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Economic implications of international energy trade: a comparative analysis across developed, developing, and least developed nations

Mmaduabuchi Chigozie Emeghebo
World Maritime University

Bintou K.B. Janneh
World Maritime University

Semeria Youlo Maurice
World Maritime University

WORLD MARITIME UNIVERSITY

ECONOMIC IMPLICATIONS OF INTERNATIONAL ENERGY TRADE: A COMPARATIVE ANALYSIS ACROSS DEVELOPED, DEVELOPING, AND LEAST DEVELOPED NATIONS

EMEGHEBO, MMADUABUCHI CHIGOZIE
Nigeria

JANNEH, BINTOU K.B
The Gambia

SEMERIA, YOULO MAURICE
Liberia

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified and that no material is included for which a degree has previously been conferred on me. The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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(Signature): ………………………………….. (Date): 26th September, 2023

Supervised by: Dr. Satya Sahoo …………………………..

Supervisor's affiliation: Assistant Professor of Shipping Management and Finance, Shipping and Port Management Specialisation, World Maritime University, Malmo, Sweden.

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Abstract

Title of Dissertation: **Economic Implications of International Energy Trade: A Comparative Analysis Across Developed, Developing, and Least Developed Nations**

Degree **Master of Science**

Energy trade and consumption constitute vital components of international trade, a significance that has been amplified by escalating global industrialization and globalization. Nonetheless, the patterns of demand, trade, and utilization of energy differ markedly across various categories of economies, as delineated by the United Nations into Developed, Developing, and Least Developed Nations.

This study endeavors to elucidate the influence of international energy trade and consumption on the economic development trajectories of these three distinct categories of nations. Employing linear panel regression methodologies on panel data sets spanning the period from 1995 to 2021 for each category, the analysis reveals that international energy trade exerts a notable impact on the economic prosperity of all examined categories, albeit with varying degrees of intensity and characteristics. Specifically, both energy exports and imports have been found to exert a considerable influence on the per capita Gross Domestic Product (GDPs) of developed and developing nations, with the magnitude of this impact proving greater in developed economies. In contrast, Least Developed Nations demonstrated a pronounced inclination toward energy imports, indicating a lack of the requisite capacity to produce, utilize, or export energy at commercially significant scales.

Additionally, energy consumption emerged as a positive causal factor affecting the economies of all categorized nations, albeit more significantly in developed countries compared to their developing and least-developed counterparts. In terms of energy types, oil electricity appeared to significantly impact the per capita GDPs across all categories of countries. Notably, the impact was positive for developing and leastdeveloped nations, but negative for developed nations. Conversely, gas electricity showed a positive and significant correlation with the per capita GDPs of developed and least-developed countries, however, its influence on developing nations remained inconclusive due to the multicollinearity with per capita energy consumption within this category.

These findings carry significant policy implications for the spectrum of economies under consideration, particularly in shaping their international energy trade and consumption strategies. Given the current climate change efforts and heightened global environmental concerns over fossil energy, future research endeavours may delve into the potential impact of various forms of renewable energy on the economies of developed, developing and least developed nations.

KEYWORDS: Gross Domestic Product, Energy, Oil and Gas, International Trade, Economic Development.

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List of Abbreviations

ARDL	Autoregressive Distributed Lag
BLUE	Best Linear Unbiased Estimators
BOP	balance of Payment
CGEP	Centre on Global Energy Policy
CGEP	Centre on Global Energy Policy
CLRM	Classical Linear Regression Model
COE	Crude Oil export
COI	Crude Oil import
COP	Crude Oil Production
EIA	Energy Information Administration
EU	European Union
EU	European Union
FDI	Foreign Direct Investment
FMOLS	Fully Modified Ordinary Least Squares
GDP	Gross Domestic Product
GDP	Gross Domestic Product
GNI	Gross National Income
HDI	Human Development Index
ICE	Intercontinental Exchange
IEA	International Energy Agency
IMF	International Monetary Fund
IMO	International Maritime Organization
KWH	KiloWatt Hour
KZT	The Kazakhstan tenge
LDCs	Least Developed Countries
LDCs	Least Developed Countries
LDNs	Least Developed Nations
LDNs	Least Developed Nations
LNG	Liquefied Natural Gas.
LPG	Liquefied Petroleum Gas
MDGs	Millennium Development Goals
NAFTA	North American Free Trade Agreement
NGLs	Natural Gas Liquids
NYMEX	New York Mercantile Exchange
OECD	Organisation for Economic Co-operation and Development
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OPEC	Organization of the Petroleum Exporting Countries
OPEC	The Organization of the Petroleum Exporting Nations
OPPI	Other Petroleum Products Imports
QARDL	Quantile Autoregressive Distributed Lags
SDG	Sustainable Development Goal
SMEs	Small and Medium-Sized Enterprises
TWH	TeraWatt Hour

The U.S.	United States
UK	United Kingdom
UK	United Kingdom
UN	United Nations
UNCDP	The UN Capital Development Fund
UNDP	United Nations Development Program
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America
USEIA	U S Energy Information Administration
USMCA	United States-Mexico-Canada Agreement
VECM	Vector Error Correction Model
WTI	West Texas Intermediary
WTO	World Trade Organization

Chapter 1 - Introduction

1.1 International Trade

The exchange of goods and services between countries is referred to as international trade (Schulze, 1999). It establishes a global economy where supply and demand have a significant influence on the development of countries. Industrialization of economies is significantly influenced by trade (Krugman & Obstfeld, 2021). Trade enables countries to widen their markets, increase their income, and accelerate economic growth. However, depending on the degree of development in each country as well as global events, the effects of international trade on the economy might vary significantly from one country to another.

Measuring economic growth can be complex but the role of international trade in fostering economic growth has become increasingly prominent (Kaplinsky, 2005). The connection between neoclassical growth and international commerce may be most effectively elucidated through David Ricardo's idea of comparative advantage. According to this theory, countries are advised to manufacture items with lower opportunity costs compared to other countries. This phenomenon took place within the framework of the neoclassical trade regime, which posits that nations may enhance their Gross Domestic Product (GDP) by leveraging changes in capital and labour, facilitated by the adoption of technological advancements (Krueger, 1985). The World Trade Organization (2020) defines international trade as a transaction that occurs across borders and results in the flow of goods and services between nations. Maritime transport is a critical and inevitable component of international trade as 70% of global trade value and about 80% of global trade volume is transported by sea primarily because maritime transportation is cheap and can move large amounts of cargo across long distances to diverse destinations (UNCTAD, 2020).

Internationally traded commodities may often be split into two categories namely hard and soft commodities. Natural resources like gold and oil are examples of hard commodities. These resources are mined or exploited from their natural sites. Contrarily, soft commodities are agricultural goods or livestock such as coffee or cattle (CFI Team, 2019). According to value and volume, the top commodities traded internationally on a global scale are hydrocarbon Commodities (Oil and Natural Gas) also referred to as energy commodities, Agricultural goods (coffee, wheat, cotton), and animal and animal products. (Thaxton, 2022). Metals (gold, silver, copper), and minerals (coal, iron ore) are also examples of internationally traded commodities. However, both industrial production, local consumption, or international trade of these commodities have implications for the economic development of trading nations. The GDP of a nation is used to measure its economic development (United Nations, n.d.), and the global economy may be significantly impacted by trade of commodities. Revenues are generated from exports and imports of commodities. When demand and prices are high globally, countries that export many goods may see significant gains in GDP (Hufbauer, 1970). Revenue from exports can be used in infrastructure and economic expansion. On the other hand, nations that rely significantly on commodity imports could experience financial difficulties as prices increase, which would hurt their GDP. A country's GDP may benefit when its terms of trade improve because it will have greater buying power for imported items when export prices increase in relation to import prices (Wong, 2009). Globally, while the volume of commodities used has increased significantly due to population growth and wider income, their relative importance has changed through time as a result of technical advancements that have given birth to new applications for some materials and made it easier for commodities to be substituted (Baffes & Nagle, 2022). The International Trade of a nation is heavily influenced by commodities, particularly in economies that are heavily dependent on these commodities, thus, contributing to foreign direct investment (FDI) and promoting economic growth. For instance, countries with significant mineral resources could experience a surge in FDI for mining and related businesses, resulting in the creation of jobs the expansion of infrastructure, and overall improvements in the economy (Mottaleb & Kalirajan, 2010).

1.2 International Commodities Trade

The energy industry covers a diverse array of commodities that are utilized for the purposes of power generation, heating, and transportation (Speight, 2018). According to Chan, (2020) report on the most traded commodity globally, Brent Crude oil is number 1, followed by coffee and Natural Gas at number 3. Thus international energy trade is vital. Energy trading involves products like crude oil, electricity, natural gas, and wind power and trading in these commodities comes with a lot of fluctuations (Federal Energy Regulatory Commission, 2020). Energy is divided into two types Renewable and non-renewable. Fossil fuels account for 63% of global electricity (Ritchie & Roser, 2022). The term "Energy Commodities" refers to electricity, Green Power, natural gas, methane, and any other petroleum-based fuel products such as diesel, bio-diesel, unleaded, fuel oil, and propane (Vacha & Barunik, 2012). However, it is important to note that the energy sector is expansive and always expanding, as novel technology and resources continue to emerge. The world's Trade in goods is significantly influenced by primary commodities. Although industrialised nations dominate primary commodity trade, the LDCs are far more dependent on it for their national income, export revenues, and jobs (T. Ademola Oyejide, 1989). Due to this dependency, the LDCs face serious issues with several major commodity trade features. Primary commodity export-dependent nations frequently experience decreases in their terms of trade; the volatility of primary commodity prices and export revenues adds to the difficulties. Crude oil has been one of the most important commodities in the 20th and 21st centuries, significantly due to the influence and importance it has on industrialization. Crude oil is a major energy source for the production of power, heat, and transportation (CAPP, 2019). Petroleum-based products were crucial to the development of internal combustion engines and the expansion of the car industry (Seo, 2016). Because of its dependence on oil, modern lives and economic activities are largely driven by it compared to other commodities.

1.2.1 Crude Oil

Crude oil is a natural resource composed of hydrocarbon deposits and other organic matter that is found in nature and serves as a primary source of petroleum (Daniel Liberto, 2023). Its widespread usage in manufacturing, transportation, and many other economic areas serves as evidence of its significance. It is traded both as spot oil or contract derivatives with over a billion Dollars traded daily (Adi Imsirovic, 2022). Geopolitical developments, dynamics of supply and demand, and actions made by major oil-producing nations may all affect its pricing. The economic and plentiful supply of crude oil has been a key driver of industrialization. It is highly sought after on a global scale and is actively traded on futures markets such as the New York Mercantile Exchange (NYMEX). Upon undergoing the process of refinement, crude oil can yield several valuable products, including but not limited to petrol, diesel, and jet fuel (U.S. Energy Information Administration, 2022). Crude oil is refined into petroleum products, also used to make polymers, chemicals, synthetic materials, and other goods in addition to being utilised as a fuel. (Energy Information Administration, 2016) Because they rely on oil-derived inputs, industries like petrochemicals, plastics, and manufacturing have prospered.

1.2.2. Natural Gas

As the world moves towards cleaner energy sources (Singh et al., 2021), natural gas demand has been rising as a bridge fuel from fossil to renewable energy sources (Birol, 2019). It is a type of fossil fuel that is predominantly composed of methane, used in electricity generation, heating, and as a source of fuel for cars (Birol, 2019). Crude oil reserves frequently coexist with natural gas deposits. Liquefied natural gas (LNG), which enables simpler transportation over long distances and access to markets that were previously inaccessible by pipelines, has contributed to natural gas' rise to prominence as an important commodity in international commerce (Cattlin, 2021). This is particularly true given the emergence of LNG. Several nations have increased the amount of LNG they import to broaden their variety of energy sources, enhance their energy security, and move to fuels that produce less pollution (IEA, 2022). According to the International Energy Agency by 2030, global electricity demand for electric vehicles will increase five- to eleven-fold more than the demand in 2019 (IEA, 2020). The worldwide commerce of gas has ramifications for geopolitics, and it frequently affects the relationships between different nations. The use of futures contracts, such as the Henry Hub natural gas futures contract offered by the CME, is the method that is most frequently utilised by traders to take a position on natural gas. Traders agree, as part of a futures contract, to take delivery of a predetermined quantity of natural gas at a predetermined date in the future at a price that has been predetermined. Policies about energy can have repercussions on many continents due to the increased interconnection of nations brought about by the development of gas infrastructure (U.S. Energy Information Administration, 2016).

