 years or so, from 57 billion barrels in the 1980's to around 124 billion barrels in the millennium (2000's), and the contribution of the continent to the world daily oil production is about 9.4 percent (OPEC (2), 2017). Moreover, it is estimated that, there is at least another 100 billion barrels which are on the offshore of African continent, only waiting to be explored (EIA, 2013). With all the advancement in the world renewable energy system and other energy alternatives, crude oil still remains the most valuable trading commodity in the sector of non-financial commodities in the world because of its high demand. Despite the several calls in climate-change conventions to reduce the usage of crude oil because of the damaging effects of its exhumes to the human environment, the fact is that crude oil still remain the leading part of raw materials to the manufacturing activities, actually it is the most important raw material for many industries in the world (EIA, 2016).

1.3 Statement of the problem

Increase in oil price is leading to transfer of wealth from oil importing to oil exporting countries, and that causes the expansion of national income through larger export earnings which is expected to increase consumer demand and purchasing power of the citizenry. However, further increase in oil price is not always beneficial to the oil exporting countries due to the effect of Dutch disease. The Dutch disease takes place when the higher oil revenue to the oil exporting countries persistently renders their real exchange rates overly appreciated. The appreciation in the real exchange rate renders the exportation from other sectors of the economy such as manufacturing and agriculture to be unattractive, which has implications for growth and as a consequence the export sector shrinks and import sector grows. In essence, other alternative sources to the government revenue in form of economic diversification are either not effective or are not utilized.

Basically, the SSA countries import oil and other consumer goods for their domestic consumption. This indicates that, inflation is imported into these countries via importation of foreign goods that are already affected by the increased in oil price in the international market. The changes in the price of oil also affect the economies of various countries irrespective of being oil exporters or importers because oil resources serve as major production inputs to several manufacturing activities,[1] and the cost of imported goods is being increased. The changes in the oil price do affect the costs of production and in return that might put upward pressure to the price level. When the oil price rises up, the cost of production may rise, and the price level is likely to go up too. Higher oil prices are also affecting the price level because it is leading to the increase in the prices of imported goods. Oil is served as one of the major production inputs alongside capital and labor. Consequently, the provision of efficient indigenous oil refineries that can provide enough energy at lower price for local manufacturers of consumer products is not efficient.

Increase in energy consumption is an indicator of increased economic activities as that is associated with a boost in various manufacturing activities and services. However, changes in the consumption of energy (at aggregate level) and at disaggregate levels (oil, gas and kerosene) due to changes in income level is a factor that is likely to affect the level of environmental pollution. Increase in income may lead to increase in economic activities and consumption of energy as well. When the energy consumption increases, the level of environmental pollutions via CO_2 emission is likely to increase also. In essence, the provision of renewable energy sources is not available enough to reduce the usage of nonrenewable ones and their harmful effects.

While there is near consensus as to the adverse effects of negative oil price shock on these economies, the bond of contention is on the link between positive oil price shock and economic development. Evidence does not support the argument that, substantial upward spikes in oil price must be correlated to positive economic growth with improvement in the economic condition and standard of living of the citizenry of these countries. This is because positive oil price shock has its attendant economic implications

[1] Please refer to Kriskkumar and Naseem (2019) for detail discussion.

especially for the economies of these oil exporting countries that export only crude oil and import virtually all they need. That is always translating to higher import price due to rise in oil price, reducing living standards, leading to exchange rate appreciation, providing avenue for corruption and waste and generally contributing to under development in these countries. Hence, the argument is that, positive oil price shock may have positive impact on the economy but only to a certain threshold. In other words, the benefits from the rise in oil price should be up to a certain point and then it stabilizes. Therefore, there is a need to investigate the threshold impact of oil price shock on economic development for these oil dependent countries.

As stated earlier, variations in energy consumptions affect the CO_2 emission of many countries as energy use is serving as one of the production inputs to various manufacturing activities and also for households' consumption. Changes in energy consumption affect the level of CO_2 emissions, because if energy consumption rises, the rate of pollution is likely to increase. The rise in the use fossil fuel contains almost 40 percent of energy mix in total within the SSA region. The consumption of oil stands to be about four million barrels in a day (mb/d). About 60 percent of the oil is consumed by the transport activities, consumption of diesel (gas) is mostly done for back-up generators, the kerosene and liquefied petroleum consumption (LPG) consumption is mostly by households for lighting and cooking (I.E.A., 2019).

The changes in oil price if not properly addressed may hamper the economic growth of SSA oil exporting countries due to the effect of Dutch disease. It might as well affect the price level and or inflation of these countries regardless of being oil exporters or importers as long as these countries remain importers of consumer goods, and oil continue to serve as a production input in addition to capital and labor in various economic activities in these nations and the countries where they purchase the consumer goods from. Moreover, the emission of CO_2 due to the increase in energy consumption may cause problem of destroying the nature (flora and fauna) thereby decreasing the level of agricultural production. One of the great effects of CO_2 emission is climate change, the repercussion is felt in many ways in the SSA region including both natural and human systems. The projection of climate change in SSA is in warning trend, especially in the sub-tropics inland, changes in rainfall, recurrent occurrence of excessive heat, growing aridity and so on. SSA countries could also face as much as 1 meter of the rise in sea level by the end of the century under 4°C warming situation. The SSA region is already facing problem of higher rate of undernutrition and prevalence of infectious diseases which are anticipated to grow as a result of climate change due to the increase in the rate of CO_2 emission. It is based on these problems this study assembles to examine the effect of oil price changes on economic growth for oil exporters, the effect of oil price changes on inflation and the effect of energy consumption on CO_2 emissions.