1.2.3. Coal

Coal is classified as a fossil fuel, derived from the organic matter of ancient plants that underwent decomposition over millions of years. It is a sedimentary rock with a black or brownish-black coloration, and is predominantly utilised to generate power. Despite experiencing a decrease in utilisation in certain regions as a result of growing environmental apprehensions, it continues to be a significant worldwide energy provider (U S Energy Information Administration, 2016).

1.2.4. Uranium

Although uranium is not often regarded as a conventional commodity, it serves as the principal fuel source for nuclear energy. Nuclear reactors employ uranium rods as a means of generating electrical energy. Biofuels, which are obtained from biological matter, have the potential to serve as viable alternatives to conventional petrol and diesel fuels (US Energy Information Administration, 2016).

1.3 International Crude Oil Trade and Energy Mix

Figure 1: 2021 World Crude Oil Trade

Source: The Observatory of Economic Complexity, 2021

The global trade of crude oil and Natural Gas products is extensive. There are not all that many commercial ties between the nations. A global pattern of international trade is formed by the tight or loose ties that certain nations have with other nations. The worldwide commerce network is clustering into communities (or groupings) based on criteria like geography or GDP rather than using regional trade agreements (Zhang et al., 2018). For the benefit of policymakers, it is crucial to statistically demonstrate the global pattern. Since the 20th century, oil and Gas have dominated the world's energy use. The number of nations engaging in the global oil trade as well as the volume of commerce have increased significantly, along with the glaring disparity in the distribution of oil resources, (Zhang et al., 2015). However, the global oil trade patterns have had a difficult evolution from the beginning of the oil trade, from their initial bilateral patterns to their present multilateral patterns. Thus, the main supply regions are the Middle East, Africa, and the former Soviet Union, whereas the primary demand regions are North America, Europe, and the Asia-Pacific region, (Garlaschelli & Loffredo, 2005).

Two-thirds of the price of oil in the world is based on Brent Crude, which is derived from the North Sea, and has been the most traded commodity in the world for several years. Brent Crude is mostly refined into diesel and petrol which are mostly used to power combustion engines. On the other hand, WTI (West Texas Intermediary) is sourced from the United States. WTI has less sulfur than Brent Crude, the second major oil standard, and it is lighter, sweeter, and more refined. The easier and less expensive it is to refine crude oil, the lower its sulfur concentration. Recent WTI oil production has grown recently due to Fracking (Thaxton, 2022). However, Brent Crude has a greater impact than WTI due to its proximity to Europe, Africa, and Asia. WTI crude oil costs a little less than Brent crude, on average. The Brent/WTI spread, or price differential, fluctuates frequently due to disparate supply sources. Global disputes in Europe and the Middle East are more likely to have an impact on Brent Crude oil prices, but WTI prices are more significantly impacted by political or economic events in the US economy. Oil contracts for Brent Crude measure 1,000 barrels and are mostly traded on the Intercontinental Exchange (ICE).

The economies of all countries are significantly impacted by the trade in crude oil and Natural Gases (Alekhina & Yoshino, 2018). These effects can differ dramatically depending on whether a nation exports or imports crude oil. The gross domestic product (GDP) of countries that export oil is heavily influenced by oil sales earnings (Hutt, 2016). In 2020, 70% of the national incomes of OPEC nations were generated from oil exports. With large spending abilities. These nations grow their economies by supporting various Sectors and industries such as infrastructure, manufacturing, health care, and education (OPEC, 2021) while building safety nets during financial crises by buffing up foreign reserves (Van der Ploeg, 2011).

Relying on oil exports comes with several concerns, including unstable earnings owing to shifting oil prices globally. According to the "resource curse" or "paradox of plenty," countries with abundant natural resources like oil suffer less economic growth, weaker democracy, and inferior development outcomes (Auty, 1993). On the other hand, nations that often import oil experience the reverse result. They are vulnerable to variations in the price of oil since it frequently makes up a sizable portion of their energy mix. Inflation, a slowdown in economic development, and a worsened trade balance can all result from price increases (Hamilton, 2011). High-income economies such as Germany and Japan over the years, have been able to maintain a robust economy even though they are heavily dependent on oil importation. To achieve such an economy, tactics such as energy efficiency, source diversification, and the creation of alternative and renewable energy technologies are utilised (IEA, 2020). The oil embargo of 1973 caused a severe recession in oil-importing nations, however, not all countries that import oil suffer from these effects (US EIA, 2021). Both oilexporting and oil-importing countries' economic conditions are significantly influenced by the global trade of energy. Depending on several variables, such as price stability, economic diversification, and energy policy, (which may be either advantageous or detrimental), trade in crude oil may influence the economic prospects of nations. Nations with considerable crude oil reserves frequently see major economic gains. Oil exporting nations may generate sizable earnings, resulting in the expansion of their infrastructure, investments in other industries, and GDP growth. However, these economies may also be susceptible to changes in the price of oil, which might affect their capacity to remain stable.

Furthermore, Relationships and conflicts in the world today are determined by who has access to and control over crude oil/ Natural Gas resources. There have occasionally been tensions and wars between states as a result of the search for oil resources and geopolitical dynamics. Thus, geopolitical tensions and global uncertainties could seriously affect energy trade and may alter the economic trajectory of nations.

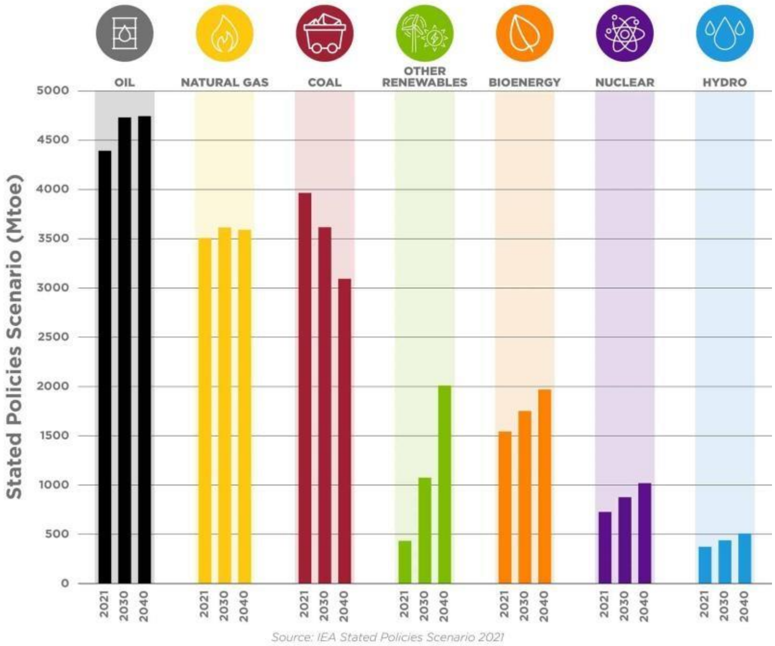

Figure 2:Changes in the Global Energy Mix 2020-2040
Source: Canadian Association of Petroleum Producers (2019)

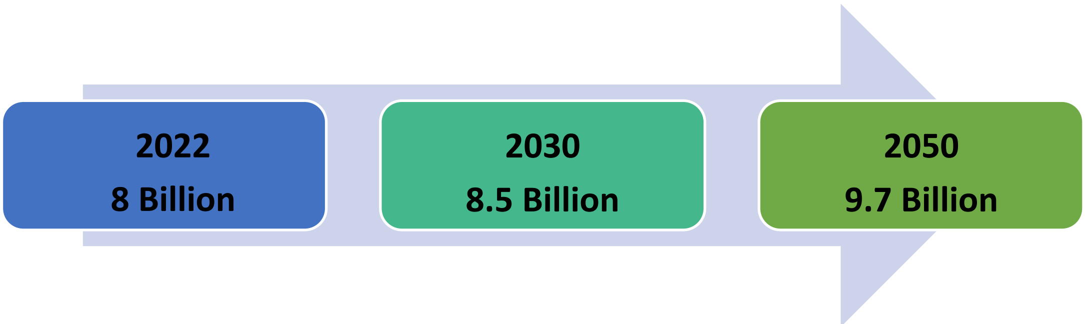

Figure 3: Projected World Energy Consumption in USD Source: Canadian Association of Petroleum Producers, 2019

An increase in population and energy demand has a positive correlation, i.e. an increase in population reflects a direct increase in energy demand. It will also lead to a higher demand for petrochemicals used in transportation (The Canadian Association of Petroleum Producers, 2019). However continuous improvements in energy efficiency help reduce energy usage and demand. Natural Gas has become a popular option as it is affordable and reliable with less emission compared to coal. By 2050 renewable energy would be 63% of the total primary energy supply (Gielen et al., 2019).

1.4 International Energy Trade (Crude Oil & Natural Gas Trade) in Normal Times and in Crises Times

Exports play a crucial role in the economy by enabling the efficient allocation of scarce resources for the production of commodities and services. Additionally, the surplus of exports can be traded to foreign markets to meet their needs, thereby increasing national output and generating foreign exchange earnings. These revenues can then be utilised to fund and promote initiatives for economic growth (Lal, 1992). On the other hand, nations import crude oil and natural gas to satisfy their domestic energy demand. They do this by increasing the variety of sources from which energy may be obtained, hence decreasing reliance on any one particular source (EIA, 2018). When compared to home production, the cost of acquiring goods or services from another nation may be lower, making imports an attractive alternative. In addition, participation in international trade helps nations improve their diplomatic and economic relations with one another, which in turn makes participation in geopolitical cooperation easier. Countries that are net importers of energy often have the necessary infrastructure, such as refineries and processing facilities, to turn raw oil and natural gas into goods that can be used, thereby adding value and supporting domestic companies to greater productivity and national economic development (Di Bella et al., 2022). Thus, both importing energy to add value locally or for resale at a favourable international price are all dimensions of energy trade that nations could exploit for their economic progress, based on their comparative advantages.

The global economy depends heavily on the trade of crude oil, although its trading is quite complex and extremely susceptible to both macroeconomic and geopolitical influences impacting everything from transportation to manufacturing. Normal economic times and crisis events like wars, calamities, or pandemics have quite different dynamics. Crises reveal the brittleness and complexity of the world oil market, but normal times permit stability and predictability in the trade of this crucial commodity. As nations negotiate the opportunities and difficulties of the world's energy markets, governments, corporations, and international organisations must understand these dynamics.

1.4.1 Energy Trade in Normal Times

The worldwide crude oil trade is regulated throughout ordinary economic periods by well-established customs, open market forces, and complex agreements. Crude oil production and demand are often quite predictable. Major oil-producing nations modify the output to suit global demand, frequently in concert with OPEC. Seasonal fluctuations can be found in consumption habits, which are generally steady. The nature of international economic interactions is frequently characterised by long-term agreements and strategic partnerships. Pricing mechanisms are open, often enacted by commodity exchanges like the NYMEX and Brent, and they take into account things like transportation expenses, production costs, and market sentiment. To further ensure the steady flow of oil and gas, countries often invest in infrastructures, such as refineries, pipelines, and shipping facilities. This calls for both financial resources and technical innovation to boost sustainability and efficiency (Cronshaw, 2015). International agreements regulate commerce and guarantee conformity to international norms for the preservation of the environment, safety, and morality. Also, natural gas is directed by long-term contracts, the dynamics of demand and supply, and considerations of the geopolitical environment. Natural gas is exported from nations that have an abundance of reserves, such as Russia, the United States, and Qatar, to nations that have a strong demand for the commodity, such as those in Europe or Asia (Geng et al., 2014). Pipelines are often used to transport natural gas from one location to another, while liquefied natural gas (LNG) is shipped to more distant markets. According to the IEA, natural gas plays a substantial part in the process of satisfying the world's need for energy.

1.4.2 Energy Trade in Crisis Periods

Regular patterns might be disrupted during crisis times like geopolitical wars, natural disasters, or global economic recessions, necessitating techniques and solutions. A crisis may bring about sudden changes in supply chains. Geopolitical tensions that led to the 1973 oil embargo are an example of how political choices may significantly influence the supply environment. The recent Russia-Ukrainian conflict has gone beyond the battlefield, resulting in repercussions for the energy industry. One of the biggest changes in the global energy market in decades as a result of the disruption of the flow of crude oil, natural gas, and refined goods like diesel, caused a significant and permanent shift in the world's oil market, leading to new geopolitical alliances comparable to the Arab Oil Embargo of the 1970s (Northam, 2023). For natural Gases, a disruption in the supply chain causes volatility. There is a possibility that prices could skyrocket, and there may also be shortages, which will undermine energy security. For instance, the conflict between Russia and Ukraine in 2014 resulted in disruptions in the supply of natural gas to Europe (Stulberg, 2017). These disruptions brought to light the dangers of over-reliance on a single supplier. As a result, governments are looking more seriously into diversifying their sources and channels, as well as investing in their capacity to store supplies, to protect themselves against any future crises.

Global occurrences like the COVID-19 Pandemic caused a global economic hit, leading to abrupt decreases in demand because they imposed constraints on commerce and travel (Norouzi, 2021). On the other hand, unanticipated demand pressures might result from unexpected economic booms. Also, Price volatility frequently follows catastrophes. Sharp price variations can occur when supply shocks and demand shifts combine. This may be observed in the oil price war of 2020, where both a supply surplus and a decline in demand resulted in historically low prices. However, governments frequently keep strategic oil reserves to ensure market stability during supply shortages (OPEC, 2019). To manage the local economic impact in times of crisis, policy measures like price restrictions, subsidies, or the deliberate release of reserves may be used. Crude oil, being such an important commodity, a cooperation agreement between OPEC and other significant producers throughout successive oil crises suggests that international coordination may be required to stabilise the global crises when the need arises (OPEC, 2019). The lessons learned during the COVID-19 Pandemic of 2019 and the Russia/Ukraine crisis of 2022 denote that international crude oil trading will continue to affect policies and tactics for the future as the globe faces enormous shifts in energy use, climate concerns, and geopolitical realities (Norouzi, 2021). The worldwide crude oil and natural gas trade relies on existing agreements, transparent market procedures, and infrastructure investments during normal times.

Contrarily, times of crisis frequently call for quick reactions, strategic reserves, governmental intervention, and international cooperation. Various Oil crises and events have affected the trade of crude oil and by extension the economic conditions and fortunes of trading nations.

Table 1: Oil and Gas Trade Crises

YEAR	EVENT
1970	Oil Crises of the 1970s
1990	Iraq/ Kuwait Invasion
2007-2008	Market Speculation
2019-2020	Covid 19
2021	Russia/Ukraine war

Source: Montgomery (2022)

1.5 Developed, Developing, and Least Developed Nations Classifications

Nations across the globe have been classified according to their degree of development. The classification helps with country comparison and contrast based on predetermined criteria, which promotes international collaboration, trade agreements, the distribution of aid, and policy formation (World Bank, 2020). Nations are divided into 3 categories: Developed, Developing, and Least Developed nations. They are categorised by evaluating the economic, social, and living standards or conditions of the nation and its populace. Various variables used in this classification include GDP per capita, Industrialization level, health care, and educational standards. The World Bank uses Gross National Income (GNI) per capita to classify countries according to predetermined income levels (World Bank, 2020). The United Nations Development Programme uses the Human Development Index (HDI), which takes into account elements including life expectancy, income, and education to give a more comprehensive picture of progress (UNDP, 2020). Several other international organisations and think tanks also categorise countries based on standards like political stability, technical development, or gender equality. These categories, which are developed via thorough study, data analysis, and examination of various economic and social factors, are frequently revised to reflect changes in economic environments. Beyond simple classification, understanding the intricacy and distinctive features of each country's categories' growth track is vital (Nielsen, 2012).

1.5.1 Developed Nations

Developed nations are High-Income Countries that have developed booming industrial and service sectors, high GDP per capita, and advanced healthcare and education systems (Syed et al., 2012). They usually have highly diverse economies, trade agreements, and partnerships that play a vital role in international trade. Most Developed Nations Manufacture goods that use crude oil as fuel. These include airplanes, cars, home heating machines, and heavy machinery (Britannica, 2021). Developed nations are also concerned about how using crude oil would affect the environment and contribute to climate change. These issues are increasingly influencing global trade and related policies. Switching from fossil fuel to renewable energy sources has become a priority for many developed nations, thus altering their trading patterns (EIA, 2016).

1.5.2 Developing Nations

Developing Nations are also known as Upper-Middle Income Countries or Emerging economies. These nations are distinguished by quick industrialization, expansion in the service industry, as well as improving living standards (World Bank, 2020). In developing countries, crude oil is termed ‘black gold’ as it plays a crucial role in their economies (Norouzi & Fani, 2020). Developing nations generate income mainly from exports (Henn et al., 2013). Overestimating the impact of crude oil on the geopolitical positioning, economic viability, and international trading patterns of the developing nations can be difficult. The World Bank (2020) states that many oil-rich developing countries heavily rely on crude oil exports as their main source of income. For instance, Angola, Venezuela, and Nigeria are a few nations that constantly show this tendency. There are dangers associated with over-dependence on a single commodity or service. When a country's whole economic foundation depends on oil, it is vulnerable to the vagaries of fluctuations in the world oil market (Taghizadeh Hesary & Yoshino, 2015).

Crude oil improves a nation's geopolitical position on the world stage and entices foreign investment. However, it can also cast a shadow over other key industries, maintaining an uneven path for economic growth (Lipsky, 2009). The economic characteristics that most commonly sets developing countries apart is their lower GDPs per capita. There are two clusters of developing countries with a particular category closer to developed countries and the other closer to least developed countries. The ranges in GDP between the top developing nations and the lowest of developing nations can be huge. However, some countries in the developing classifications are considered economically stable.

1.5.3 Least Developed Nations

Low-income economies struggle with issues including pervasive poverty, slow industrialization, healthcare, and education. Thus, LDCs, a phrase the United Nations used to identify the countries with the weakest economies, fall into one of these categories (UNCDP, 2020). Three factors: income, human resources, and economic vulnerability are used by the UNDP to determine least developed countries (LDCs). 46 nations are currently considered LDCs and these nations experience fundamental difficulties that obstruct their sustained development. Notably, they frequently have constrained resources, and undiversified economies, and deal with a wide range of societal issues including high rates of poverty and low educational levels (UNCDP, 2020). International trade has traditionally been considered a possible tool to help these nations out of their economic difficulties. Global trade trends, however, are not always in their favour. The world's least developed nations struggle to enter global markets as a result of their inability to compete favourably (WTO, 2022). As a result, trading with these nations is severely constrained. By seizing the chances provided by global trade, these countries may be able to increase their income and promote economic growth. The LDCs face significant obstacles when striving to gain access to international markets due to infrastructural deficit, limited finance, and low levels of education and expertise, hence only contributing about 1.1% of global commerce in 2020 (WTO, 2021). A small number of primary commodities are frequently exported by LDCs, which makes them particularly sensitive to fluctuating global market prices

(UNCTAD, 2019). Their inability to produce goods with value-added, which limits their ability to generate money through exports thus limiting their economic growth.

1.6 Problem Statement

The disparities in development levels among developed, developing, and least developed nations are not diminishing as anticipated, despite worldwide endeavours to mitigate and maybe eliminate them. Many internationally coordinated initiatives appear to be overly broad in their approach, without the specificity required to effectively address the unique characteristics and circumstances of each nation. General interventions include initiatives such as the MDGs, which have since evolved into the SDGs.

Developing and least developed nations often exhibit a proclivity to emulate and adopt the economic strategies or models employed by developed nations, in the pursuit of attaining accelerated economic progress. Due to varying circumstances, the majority of these adopted strategies are unsuccessful in attaining the intended outcomes. Hence, it is crucial to undertake an examination of energy trade patterns of the various country categories of the United Nations focusing on significant and impactful strategies with the view to adapting them to the peculiarities of other nations for economic development. Economic development has been variously linked to energy consumption. Thus, this study evaluates the economic implications of international energy trade across Developed, Developing, and Least Developed Nations. It therefore focuses on examining the trade patterns and the link between crude oil and natural gas trade and gross domestic product (GDPs). It further tests the causal relationship between energy use and economic growth.

1.7 The Research Aim

This research aims to evaluate the economic implications of international energy trade (vis-à-vis crude oil and natural gas) on the economies of developed, developing, and least developed countries.

1.8 Research Objectives

a. To determine the implications of international energy trade on the economies of developed, developing and least developed nations.
b. To determine the implications of energy consumption on the economies of developed, developing and least developed nations.

1.9 The Research Questions

i. How does international energy trade impact the economic development of nations vis-à-vis developed, developing and least developed nations? ii. How does per capita energy consumption impact the economic development of nations vis-à-vis developed, developing and least developed nations?

1.10 The Scope of the Study

The study covers the developed, developing and the least developed nations in a broad sense and not country-wise analysis. The data for this study covers a period from 1995 to 2021 and were obtained from secondary sources. Economic development of nations was viewed from a per capita GDP perspective. International trade in crude oil variables was also limited to values per capita in millions of USD.

1.11 Significance of the Study

In accordance with the stated aim and objectives of this research, it is anticipated that the findings will hold substantial implications for nations, particularly those classified as developing or least developed. These nations will be able to assess the intricacies of international trade in crude oil and natural gas, as well as the trading patterns of developed countries, in order to implement crucial strategies aimed at achieving economic benefits. Therefore, the results of this study will provide valuable insights for stakeholders and policy makers to optimally allocate resources, focusing on trade patterns that foster economic growth.

This study will also have relevance for all countries engaged in oil and gas trading, international trade organisations, as well as research material in the area of economics, statistics, international trade and development.

1.12 Structure of the Study

This research has been structured into six chapters in order to provide a logical and coherent flow of ideas, hence facilitating understanding. Chapter one provides a comprehensive introduction to the subject matter, ultimately leading to the formulation of the problem statement and the establishment of research objectives. Chapter two of this research paper encompasses a comprehensive literature analysis that delves into relevant studies, methodologies employed, and consequent discoveries. Accordingly, this review establishes the research gap that this study aims to address. Chapter three of the study focuses on the aspects of data and methodology, which include the identification of variables, the gathering and presentation of data, and the use of the chosen technique for data analysis. Chapter four provides a comprehensive exposition of the findings derived from the data analysis, accompanied by a concise statistical interpretation of the results. Chapter five provides an in-depth analysis of the research findings on the impacts of crude oil and gas trade variables on the gross domestic products (GDPs) of developed, developing, and least developed countries. This chapter also examines the crude oil and natural gas trade patterns in these countries and explores the implications of the patterns for global maritime transportation of crude oil and natural gas.

Chapter six provides a comprehensive overview of the research conducted, focusing on the outcomes of the analysis and their significance for the three distinct nation groups. Additionally, the chapter offers suggestions that are grounded in the study's findings.

1.13 Limitations of the Study

The study was carried out with secondarily sourced data that covers between year 1995 and 2021. The timeframe places some limitation to the applicability of the findings in explaining events before or after this time. There were cases of incomplete observation especially from the least developed countries. However, this was addressed by the panel regression which makes up for such missing values.

Chapter 2 - Literature Review

2.1. The Role Of Energy In Economic Development

The role of energy in the economic development of nations has been of significant importance throughout history, as it serves as an essential and predominantly indispensable factor in the production process. It is worth noting that oil and gas, which account for approximately two-thirds of global energy consumption, have been the primary sources to meet the world's energy demands (Bashiri Behmiri & Pires Manso, 2013).

According to the Corporate Finance Institute, (2023), over a third of the world's energy consumption has historically come from crude oil, while OPEC, (2010) put the figure at 40% of the global energy mix, making crude oil one of the most important fuel sources. Due to the significance of crude oil as an energy source, it has an extensive market that includes both physical and derivatives trading (Corporate Finance Institute, 2023). The Organization of Petroleum Exporting Countries (OPEC) claimed that throughout the 20th century and into the 21st century, crude oil's pre-eminence has paralleled the immense economic advancements made as four-fifths of this development is estimated to have occurred in the second half of the 20th century, beginning with the period of reconstruction, leading to a significant increase in energy consumption, following the second world war (OPEC, 2010)

After World War II, according to OPEC, oil became the dominant energy source worldwide, with the OECD consuming between 60 and 70 percent of all oil produced. During this time period, both total and per capita energy use were significantly lower in developing countries but this trend is starting to change as consumptions of gas have increased consistently in both OECD and developing countries (OPEC, 2010).

In recent years, however, there has been an observable inclination among nations to reduce their energy consumption. This trend can be attributed primarily to the deterioration of the environment and climate change concerns caused by oil exploration as well as the significant increases in crude oil prices. Consequently, there has been a heightened emphasis on examining the relationship between energy usage and the economic growth of nations (Behmiri & Pires Manso, 2014).

2.2. Previous Research Findings

Several prior studies have looked at how energy use affects GDP growth over time, however, further investigation is needed to enhance our understanding in this area from a different perspective.

Research was conducted on the correlation between increasing economic activity and its impact on energy consumption, as well as the reciprocal relationships. Several of these studies demonstrated positive relationships between economic growth and increased energy consumption (Sama & Tah, 2016), but not only crude oil and gasgenerated energy.