1.4 Research questions

The following are the research questions that this study seeks to answer:

i. What is the effect of oil price changes on economic growth and to what extent does further increase in oil price affects the economic growth of the SSA net oil exporting countries?

ii. What is the effect of oil price changes on the inflation level for the SSA countries?

iii. What is the effect of energy consumption on CO_2 emission for SSA countries at both aggregate and disaggregate levels?

1.5 Objectives of the study

The broad objective of this study is to investigate the relationship among oil price changes, inflation, energy consumption, CO_2 emissions and economic growth, however, the specific objectives are as follow:

i. To investigate the effect of oil price changes on the economic growth of SSA net oil exporting countries.

ii. To examine the effect of oil price changes on the inflation level for SSA countries.

iii. To investigate the effect of energy consumption on CO_2 emission at both aggregate and disaggregate levels in the SSA region.

1.6 Significance of the study

The study is important as it would shed light on the oil price-macroeconomic relationship for those oil exporting countries that relied on oil for revenue and majority of their foreign exchange earnings in the region of SSA. It would be of vital importance to explore if the increase in oil price for those oil exporting countries is always yielding positive impact on their economic growth or it is only beneficial to the GDP growth to a certain threshold, then it would start diminishing. Although (Nusair, 2016; Sadeghi, 2017; Sek, 2017; Tuzova & Qayum, 2016; Farzanegan & Markwardt, 2009; Olomola, 2006; Olomola & Adejumo, 2006), have all tried to investigate this issue of oil price-macroeconomic relationship. This study is an improvement on their studies as it will try to pinpoint the threshold level where the further increase in the price of oil is not contributing to the economic growth of oil exporting countries especially SSA oil exporting nations where there is paucity of studies on oil price-macroeconomy relationship with regards to them and other developing countries that export oil, but there is abundance of such studies on advanced oil importing countries. This study contributes

to the literature by applying a second-generation panel econometric method that tackles the issue of cross-sectional dependence in determining the threshold point on SSA net oil exporting countries.

This study also contributes to the literature on the oil price-inflation relationship for developing countries especially in the SSA region where such kind of studies are scanty but available for many developed countries. The application of second-generation econometric panel method is also another contribution of this study as it takes care of the issue of cross-sectional dependence which the first-generation method could not. In essence, application of first-generation panel technique on the data of countries with cross-sectional dependence is makes the findings inconsistent and misleading (Pesaran, 2007; Westerlund, 2007). Many of the previous studies on oil price-inflation nexus utilized a first-generation technique even though the issue of cross-sectional dependence is inevitable. This is due to the increased economic and financial integration, globalization, being under same club, national and international legislations, global crises et cetera among countries consist of unobserved time invariant and time-varying factors that made interdependencies among the countries of the world.

This study contributes to the literature on energy consumption-CO_2 emission relationship at aggregate and disaggregate levels for emerging economies (SSA countries) that are striving to strike a balance between the rate of their energy consumption and environmental pollution where the existence of such kind of studies is few but are available for the advanced economies that already tackled the problem of environmental pollution. Also, utilizing a second-generation econometric panel method is additional contribution given by this study as it tackles the issue of cross-sectional dependence. Application of a first-generation panel technique on the panel data that contains cross-sectional dependence leads to an inconsistent and misleading results (Pesaran, 2007; Westerlund, 2007). Bulk of the past studies in relation to Energy consumption-CO_2 emission relationship applied a first-generation panel technique despite the presence of cross-sectional dependence in the panel data. Nowadays, the existence of cross-sectional dependence is rarely avoidable due to the increased in economic and financial integration, global crises, globalization and so on. It is these unobserved time invariant and time-varying factors that made interdependencies between the countries.

1.7 Scope of the study

This study covers the examination on oil price changes, inflation, energy consumption, CO_2 emissions and economic growth. Specifically, the first objective is on oil price-economic growth relationship for SSA net oil exporting countries[2] covering the period (1990 to 2018). The second objective is on oil-inflation relationship for the SSA

[2] Sub-Saharan Africa consists of 54 countries out of which only 7 are deemed to be net oil exporting, namely Angola, Cameroon, Congo (The Republic), Congo (Democratic Republic), Equatorial Guinea, Gabon and Nigeria. The selection of the countries was carried out by comparing the amount of exports and imports of crude oil for all the 54 SSA countries for 27 years (1990-2016), finally seven countries emerged to be net oil exporting as their exports exceeds import levels throughout. These countries maintained a consistent positive net oil exporting for quite a long period of time. This is indicated in figure 3.1, which shows the consistent export of oil for 27 years (1990-2016) among these oil rich countries.

countries that covers the period (1990 to 2018). The third objective covers the examination of energy consumption-CO_2 emission relationship at aggregate and disaggregate levels for the SSA countries covering the period (1990-2016). For the first objective, the selection of countries is strictly based on the explanation on (footnote 2). For the second and third objectives, all the Sub-Saharan African countries included in the sample are selected based on data availability. Whereas those countries without required data are not included from the sample.

1.8 Organization of the study

This study is a thesis that is based on essay, and it covers 3 essays. It is organized as: Chapter 1 comprises of introduction, background of the study, problem statement, objectives of the study, the scope as well as the organization of the study. The second chapter (chapter 2), covers the literature review, both theoretical and empirical. Chapter 3 examine the relationship between oil price changes and economic growth, including the methodology, findings and conclusion. Chapter 4 examines the effect of oil price changes on inflation, including the methodology results and conclusion. Chapter 5 examines the relationship amongst the energy consumption and CO_2 emission, at aggregate and disaggregate levels, which include the methodology results and conclusion. Finally, chapter 6 covers conclusion and policy implications.

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