Different academic views exist on the causality between energy use and economic development, as shown by the results of econometric analysis. These differences could be attributed to factors such as econometric approaches or analytical tools, historical periods covered, countries' varying climates and geopolitical differences, economic growth plans, as well as energy output and consumption rates (Sama & Tah, 2016). Crude oil and petroleum products are vital for energy generation for economic activities and house use and are frequently traded globally (Zhang et al., 2018). However, there is no consensus on the impact of energy consumption and/or trade on economic growth.

In their study, Bildirici and Bakirtas (2014) employed an ARDL (Autoregressive Distributed Lag Bounds) testing methodology to examine the influence of international trade in crude oil on the economic development of a selected group of countries. The study utilised data from Brazil, Russia, India, China, Turkey, and South Africa spanning the years 1980 to 2011 and the findings of the study indicate the presence of a significant bidirectional causal relationship between oil energy consumption and GDP in all of the countries under investigation, suggesting a longterm impact.

Žiković and Vlahinic-Dizdarević (2011) examined the potential existence of a causal association between oil consumption and economic growth within the context of small European countries. The time frames considered for this analysis were 1980-2007 for small developed European economies and 1993-2007 for transition economies. It was found that in the case of the most developed European countries and certain transition economies, there exists a causal relationship wherein real GDP influences oil consumption. Conversely, the less developed European countries exhibited a directional relationship where oil consumption influenced economic growth. The result showed a distinction between the impact of crude oil consumption in developed European countries and less developed small European countries. That is to say that economic development drives the demand for crude oil consumption in most developed European countries whereas the consumption of oil drives economic development in less developed European countries.

Žiković and Vlahinic-Dizdarević (2011) also demonstrated that the causality in the developed European nations was influenced by the presence of a well-advanced postindustrial society characterised by a robust tertiary sector. Conversely, in the economies undergoing transition, the causality can be attributed to the phenomenon of deindustrialization and the subsequent transition depression. These factors resulted in a significant decline in the industrial sector and a consequent decrease in the demand for crude oil (Zikovi & Vlahinic-Dizdarevic, 2011). Moreover, the research findings signposted that greater levels of crude oil consumption were indicative of heightened levels of industrialization and economic advancement among the less developed European nations. Consequently, it was suggested that increased financial resources should be allocated towards subsidising oil prices and ensuring the acquisition of stable, sustainable oil supplies. This recommendation was based on the positive influence that such measures would have on the economic growth of the least developed European countries (Zikovi & Vlahinic-Dizdarevic, 2011).

In their study, Bashiri Behmiri and Pires Manso (2013) employed a multivariate panel Granger causality framework to investigate the causal association between crude oil consumption and economic growth in a sample of 23 Sub-Saharan African countries during the period spanning from 1985 to 2011. The researchers utilised crude oil price as the control variable in their model and discovered that, in the short term, there exists a bidirectional causal relationship between crude oil consumption and economic growth in economies that import oil. Additionally, a positive correlation was observed between these two variables in economies that export oil. However, it was noted that there exists a significant and reciprocal causal relationship between the Gross Domestic Product (GDP) and the consumption of crude oil in both regions. Therefore, Bashiri Behmiri and Pires Manso (2013) concluded that a reduction in crude oil consumption, in the absence of appropriate regulations, exerts a detrimental impact on the economic growth of Sub-Saharan Africa.

Behmiri and Pires Manso, (2014) also investigated the relationship between the economic development of Latin America and crude oil consumption. Using the framework of panel regression, they examined the relationship between several regions, including six Caribbean, six Central American, and eight South American nations. The findings of the study indicated that there is no Granger causality between economic growth and crude oil consumption in the examined regions. This implies that policymakers can implement crude oil conservation policies without incurring substantial negative economic consequences. The study additionally revealed that there exists a positive, long-term relationship between crude oil consumption and GDP in Central America. Specifically, a 1% increase in crude oil consumption leads to a 0.16% increase in GDP, indicating the relatively low responsiveness of GDP to fluctuations in crude oil consumption. Based on this discovery, it was advised that the implementation of crude oil conservation strategies in such regions should be approached with increased caution.

Sama & Tah, (2016) established that GDP, population growth, and the prices of petroleum are positively related to energy use. After researching the impact of energy consumption on economic growth in Cameroon from 1980 to 2014 using the

Generalised Method of Moments. The study further revealed that since economic growth is directly correlated with energy production and consumption, expanding alternative energy sources like solar, wind, and thermal energies will be beneficial for economic development. In other words, barring the availability and sustainability advantages of green energy sources, increasing crude oil consumption in Cameroon will further improve the country's economic development.

Bhusal (2012) looked into what role crude oil plays in the economy of Nepal and how that can affect GDP. Short-term and long-term effects were examined using yearly data from 1975 to 2009. Employing the Granger causality test, evidence of short and long-term reciprocal Granger causality between oil consumption and economic growth was observed. These two variables share the same order of cointegration (I (1)), suggesting that they are highly correlated.

Sultan & Alkhateeb, (2019) noted that the 1970s oil price shock had a profound effect on economies all around the world. It found that energy consumption and actual output were found to interact, but the direction of causality between the two could not be established. Moreover, the study revealed a sustained equilibrium between energy consumption and actual economic production in India over an extended period, as evidenced by the analysis of data spanning from 1971 to 2014. According to Sultan and Alkhateeb (2019), the findings of the study indicate the presence of a unidirectional association between energy and India's economic development in the short term, while a bidirectional relationship is observed in the long term.

An alternative approach to assessing the economic implications of crude oil involves examining the effects of price fluctuations on two distinct categories: countries that are net importers of crude oil and countries that are net exporters of crude oil. Behmiri and Pires Manso (2014) assert that a positive shock in crude oil prices leads to an increase in the purchase price of crude oil for net importing countries. This, in turn, may have detrimental effects on their economic growth. Conversely, net exporting countries experience a positive impact on their economic growth as they can sell oil at higher prices. It is important, however, to note that while this may be advantageous in the short term, in the long-term these countries may face negative consequences due to the global crisis that occasioned the rise in oil prices. Accordingly, the effect of an oil price surge or crude oil consumption on a nation's economic activity depends on whether the nation is a net oil importer or exporter (Behmiri & Pires Manso, 2014).

2.3 The Energy Market Dynamics

Energy plays a central role in the course of development by facilitating investments, fostering innovations, and nurturing emerging industries, thereby serving as the driving force behind job creation, inclusive economic growth, and the promotion of shared prosperity at a macroeconomic level (World Bank, 2023). However, about 675 million people continue to lack access to electricity (World Bank, 2023). Approximately 2.3 billion individuals engage in the utilisation of fossil fuels for cooking or heating their residences, thereby posing detrimental effects on both their well-being and the surrounding ecosystem, according to the World Bank 2023 report. Despite this global challenge, occasional shocks in the energy market further compound the existing energy crisis. The World Bank (2023) reported that from the onset of 2022, the global energy markets experienced a substantial disruption of unprecedented magnitude. This disruption was attributed to the effects of the COVID19 pandemic, along with the current conflict in Russia and Ukraine, which has contributed to increased volatility in energy prices resulting in worsening energy shortages and raising concerns about energy security. Furthermore, these factors have impeded advancement in achieving universal access to affordable, reliable, sustainable, and modern energy by the year 2030, as outlined in SDG 7 of the United Nations.

Energy price shocks have a significant impact on a majority of countries, with developing and least developed nations bearing the greatest burdens, particularly those that rely on energy imports. The insufficient capacity to address energy price fluctuations has resulted in energy apportioning in certain nations and an increase in poverty levels.

Like in a typical competitive market, the forces of demand and supply largely determine the world energy outlook and key factors to consider in this regard are the drivers of energy demand (Watchwire, 2018). Similar to other commodity markets, the pricing of electricity is determined by these forces. When the quantity demanded exceeds the quantity supplied, prices tend to increase, and conversely, when the quantity supplied exceeds the quantity demanded, prices tend to decrease. During periods of extreme cold in winter, there is a notable increase in prices due to the competition between power generation and heating systems for the limited supply of natural gas (Watchwire, 2018).

Three key sectors that drive the energy demand are electricity for industrialization and households, transportation, and heating. In effect, the level of industrialization of a country may influence its demand for electrical energy. The same goes for transportation. A highly industrialised nation will need for more energy to improve and sustain its industrialization and transportation network that keeps its economy thriving. On the other hand, heating-induced demand for energy follows the climatic conditions of countries. For instance, the Nordic region of Europe usually experiences very cold weather conditions for the most of the year and this positively influences their need for energy for heating. Countries located near the equator experience very hot weather conditions and will require energy for cooling, hence influencing the global energy demand. However, during periods of low demand, such as the shoulder months characterised by minimal requirements for heating or cooling, prices typically exhibit a stable trend (Watchwire, 2018).

The gradual decline and decommissioning of nuclear, coal, and oil-fired power plants have resulted in a growing dependence on natural gas-fired generators. The United States in 2017 generated approximately 32% of electricity using natural gas (EIA, 2022)

2.4 Energy Consumption and Economic Development

Energy demand and consumption drive the trade in crude oil and natural gas. However, there are varying opinions about energy consumption and per capita GDP. The discourse around the correlation between energy consumption and per capita GDP has been a subject of continuing analysis and discussion among academic circles, governmental bodies, and research communities. There is a contention among scholars that energy, in conjunction with other variables of production such as capital and labour, plays a significant role in driving economic growth (Huseyin Kalyoncu et al., 2013). Conversely, there exists a viewpoint positing that energy consumption is just a small fraction of the gross domestic product (GDP) and lacks much influence on the trajectory of economic development.

It is crucial to admit that our examination of international trade of energy primarily focuses on the monetary values of these trades, rather than the energy consumption within a country. It is recognized that an increase in trade values of crude oil and natural gas by a nation during a certain time frame might potentially indicate a rise in demand, probably due to increasing consumption. However, it is important to note that this correlation may not always hold.

The existing body of research presents varying perspectives on the correlation between energy usage and economic development. The diverse empirical findings may be explained by differences in the time frame considered, the variables are chosen, the geographical area of emphasis, and the econometric methods utilised (Huseyin Kalyoncu et al., 2013), as demonstrated in several research mentioned hereunder. In their study, Yu and Jin (1992) employed the Bivariate Granger Test to demonstrate the absence of a causal association between energy consumption and economic growth in the United States, a nation classified as developed. Similarly, Stern (1993) employed the Granger Causality Test to establish the lack of a causal relationship between economic progress and energy consumption in the United States.

Masih and Masih (1996) employed the Sims Causality and Granger Causality frameworks to examine the association between economic growth and energy consumption in several countries, namely Malaysia, Singapore, Philippines, India, Indonesia, and Pakistan. The findings of their analysis revealed that no significant relationship exists between economic growth and energy consumption in Malaysia, Singapore, and the Philippines. However, in the case of India and Indonesia, energy consumption was found to have a unidirectional impact on economic growth. Conversely, in Pakistan, the relationship between energy consumption and economic growth was found to be bidirectional.

Yu and Choi (1985) utilised the Granger Test to examine the causal relationship between energy consumption and economic growth in several countries, including the United States, the United Kingdom, Poland, South Korea, and the Philippines. Their findings indicated that no causal influence was seen between energy consumption and economic development in the US, UK, and Poland. However, they did find evidence suggesting that energy consumption leads to economic development in South Korea and the Philippines.

Moreover, Glasure and Lee (1998) employed the Bivariate Vector Error Correction Model (VECM) to demonstrate the presence of bidirectional causation between economic growth and GDP in South Korea and Singapore. Similarly, Cheng (1999) demonstrated that in the context of India, there exists a positive relationship between economic growth and energy use.

Asafu-Adjaye (2000) used the Trivariate Vector Error Correction Model (VECM), to show that energy consumption in India and Indonesia has unidirectional positively associated with economic growth. However, in the case of Thailand and the Philippines, a bidirectional causal relationship was seen between economic growth and energy consumption.

Soytas and Sari (2003) employed a Bivariate Vector Error Correction Model (VECM) to demonstrate the causal effects from economic growth on energy usage in Turkey and South Korea. Conversely, their findings indicate that in Argentina, Canada, the USA, and the United Kingdom, there exists a mutual impact between energy use and economic growth.

In their study, Fatai et al. (2002) employed the Granger causality test to determine whether there was a statistically significant association between economic development and energy consumption in New Zealand. Their findings led them to conclude that no such link was seen. Altinay and Karagal (2005) conducted a study whereby they employed Hsiao's version of Granger Causality to demonstrate the absence of a correlation between energy consumption and economic development in Turkey.

Narayan and Smyth (2008) employed a multivariate panel Vector Error Correction Model (VECM) to analyse the relationship between energy consumption and economic growth in the G-7 nations. Their findings indicated that energy use had a positive impact on economic development within the G-7 countries. In a similar study conducted by Ozturk et al. (2010), panel causality was employed to examine the relationship between economic growth and energy use across 51 countries categorised as low-income, lower-middle-income, and upper-middle-income. The findings revealed that in low-income countries, economic growth positively influences energy use. In middle-income countries, a two-way causality was observed between economic growth and energy use. However, no significant relationship between energy use and economic development was found in upper-middle-income countries.

Furthermore, Apergis and Payne (2009) employed a multivariate panel Vector Error Correction Model (VECM) to examine the causative relationships in 11 nations belonging to the Commonwealth of Nations. Their findings indicated the presence of a bidirectional causation between energy consumption and economic development within these countries.

Moreover, a scholarly investigation conducted by Lee and Lee (2010) employed a multivariate panel Vector Error Correction Model (VECM) to demonstrate the existence of bidirectional causation between economic development and energy consumption across 25 member nations of the Organization for Economic Cooperation and Development (OECD). In a similar vein, Bekle et al. (2010) employed the Granger Causation Test to demonstrate the presence of bidirectional causation between economic development and energy consumption across a sample of 25 OECD nations.

2.4. The Established Gap from Previous Studies

In the above-referenced literature, we see conflicting results which could be attributed to the time frame covered by the research or the level of industrialization of the country of study. It is evident also that the studies focused mostly on individual countries or regional countries. However, there is yet any research that considers the energy consumption across the World Bank country groupings vis-à-vis developed, developing, and least developed countries.

In most of the existing work, there was broad consideration of energy consumption to include solar, coal, and other sources of electricity apart from hydrocarbons.

In a study conducted by Samawi et al. (2017), path analysis and structural equation modeling were employed to examine the relationships between energy supply and economic growth in oil-importing countries. The researchers investigated both the direct and indirect effects of energy supply, identifying the linkages and mediating variables involved in this relationship. The researchers discovered a robust correlation between energy supply and economic growth, wherein the impact on the economy is contingent upon the specific energy source and the mediating variables involved. Although the research focused on the impact of energy, it paid attention to the oilimporting countries and not the exporting countries. Also, oil-importing countries cut across the various categories of economies, hence, the study did not show how patterns of trade in crude oil influence economic development across the three major economy groupings of the World Bank, which is one of the main thrusts of this research.

In their study, Sultan and Haque (2018) utilised the cointegration method developed by Johansen to analyze empirical data from Saudi Arabia. Their findings revealed the existence of a long-term association between economic growth and variables such as crude exports, imports, and government consumption expenditure. While Saudi Arabia is recognized as a developing nation and maintains a significant role as a net exporter of crude oil, it would be misleading to assume that the effects of crude oil exports in other developing countries that also engage in net oil exports would be identical.

In a similar research by Gbadebo, (2008) on the impact of the crude oil sector on Nigeria's economic performance, it was found using Ordinary Least Squares regression analysis that rising crude oil consumption and exports have boosted the Nigerian economy. Again, the study focused on a single country’s (Nigeria’s crude) exports but not imports. Although Nigeria is a net exporter of crude oil, it also imports large quantities of refined products using various trade models, including crude oil swaps (Gbadebo, 2008). Thus, isolated analysis of countries' crude oil trade is unlikely to give a more generally acceptable relationship due to the impact of some intervening variables from country to country.

In their study, Mlaabdal et al. (2020) proposed a comprehensive approach to analyzing the cointegration and causal relationships that underlie national economic development. They employed a two-step methodology, beginning with the application of a heterogeneous modified ordinary least squares (HMOLS) model to identify a linear relationship between economic development indicators (such as GDP, capital, and labour costs) and indicators of national economic functioning (including volumes of oil production and rent payments for oil). Subsequently, they employed the Granger method based on a developed time series model known as the Vector Error Correction Model (VECM) to determine the causal links between national economic growth, oil production, and rent payments. This method involved adjusting parameter dynamics based on the long-term relationships between variables and their deviations. The findings of Mlaabdal et al. (2020) indicate that there exists cointegration and causal relationships between the development of the oil sector and the overall national economy. Specifically, the analysis reveals that both oil output and rent payments have a positive impact on the gross domestic product (GDP) of countries belonging to the Organisation of the Petroleum Exporting Countries (OPEC), as well as high-income and middle-income nations. However, it is noteworthy that in low-income countries, a 10% increase in oil production leads to a relatively smaller increase of 0.2% in GDP. While the research conducted by Mlaabdal et al. (2020) primarily concentrated on the crude oil production in high, middle, and low-income countries that are net exporters of crude oil, it did not investigate the influence of crude oil on the economies of high, middle, and low-income countries that are net importers of crude oil. This research aims to fill this knowledge gap as well.

Accordingly, considering the relevance of crude oil and natural gas in energy generation across economies (and its impact in the foreseeable future), it is considered pertinent to study how trade in crude oil and natural gas, as well as their consumption impact the three broad economic classification as developed, developing and least developed nations, using GDP as an approximation for economic development.

2.5 The Research Focus

Given the foregoing, this research work is aimed at investigating if there is a significant relationship between international energy trade (crude oil and natural gas) and GDP within the framework of developed, developing, and least developed countries. We seek to establish a pattern of development across the three major categories of economies based on their trade in crude oil and natural gas, as well as total energy consumption. In other words, using crude oil, natural gas, and other petroleum products' import and export data as the independent variables, this study aims to determine if, and how the GDPs of the three categories of economies respond to changes in these independent variables over time.

Therefore, it is imperative to conduct an investigation and ascertain a discernible pattern of crude oil and natural gas trade across different country groupings. This will facilitate the establishment of a more universally recognized correlation between international trade in crude oil and natural gas, and the economic development of these respective country groupings.

In the absence of additional factors that impact the economic development of nations, the establishment of a crude oil trade pattern in developed countries may serve as a valuable reference for developing and least developed economies. Such a pattern can offer insights on actions to undertake, actions to avoid, or actions to terminate to promote the economic development of these countries.

To achieve this, the analysis is carried out in three broad categories of economies as provided by the World Bank (2020) as follows:

- Developed economies/countries
- Developing economies/countries
- Least developed economies/countries.

This grouping is to examine the relationship or impact that these trade patterns have on the GDPs of countries within the different economic categorization.

The findings of this study will be beneficial to all economies in terms of crude oil and natural gas trade, and energy consumption policies.

Chapter 3 - Research Method And Data

3.1 Research Method

All research projects need a technique to help the researcher define the problem, collect data, and draw conclusions about the relationship between the independent and dependent variables (Bazeley, 2013). To understand or establish the natural relationship between GDP and international trade of energy, a quantitative model is imperative. Accordingly, a panel regression technique has been identified to suit the objectives, data, and the hypothesis of this research work.

3.2 Identification And Justification Of Variables

Several variables influence the GDP of a nation. Some are quantitative in nature and therefore are measurable while others are qualitative and cannot be measured. Since this study focuses on the economic implications of international energy (crude oil and natural gas) trade and the economic development of nations, using GDP per capita as an approximation for economic development, related variables have been identified. Accordingly, crude oil production, crude oil export/import, other petroleum products export/import (excluding crude oil), natural gas import/export, energy consumption, oil electricity, and gas electricity were identified as independent variables with GDP per capita as the dependent variable.

3.2.1 Gross Domestic Product per Capita (Dependent Variable - Y)

To examine the influence of energy trade on the economies of countries as classified by the United Nations, GDP is considered a suitable indicator for assessing the economic development of a nation. GDP is the conventional metric used to quantify the value generated by the production of goods and services within a specific country over a given timeframe (OECD, 2023). It quantifies the revenue generated from said production or the aggregate expenditure on end products and services (excluding imports).

According to Callen (2022), the concept of GDP involves the quantification of the monetary worth of final products and services, namely those acquired by consumers, that are generated inside a country's borders during a designated period, such as a quarter or a year. As a result, GDP serves as a comprehensive measure of all the economic production created within a nation's territorial confines. GDP includes both marketable goods and services, as well as non-market activities such as governmentprovided defense or educational services (Callen (2022). The significance of GDP lies in its ability to offer insights into the magnitude and well-being of an economy, given that real GDP growth is often employed as an indicator of the economy's general state. There are three distinct perspectives through which GDP can be analysed. Firstly, the value-added at each stage of the production approach entails computing the total sales figure while subtracting the cost of intermediate manufacturing inputs. Secondly, the expenditure method involves determining the value of final consumers' purchases. Lastly, the income strategy involves aggregating the revenues generated from production (Callen, 2022).

However, GDP alone may not adequately reflect the material well-being of individuals within a country (OECD, 2022). Therefore, alternative indicators may be suitable for capturing this aspect of people's welfare in respect of a country's overall economic well-being. Generally, an increase in real GDP reflects a positive correlation with a nation's economic well-being. As an approximation for economic development, this study uses GDP as the dependent variable and would be sourced for each of the countries under their categories (developed, developing, and least developed) for the period covering 1995 and 2021.

3.2.2 Crude Oil Production per Capita (Independent Variable X1)

The quantity of oil recovered from the earth after the removal of inert materials and contaminants is referred to as crude oil production. It consists of crude oil, Natural Gas Liquids (NGLs), and other additives (OECD, 2019). Crude oil production is a critical factor in the crude oil trade. Thus, for a meaningful study on the impact of crude oil trade on the economies of trading nations, there is a need to understand crude oil production about crude oil trade. In essence, it is general economic knowledge that the production and supply of crude oil is critical in meeting global energy demand. Thus, volatilities in the demand and supply dynamics affect international trade in crude oil and the supply of crude oil is a function of its production.

Crude oil is also referred to as the lifeblood of the contemporary international energy infrastructure. It is not just the primary energy source, but also the primary source of income which helped the development and wealth of the Western world. Due to constraints caused by peak oil, the future supply of oil is uncertain and may potentially decline despite being essential to every facet of modern life (Mikael, 2009). The main suppliers of crude oil in the global market are the OPEC and non-OPEC countries. The behaviour of these two groups in crude oil production determines the supply and price of crude oil in the global market barring the influence of other factors.

OPEC is an intergovernmental organisation that was established during the Baghdad Conference held from September 10-14, 1960 with Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela as founding members (OPEC, 2022). Over time, the organisation has expanded to include 13 member nations. The primary goal of OPEC is to facilitate the coordination and harmonisation of petroleum policies among its member nations. This objective aims to ensure equitable and stable pricing for petroleum producers, as well as guarantee a consistent cost-effective, and reliable supply of petroleum to all nations that consume it. Additionally, OPEC seeks to provide a justifiable return on investment for individuals and entities that have invested resources in the petroleum industry (OPEC, 2019). OPEC has consistently maintained a significant presence in the global oil market by effectively managing crude oil production levels among its member nations through the implementation of quotas. As a result, OPEC exercises considerable influence over global crude oil supply, pricing dynamics, and trade.

Kisswani et al. (2022) analyzed the influence of non-OPEC oil supply on the production level of OPEC oil production. This examination was carried out by employing the Quantile Autoregressive Distributed Lags (QARDL) model, which enables the investigation of both short-term influences and long-run cointegrating relationships across various quantiles. The researchers utilised monthly data spanning from January 1993 to March 2020 for their analysis. The primary results indicate that the impact of non-OPEC production on OPEC production exhibits symmetry in the long term, while being contingent on quantiles in the short term (Kisswani et al. 2022). Also, in the short term, a substantial reduction in OPEC production as a result of an upsurge in non-OPEC production was noted. Nevertheless, over time, the growth in non-OPEC production leads to an escalation in OPEC production. Additionally, the findings indicate that there is a positive relationship between oil prices and OPEC production in both the short-term and long-term (Kisswani et al. 2022).

Loosely using crude oil import and export data to signify consumption in a nation could be misleading because international trade guarantees that not all imported commodities are completely consumed in the importing country. There is a possibility of transshipment or crude oil refining to generate other products. In some instances, imported crude oil may be refined and exported to other countries. Thus, reflecting that not all crude oil imports into an economy translate to energy consumption. Hence the a need to consider crude oil production as an independent variable in the analysis of the impact of international trade in crude oil on the economic development of nations.

3.2.3 Crude Oil Export per Capita (Variable – X2)

Crude oil export was considered in this study as an independent variable since it is seen to influence the economies (GDP) of trading nations. International trade in crude oil encompasses crude oil export or import or both.

According to Workman (2023), the global export of crude oil reached a total value of US$1.35 trillion in 2022, making it the most valuable product exported worldwide. This surpasses the previous year's leading export, which was electronic integrated circuits and related parts. The proportion of crude petroleum oils in the aggregate export of commodities witnessed an increase from 4.6% in 2021 to 5.6% in 2022 (Workman, 2023).

The research conducted by Esfahani et al. (2012) established a long-term relationship between output and oil income in a significant crude oil-exporting economy. This study expands upon the stochastic growth model developed by Binder by incorporating oil exports as an additional factor in the process of capital accumulation. Specifically, the analysis reveals the presence of long-run relationships between real output, foreign output, and real oil income in six out of the nine economies that were examined (Esfahani et al. 2012).

The aforementioned studies suggest that the export of crude oil plays a significant role in a country's economic development. Therefore, it is appropriate to include crude oil export as an independent variable in this study. The aim is to examine the nature of the relationship between economic development and crude oil export across three different categories of nations.

3.2.4 Crude Oil Import per Capita (Variable -X3)

One additional factor that requires attention in the examination of the impact of energy trade on economic development is the value of crude oil imports by various nations groups. Generally, the economic contribution of crude oil trade to any nation should extend beyond the revenue generated from the sale of crude oil in terms of foreign exchange earnings. The importation of crude oil also plays a significant role in the economic value chain of a nation by providing energy support, creating employment opportunities, and adding value through refining processes, among other contributions. As an illustration, Kim and Baek (2013) noted that crude oil fulfills approximately 45% of Korea's primary energy requirements. The industrial sector in Korea is responsible for approximately 56% of the overall crude oil consumption. However, due to the absence of established domestic oil reserves, Korea is entirely dependent on imports to fulfill its demand for crude oil. Consequently, the economic growth driven by energy-intensive industries leads to a significant surge in the importation of crude oil in Korea. The importation of crude oil in Korea has experienced a steady growth trajectory since 1989, resulting in its ascent to the position of the seventh-largest oil consumer and fourth-largest oil importer globally in 2009 (Kim & Baek, 2013).

One fiscal trend observed in Ghana was the practice of financing a substantial portion of crude oil importation through export earnings. In 2007 alone, approximately 50.2% of the country's export earnings were allocated towards financing crude oil purchases, thus establishing the influence of crude oil imports on Ghana's national economy (Marbuah, 2018) and supporting the inclusion of crude oil imports as one of the explanatory variables in our study.

Unfortunately, a significant number of nations across the globe lack substantial reserves of crude oil. Consequently, to fulfil their energy needs and sustain industrial output, these countries heavily rely on the importation of crude oil. Energy consumption plays a central role in economic development and growth (Sadorsky, 2011). Given the significance of crude oil to nations, those with limited or non-existent crude oil resources within their territories depend on importing crude oil to fulfill their energy requirements for energy generation. Therefore, crude oil import value is regarded as a significant factor when examining the effects of international energy trade from the perspectives of developed, developing, and least developed countries.

3.2.5 Other Petroleum Product Export excluding Crude Oil per capita (Variable -X4)

Crude oil is source material for many other by-products including but not limited to aviation turbine fuel, petrol, diesel, kerosene, fuel oil, napalm, polyurethane, paraffin, naphtha, naphthalene, plastic, bitumen, polyester, and liquefied petroleum gas (The Editors of Encyclopaedia Britannica, 2016). Trade in these petroleum products is considered to affect the economies of nations. For instance, the use of aviation fuel in any nation may indicate how developed and viable its aviation industry is. More so, the by-products traded or exported vary from nation to nation depending on comparative advantages. Thus, exports of petroleum by-products by nations could have a significant impact on their economy (per capita GDP), hence the inclusion of other petroleum products exported (excluding crude oil) as an independent variable for this study.

To buttress the inclusion of this variable, research conducted by Azretbergenova and Syzdykova (2020) examined the "Dependence of the Kazakhstan Economy on the Oil

Sector and the significance of Export Diversification," revealing the significance of petroleum products about Kazakhstan's overall economic landscape. Approximately 50% of budget revenues in Kazakhstan are derived from oil and petroleum products export, depicting a significant reliance on oil-related income which led to the depreciation of the national currency (KZT) by 20% and 60% respectively, during the first and second stages of oil prices decline in 2014 (Azretbergenova & Syzdykova, 2020).

Pirlogea and Cicea (2012), studied the relationship between energy consumption by fuel and economic growth in Spain, Romania, and EU employed a three-step methodology using data from 1990 – 2010. It established that in the long run, there is evidence of a correlation between energy consumption from total petroleum products and economic growth, as measured by GDP per capita in constant prices while in the short term, only two relationships were highlighted, both of which support the growth hypothesis. Hence, the other petroleum products export is included as an independent variable in this study.

3.2.6 Other Petroleum Product Import excluding Crude Oil per capita (Variable X5)

In a similar consideration as above, it is safe to include other petroleum products imports to the list of independent variables to be used to explain changes in GDP on account of international trade of energy.

Fluctuations in global petroleum prices affect both importing and exporting nations economies. According to Coady et al. (2010), additional evidence to support the notion that in the absence of policy or behavioral changes, the ratio of the value of net oil imports to GDP can serve as an indicator of the potential impact, in terms of percentage of GDP, of a twofold increase in the international price of petroleum. The price of petroleum products affects GDP but this is mostly possible through the instrumentality of trade (Coady et al., 2010). Hence, the import value of other petroleum products (excluding crude oil) is considered to influence the GDP.

3.2.7 Natural Gas Export (Variable X6) and Natural Gas Import (Variable X7)

The natural gas export variable represents the total annual value of natural gas export from a given country to the rest of the world while the natural gas import variable represents the total annual value of natural gas imports from the rest of the world to a given country. Natural gas is extensively employed as a fossil fuel due to its environmental attributes, such as low carbon dioxide emissions, high efficiency in power generation as well as increasing demand from the industrial sector (UNCTAD, 2012). Natural gas reserves are geographically distributed across various regions. It is commonly regarded as the preferred fuel option, taking into account both environmental and economic perspectives. It presents prospects for industrial development and propels the economies of various nations.

Natural gas consumption and economic growth in the Gulf Cooperation Council (GCC) nations show a positive co-integration (Ozturk and Al-Mulali, 2015), using a panel dynamic ordinary least square (DOLS) and completely modified ordinary least square (FMOLS) methodologies. Since natural gas, as a bridge gas, is widely used for energy generation across the globe, the inclusion of both the export and import components of natural gas trade in our variable mix is considered appropriate for this study.

3.2.8 Total Energy Used (Variable X8)

Energy use encompasses not just the utilisation of electricity but also extends to other spheres such as transportation, heating, and cooking and it is measured in kilowatt hour (KWH) per person (Our World in Data, 2023). Understanding the causal link between energy consumption and economic development provides valuable insights in formulating effective energy conservation policies (Azam et al., 2015). A reduction in energy consumption might potentially lead to adverse consequences such as reduced income levels, higher unemployment rates, or a shortfall in the budget, hence, it is significant (Huseyin Kalyoncu et al., 2013).

Although several scholars have conducted a study of the correlation between energy consumption and GDP across various nations a definitive consensus is yet to be achieved (Huseyin Kalyoncu et al., 2013). The divergent empirical findings can be attributed to variations in temporal scopes, variable selections, geographical contexts, and statistical approaches employed.

3.2.9 Oil Electricity (Variable X9) and Gas Electricity (Variable X10)

The oil electricity per capita variable represents the quantity of electricity generated from oil per person measured in kilo-watt hour (KWH) per annum. In the same vein, the gas electricity per capita variable represents the quantity of electricity generated from gas per person measured in KiloWatt Hour (KWH) per annum.

A strong correlation between economic performance and electricity usage suggests that the economy can only grow by the pace at which electricity production grows (Hirsh & Koomey, 2015).

Figure 3.1 below shows that there is a relationship between GDP growth rate and electricity demand growth. We therefore seek to know the contribution of two main sources of electricity (oil and gas) to the economic development of the country groups to inform rational policy decisions of these nations.

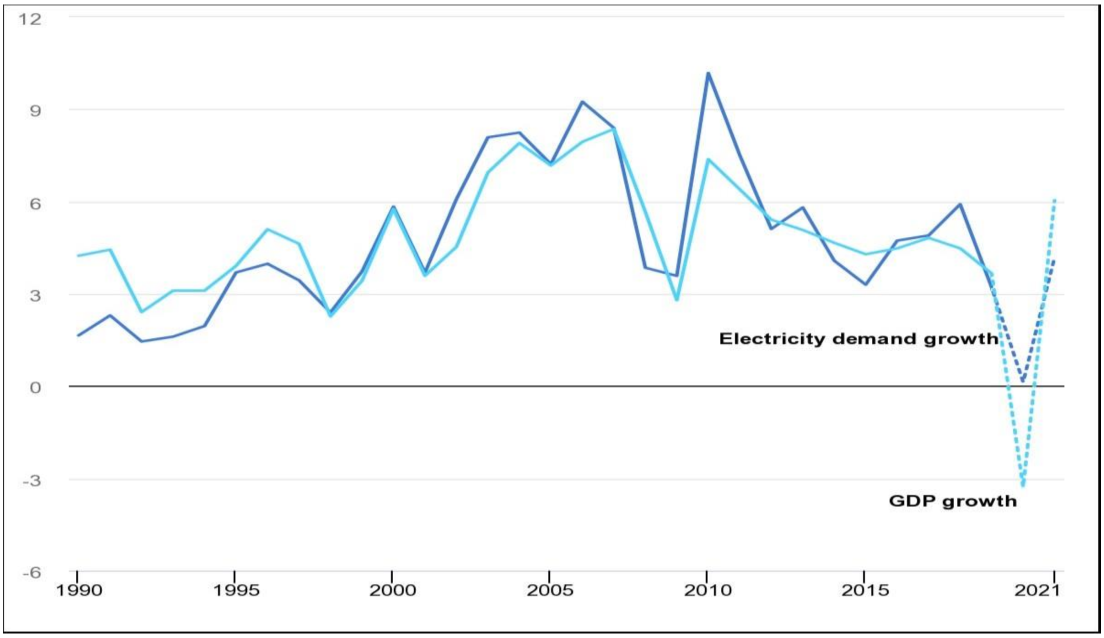

Figure 4: World GDP and Electricity Demand Growth Rates

Source: International Energy Agency, 2020

In summary, the above-identified variables (dependent and independent) will be analysed to show the nature of their relationship vis-à-vis the economic development of nations across the three broad nations categories: developed, developing, and least developed nations.

3.3 Data Collection And Presentation

3.3.1. Type of Data

This study employed secondary data. Most secondary data are sourced from surveys, observations, questionnaires, and governmental, intergovernmental, and nongovernmental organizations (Womack, 2023). The study relied on historical time series data obtained from the World Bank, UNCOMTRADE, UNDATA, World Economic Situation and Prospects, and OECD databases, since it seeks to analyse the economic implications of international energy trade.

3.3.2 The Scope and Frequency of Data

The data for this study covers the period 1995 to 2021 for all countries under the three broad categories of nations namely developed, developing, and least developed on an annual basis.

3.4 The Research Model

To understand the concept and application of panel regression, it is imperative to briefly discuss the features of panel data which is used in running a panel regression.

3.4.1 Overview of Panel Data

Panel data, often known as longitudinal data, is a type of data consisting of multiple time series observations by measuring the same variables on the same unit multiple times (Brüderl et al., 2019). Thus, it involves using at least two dimensions of observation. For example a cross-sectional dimension denoted by ‘i’ and a time series dimension denoted by ‘t’. It may further exhibit a more intricate hierarchical or clustering structure such that a variable could be the readings of air quality at a location ‘j’, of country ‘i’, at a time ‘t’ (McManus, 2011). Panel data is one of the three basic categories of longitudinal data together with time series data and pooled crosssectional data.

Time series data involves many observations (large t) made on even a single unit or entity (small N). Examples are stock price trends and aggregate national statistics (McManus, 2011).

Pooled cross-sectional data is when two or more independent observations of several units (large N) are taken from the same population at varying times such as general social surveys and population surveys (McManus, 2011).

Panel data entails more than one observation 'j', taken from many 'i' entities (large N) at a time 't' such as panel surveys of households and individuals, data on different organisations and firms at varying times, time-aggregated regional data (McManus, 2011)

3.4.2 The Panel Data Notation

In panel data involving observations on 'N' entities over 'T' time periods, measurements are taken from each of 'N' entities (subjects) 'T' a number of times. These entities could be institutions, persons, businesses, nations, etc. Some variables in the panel may change over time for t = 1,..., T, but others such as a person's gender, a company's location, or a person's ethnicity, may remain constant (Fingleton, nd). A panel data is deemed to be in balance if and only if there are no gaps or missing values or data in between them. Hence, we have unbalanced panel data if 'N' and 'T' observations do not match or they contain missing data/values. Usually, 'N' is bigger in relation to 'T' but not always (Fingleton, nd).

In panel data, given that Y denotes the dependent variable and X denotes the independent variable, the following notations suffice: Y_{it} = dependent variable value for entity i at time t

X_{1it} = Independent variable 1 value for entity i at time t

X_{2it} = Independent variable 2 value for entity i at time t

…

…

X_{Kit} = Independent variable K value for entity i at time t.

In summary, the table below shows the presentation of panel data for two time periods.

Table 2: Panel Data Outlay

id	time	Y	X
1	1	y_{11}	x_{11}
1	2	y_{12}	x_{12}
2	1	y_{21}	x_{21}
2	2	y_{22}	x_{22}
⋮	⋮	⋮	⋮
N	1	y_{N1}	x_{N1}
N	2	y_{N2}	x_{N2}

Source: (Brüderl et al., 2019)

Notably, cross-sectional data comprises of observations on ‘n’ subjects (N-entities), while panel data has observations on ‘n’ entities at $T \geq 2$ time periods indicated as (X_{it}, Y_{it}), for i = 1, . . . , n and t = 1, . . . , T where the index ‘i’ denotes the entity (subject) and ‘t’ refers to the period (Hanck et al., 2023).

3.5 Overview Of Panel Regression Model

Panel regression analyses multiple observations of a group of independent variables on multiple observations of one or more dependent variables (Hanck et al., 2023). For this study, unbalanced panel data involving N cross-sectional units, i = 1,... , N, over T periods, t = 1,... , T will be used.

To develop the panel model, we adopted the following connotations:

Y_{it} represents the dependent variable Gross Domestic Product per capita of the country i over time t.

X_{1it} represents the crude oil production per capita of country i over time t

X_{2it} represents the crude oil export value per capita of country i over time t

X_{3it} represents the crude oil import value per capita of country i over time t

X_{4it} represents the other petroleum products export value per capita (excluding crude oil) of country i over time t.

X_{5it} represents the other petroleum products' import value per capita (excluding crude oil) of country i over time t.

X_{6it} represents the natural gas export value per capita of a country i over time t.

X_{7it} represents natural gas import value per capita of a country i over time t.

X_{8it} represents the total energy use per capita of a country i over time t.

X_{9it} represents oil electricity per capita of a country i over time t.

X_{10it} represents gas electricity per capita of a country i over time t.

Thus, using generalised least squares to estimate the regression parameters, α and β, the prospective panel regression model could be presented in the form:

$$Y_{it} = \alpha_i + \beta_{1it} X_{1it} + \beta_{2it} X_{2it} + \beta_{3it} X_{3it} + \beta_{4it} X_{4it} + \beta_{5it} X_{5it} + \beta_{6it} X_{6it} + \beta_{7it} X_{7it} + \beta_{8it} X_{8it} + \beta_{9it} X_{9it} + \beta_{10it} X_{10it} + \mu_{it}$$

Where $i = 1, 2, \ldots, N$ $t = 1, 2, \ldots, T$ μ_{it} = the error term associated with the estimation of the regression parameters.

Another way of presenting the panel regression model is the vector form viz:

$$Y_{i,t1} = X'_{I,t1} \beta_{t1} + \mu_{i,t1}$$

$$Y_{i,t2} = X'_{I,t2} \beta_{t2} + \mu_{i,t2}$$

…

…

…

$$Y_{i,T} = X'_{I,T} \beta T + \mu_{i,T}$$

$T = 1,2,\ldots, T$

We can say that

$$Y_{i} = X_{i} \beta + \mu_{i}$$

Where $Y_i = Y_{i,t1}, Y_{i,t2, \ldots,} Y_{i,T}$

3.5.1. The Objective of Analysing a Panel Data

Panel data analysis is a statistical method employed to examine the dynamics of variables or factors over time (Hanck et al., 2023). It is utilised to obtain more accurate estimations of trends in social phenomena, establish causal models, or determine the nature of relationships between multiple variables. This approach involves observing and analysing data from multiple individuals or entities over an extended period. (Hanck et al., 2023), thus, it is appropriate in analysing the economic implications of international energy trade across the three categories of nations.

An illustrative instance of panel data is a collection of academic performance data for a group of students across multiple courses over a specified duration for analysis. Another instance that pertains to panel data analysis is a study consisting of aggregate information on 128 countries over a span of 30 years to examine the impact of democracy on human capital and economic growth (Hanck et al. 2023).

In the context of this research, the panel data typically consists of the Gross Domestic Products (GDPs) of the three categories of nations namely developed, developing, and least developed), observed over a specific period. Similarly, the compilation of crude oil export values from various countries within the categories under investigation from 1995 to 2021 effectively represents a comprehensive panel data set. The aforementioned principle applies to all other variables being examined in the study. We must note that panel datasets have the potential to incorporate additional variables that may vary over time or remain constant. This implies that the measurement of the panel data is not inherently subject to temporal variation. In other words, a collection of panel data can be acquired at a consistent interval, such as within a specific year or any other designated time frame.

The utilisation of a suitable panel regression model on a collection of panel data can yield results that have the potential to establish a causal connection between variables that are observed repeatedly over time. This study focuses on investigating the economic implications of international energy trade in particular, crude oil and natural gas energy in developed, developing, and least developed countries using a panel regression approach.

3.5.2 Advantages of panel regression

Panel data which combines inter-individual differences and intra-individual dynamics, offers several advantages compared to cross-sectional or time-series data (Hsiao, 2006), as stated below.

i. Panel data analysis enables the identification of causal effects with less stringent assumptions, in comparison to the utilisation of cross-sectional data. It makes it possible to ascertain the temporal sequence of events, thereby enabling the examination of the impact of an event on the outcome (Brüderl et al., 2019).

ii. It enables the examination of individual trajectories, specifically individual growth curves about various factors such as wage, materialism, and intelligence. Within this context, it is possible to differentiate between group effects and age effects. - The process of transitioning into and out of states, such as poverty (Brüderl et al., 2019).

iii. Panel data typically possess a greater number of degrees of freedom and exhibit more sample variability which provides more accurate inference of model parameters compared to cross-sectional data (Hsiao, 2006).

iv. Regression analysis with panel data can help address the issue of omitted variable bias in situations by incorporating intertemporal dynamics and individual characteristics (Hsiao, 2006) where there is a lack of information on variables that are correlated with both the independent variables of interest and the dependent variable. (Hanck et al., 2023).

v. The act of pooling data to generate predictions for individual outcomes is more likely to result in accurate predictions compared to generating predictions solely based on the data of the individual in question (Hsiao, 2006).

vi. Panel data analysis typically encompasses two dimensions, namely a crosssectional dimension and a time series dimension. Characteristically, the computation of panel data estimators or inference is anticipated to be more intricate compared to cross-sectional or time series data, assuming normal conditions. Nevertheless, in specific instances, the presence of panel data can facilitate computation and inference as presented in the following examples:

a. Analysis of nonstationary time series: If time series data exhibit nonstationarity, the normal distribution assumption for the least-squares or maximum likelihood estimators' large sample approximations no longer holds. However, in the presence of panel data and independent observations among cross-sectional units, it is possible to utilise the central limit theorem to demonstrate that the asymptotic normality of various estimators persists (Hsiao, 2006).
b. Measurement errors: Measurement errors have the potential to result in the under-identification of an econometric model, as demonstrated by Aigner et al. (1984) having access to multiple observations for a particular individual or at a specific time can provide researchers with the opportunity to apply various transformations.

Panel regression techniques can be utilised to enhance multiple regression models when panel data is available. This is due to the possibility that findings from multiple regression models might be invalid (Hanck et al., 2023). However, it allows for the examination of causal relationships between multiple variables, such as the association between GDP and international trade in crude oil, across different categories of countries over a specific time frame. The application of linear or multiple regression analysis to the aforementioned phenomenon may present challenges, intricacies, or potential limitations due to the inclusion of three observational dimensions, namely the GDP of entities categorised over a specified time frame.

3.6 Research Design

The research design characteristically outlines the steps taken to answer the research questions which bother on the nature of the relationship between GDP and international trade of crude oil and natural gas across country groupings. The research also sought to establish the energy trade patterns their effect on the GDP of country categories.

To achieve this, relevant variables were identified (dependent and independent), and data was collected. The data were thereafter organised in panels according to the categories suitable for the panel regression approach.

The research hypothesis is such that:

i. H_0: The regression coefficients are not significant ($H_0 : \beta_i = 0$) for P-value greater than 5% ii. H_1: The regression coefficients are significant ($H_1 : \beta_i \neq 0$) for p-values less than 5%

3.6.1 Level of significance (Critical Level)

The chosen level of significance for this study is 5%. This means that the study tolerates a maximum of 5% chance events under the research hypothesis.

3.6.2 The Panel Regression Models

Given that there are three country classifications/categories under consideration (developed, developing, and least developed), three models are expected from this research as follows:

a. Model for the relationship between GDP per capita and international energy (crude oil and natural gas) trade in the developed countries category.
b. Model for the relationship between GDP per capita and international energy (crude oil and natural gas) trade in the developing countries category
c. Model for the relationship between GDP per capita and international energy (crude oil and natural gas) trade in the least developed countries category

The models will be used to establish trends in the international energy trade (crude oil and natural gas) to provide a comparative analysis across country classifications.

3.6.3 Descriptive Statistics

In this study, the initial statistical analysis will include measures of central tendency (such as mean, mode, and median), deviations from the mean (standard deviation and variance), measures of deviation from normality (skewness and kurtosis), and the range of values (maximum and minimum) for all variables (George & Mallery, 2016).

3.6.4 Test for Multicollinearity

A multi-collinearity test will be employed to detect and eliminate any instances where two or more independent variables exhibit a high degree of correlation. Based on sound economic rationale and careful consideration of trade-offs, it is deemed necessary to eliminate one of the variables from the model due to its correlation exceeding 80%. The calculation of correlation between two variables X and Y, based on a sample size of n, is expressed as:

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2]\ [n\sum Y^2 - (\sum Y)^2]}}$$

3.6.5 T-Test for regression coefficients

The t-test will be employed to determine the statistical significance of the independent factors in impacting the dependent variable. Additionally, it will show the degree to which the independent factors influence the dependent variable.

The research hypothesis is:

H_0: The regression coefficients are not significant ($H_0 : \beta = 0$) for P-value greater than 5%

H_1: The regression coefficients are significant ($H_1 : \beta \neq 0$) for p-values less than 5%

Chapter 4 - Data Analysis And Findings

In keeping with the research structure elucidated in chapter one, this chapter focuses on statistical analysis of the secondary data obtained. The identified dependent and independent variables are presented below.

Table 3: Identified Variables

Variable	Variable Description	Status
Y	Gross Domestic Product Per Capita	Dependent Variable
X_1	Crude Oil Production Per Capita	Independent Variable
X_2	Crude Oil Export Per Capita	Independent Variable
X_3	Crude Oil Import Per Capita	Independent Variable
X_4	Other Petroleum Products Export Per Capita	Independent Variable
X_5	Other Petroleum Products Import Per Capita	Independent Variable
X_6	Natural Gas Export Per Capita	Independent Variable
X_7	Natural Gas Import Per Capita	Independent Variable
X_8	Total Energy Use Per Capita	Independent Variable
X_9	Oil Electricity Per Capita	Independent Variable
X_{10}	Gas Electricity Per Capita	Independent Variable

4.1. Preliminary Statistics

A descriptive analysis was carried out on the quantitative data to provide an overview of its characteristics before the regression analysis. These include the measure of central tendency and dispersion from the mean, skewness and kurtosis, minimum and maximum values, and data count. Line graphs were also used to show how the time series data behaved during the period under study (1995-2021). The graphs are presented in appendixes 1 – 3 according to the country classifications.

The central tendency was determined by utilising the mean of each variable (to represent the average of the data points) as well as the standard deviation which measured the dispersion of values and their associations with the mean values. Additional statistical measures, such as skewness and kurtosis, were computed to assess the extent of sample deviations from normality.

Furthermore, the maximum and minimum values were determined to quantify the range of the data.

Details of the preliminary statistics for all country categories are presented in Tables 4.2, 4.3, and 4.4.

Table 4: Preliminary Statistics for Developed Countries

	Y	***X1***	***X2***	***X3***	***X4***	***X5***	***X6***	***X7***	***X8***	***X9***	***X10***
Mean	32,135.94	249.41	285,546.31	401,606.84	383,888.11	726,281.86	16,996.12	19,415.92	51,437.93	717.99	1,087.01
Standard Error	716.41	24.00	41,514.67	16,860.15	19,915.50	48,237.21	3,265.06	1,745.66	926.45	45.52	36.71
Median	27,824.47	-	2,197.99	271,699.86	166,738.22	255,645.79	5.10	89.36	44,694.92	265.52	694.27
Standard Deviation	22,335.45	748.17	1,294,299.46	525,647.58	620,903.73	1,503,887.38	101,794.57	54,424.42	28,883.73	1,411.96	1,138.72
Sample Variance	4.99E+08	5.60E+05	1.68E+12	2.76E+11	3.86E+11	2.26E+12	1.04E+10	2.96E+09	8.34E+08	1.99E+06	1.30E+06
Kurtosis	2.17	16.67	47.65	23.10	18.19	41.60	104.40	33.78	4.30	12.30	3.16
Skewness	1.24	3.97	6.62	4.06	3.71	5.63	9.44	5.09	1.83	3.45	1.58
Range	132,385.12	5,195.15	13,743,396.19	4,995,478.26	5,395,846.65	16,706,041.36	1,447,855.61	561,401.13	172,514.02	9,066.87	6,880.76
Minimum	1,360.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15779.98	0.00	0.00
Maximum	133,745.40	5,195.15	13,743,396.19	4,995,478.26	5,395,846.65	16,706,041.36	1,447,855.61	561,401.13	188,294.00	9,066.87	6,880.76
Sum	3.12E+07	2.42E+05	2.78E+08	3.90E+08	3.73E+08	7.06E+08	1.65E+07	1.89E+07	5.00E+07	6.91E+05	1.05E+06
Count	972.00	972.00	972.00	972.00	972.00	972.00	972.00	972.00	972.00	962.00	962.00

Source: Created by the Authors

Table 4 above summarizes the data for developed nations. The variable with the highest mean value was X5 with 726,281.86 while the variable with the lowest mean value was X1 with 249.41. the variable that showed the highest standard deviation from the mean within this classification was also X5 with 1,503,887 while the one with the least standard deviation was X10 with 1,138.72. unequal observation count was also seen indicating that the panel data is an unbalanced one with missing values which a panel regression technique addresses. The highest data point within this category was 16,706,041.36 found in X5 while the minimum value of 0.00 was found across X1, X2, X3, X4, X5, X6, X7, X9, X10. This means that within this classification, only the variable X8 had a non-zero observation on all entities.

5: Preliminary Statistics for Developing Countries

	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*
Mean	8,368.36	6,891.87	688,674.93	173,549.99	344,567.21	375,510.07	225,867.50	12,104.88	26,887.18	541.10	1,557.06
Standard Error	281.44	919.69	53,643.99	16,382.19	28,378.69	28,290.27	42,818.68	1,413.40	979.16	25.45	96.78
Median	4,189.35	30.71	9,603.53	1,111.14	16,855.80	70,351.05	0.00	1.15	12,559.77	195.80	145.56
Standard Deviation	11,648.33	38,230.83	2,229,938.79	680,994.68	1,179,680.17	1,176,004.53	1,779,938.90	58,753.87	40,703.04	979.77	3,726.92
Sample Variance	1.36E+08	1.46E+09	4.97E+12	4.64E+11	1.39E+12	1.38E+12	3.17E+12	3.45E+09	1.66E+09	9.60E+05	1.39E+07
Kurtosis	13.92	63.48	33.69	53.69	46.22	50.33	187.39	72.42	9.80	9.75	12.60
Skewness	3.25	7.92	5.28	6.71	6.09	6.54	12.73	7.78	3.02	3.07	3.57
Range	97,941.60	386,491.51	21,764,172.87	8,154,477.72	14,214,268.43	12,754,718.91	32,475,762.17	845,470.91	301,937.98	5,731.41	21,704.87
Minimum	99.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	875.42	0.00	0.00
Maximum	98,041.36	386,491.51	21,764,172.87	8,154,477.72	14,214,268.43	12,754,718.91	32,475,762.17	845,470.91	302,813.40	5,731.41	21,704.87
Sum	1.43E+07	1.19E+07	1.19E+09	3.00E+08	5.95E+08	6.49E+08	3.90E+08	2.09E+07	4.65E+07	8.02E+05	2.31E+06
Count	1,713.00	1,728.00	1,728.00	1,728.00	1,728.00	1,728.00	1,728.00	1,728.00	1,728.00	1,482.00	1,483.00

Source: Created by the Authors

Table 5 above shows that the variables with the highest and lowest means values within the developing nations classification are X2 and X9 respectively while the variables with the highest and lowest standard deviations are X6 and X9 with 1,779,938.90 and 979.77 respectively. The large gap between these measures of central tendency indicates how diverse patterns of energy trade within this classification can be. Also, the unequal data points/observations show that the panel data is unbalanced one due to missing values. The maximum data point was found in X6 while the lowest data point is 0.00 found in X1, X2, X3, X4, X5, X6, X7, X9, X10. Again, the gap between the highest and the lowest observations indicates how varied the energy trade among this country classification was within the timeframe of the study. However, the panel regression analysis will reveal in detail, the level and nature of international energy trade of this country group.

Table 6: Preliminary Statistics for Least Developed Countries

Table

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
Mean	8.49E+02	6.77E+03	7.60E+06	7.39E+05	1.29E+06	1.82E+07	3.30E+05	3.62E+04	1.81E+03	5.86E+01	7.75E+00
Standard Error	21.03	1,679.83	2,128,904.38	191,716.18	248,978.44	2,814,250.51	141,913.15	16,520.00	92.52	2.46	1.09
Median	628.95	0.00	0.00	0.00	0.19	20.49	0.00	0.00	922.82	26.40	0.00
Standard Deviation	7.33E+02	5.92E+04	7.50E+07	6.76E+06	8.77E+06	9.92E+07	5.00E+06	5.82E+05	3.20E+03	7.62E+01	3.38E+01
Sample Variance	5.38E+05	3.50E+09	5.63E+15	4.56E+13	7.70E+13	9.84E+15	2.50E+13	3.39E+11	1.03E+07	5.80E+03	1.14E+03
Kurtosis	8.43	109.64	790.40	310.30	186.55	72.37	297.30	872.04	33.02	4.60	51.58
Skewness	2.47	10.20	25.80	16.14	12.18	7.93	16.86	27.85	5.39	2.04	6.60
Range	5.28E+03	7.77E+05	2.37E+09	1.46E+08	1.74E+08	1.22E+09	1.01E+08	1.88E+07	2.78E+04	4.22E+02	3.60E+02
Minimum	86.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	5.37E+03	7.77E+05	2.37E+09	1.46E+08	1.74E+08	1.22E+09	1.01E+08	1.88E+07	2.78E+04	4.22E+02	3.60E+02
Sum	1.03E+06	8.40E+06	9.44E+09	9.18E+08	1.60E+09	2.26E+10	4.10E+08	4.50E+07	2.17E+06	5.60E+04	7.41E+03
Count	1,216.00	1,242.00	1,242.00	1,242.00	1,242.00	1,242.00	1,242.00	1,242.00	1,198.00	956.00	956.00

Source: Created by the Authors

Within the LCDs, the variables with the highest and lowest mean values were X5 and X10 respectively with 18,229,178.14 and 7.75. The variables with the highest and lowest standard deviations were X5 and X10 with 99,179,873.86 and 33.78 respectively. The maximum data point was found in X5 with 1,222,366,313.85 while the lowest data point is 0.00 found in all the variables.

In conclusion, the descriptive statistics as seen in the three classifications suggest that that energy trade significantly varies across country classifications. However, variations will be revealed in detail by the panel regression analysis both in terms of nature and magnitude.

4.2. Test for Multicollinearity

To conduct a regression of the dependent variable on the independent variables, a multicollinearity (correlation of independent variables) test was conducted within each country category. The outcomes are presented in the subsequent subsections.

4.2.1. Multicollinearity Test for the Developed Countries' Category

A correlation test conducted for developed countries' independent variables dataset revealed that they were all uncorrelated. This indicates that there is no statistically significant association or influence between any of the independent variables and one or more of the other independent variables. Consequently, the correlation results as presented in Table 7 satisfied an important condition for regressing a dependent variable on a set of independent variables.

7: Correlation Coefficients for the Developed Countries

	X1	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*
X1	1									
X2	0.10	1								
X3	-0.02	-0.03	1							
X4	-0.06	0.21	0.54	1						
X5	-0.09	-0.03	0.13	0.61	1					
X6	0.07	0.20	0.00	0.00	-0.01	1				
X7	-0.10	-0.03	0.20	0.10	0.07	-0.01	1			
X8	0.33	0.37	0.01	0.12	0.18	0.12	-0.06	1		
X9	-0.09	-0.09	-0.07	0.23	0.31	-0.06	-0.04	-0.08	1	
X10	0.15	-0.07	0.34	0.11	0.13	0.08	0.30	0.15	-0.18	1

Source: Created by the Authors

4.2.2. Multicollinearity Test for the Developing Countries' Category.

After conducting a correlation analysis on the independent variables within the category of developing countries, it was found that there was an 80% correlation between variable X_8 -(total energy use per capita) and variable X_{10} - (gas electricity per capita). The output is presented in Table 4.6 below.

Table

Table 8: Correlation Coefficient for Developing Countries

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1									
X2	0.05	1								
X3	0.02	-0.04	1							
X4	-0.01	0.35	0.68	1						
X5	0.00	-0.05	0.71	0.72	1					
X6	0.04	0.54	0.00	0.25	-0.02	1				
X7	-0.01	0.06	0.47	0.41	0.36	-0.02	1			
X8	0.03	0.57	0.38	0.68	0.35	0.49	0.24	1		
X9	0.02	0.05	0.24	0.19	0.44	-0.07	0.02	0.13	1	
X10	0.01	0.60	0.24	0.60	0.22	0.41	0.17	0.87	-0.05	1

Source: Created by the Authors

To rectify the anomaly of multicollinearity of the two variables, the variable representing "gas electricity per capita" was excluded from the set of variables for the developing countries, while the variable representing total energy use per capita was retained.

The rationale for this decision was based on the fact that total energy use per capita encompasses various sources such as coal, oil, wind, and hydropower, including gas and electricity. Thus, given that the focus of this research borders on the international trade of energy, it is interesting to reveal and understand how energy use per capita influences the per capita GDPs of developing countries. If found to be significant, the research findings will contribute to the formulation or reinforcement of public policies on energy investment and use in the developing countries.

The final variable set for the developing countries category after the removal of one of the correlated variables (gas electricity per capita) is presented in Table 9 below.

Table 9: Final Variables Set for Developing Countries

Variable	Variable Description	Status
Y	Gross Domestic Product Per Capita	Dependent Variable
X_1	Crude Oil Production Per Capita	Independent Variable
X_2	Crude Oil Export Per Capita	Independent Variable
X_3	Crude Oil Import Per Capita	Independent Variable

X_4	Other Petroleum Products Export Per Capita	Independent Variable
X_5	Other Petroleum Products Import Per Capita	Independent Variable
X_6	Natural Gas Export Per Capita	Independent Variable
X_7	Natural Gas Import Per Capita	Independent Variable
X_8	Total Energy Use Per Capita	Independent Variable
X_9	Oil Electricity Per Capita	Independent Variable

4.2.3. Multicollinearity Test for the Least Developed Countries' Category

The correlation test conducted on the set of independent variables for the Least Developed Countries category indicated that there was no statistically significant correlation between the variables. This shows that none of the independent variables influences the other or co-vary with as much as 80%, hence satisfying an important condition for regressing the dependent variable (per capita GDP) on the independent variables as presented in Table 10 below.

10: Correlation Coefficient Table for Least Developed Countries

	X1	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*
X1	**1**									
X2	0.00	**1**								
X3	-0.01	0.00	**1**							
X4	-0.01	0.10	0.70	**1**						
X5	-0.02	0.09	0.27	0.42	**1**					
X6	-0.01	0.12	-0.01	0.14	0.03	**1**				
X7	-0.01	0.00	-0.01	0.00	0.33	0.00	**1**			
X8	0.01	0.00	0.01	0.00	-0.07	0.03	-0.03	**1**		
X9	0.00	0.19	-0.03	0.05	-0.02	0.14	0.01	0.06	**1**	
X10	0.05	0.02	-0.02	-0.01	-0.02	0.11	-0.03	0.02	0.09	**1**

Source: Created by the Authors.

Table

4.3 Regression Analysis

According to the research design, panel regression analysis was carried out for the panel dataset for the three categories of countries. MATLAB application software was used to analyse the datasets to show the cause-effect relationship between the dependent variable (per capita GDP) and the independent variables. The following sections contain the three-panel regression models output and interpretations.

4.3.1 Model 1: Regression Model for the per capita GDP of Developed Countries.

Table 11: Panel Regression Analysis Output for Developed Countries

Table of Coefficients for Regression 1 (Developed Countries)					
Variables (per Capita)	**Parameter Estimate**	**Standard Error (SE)**	**Test Statistic (tStat)**	**Probability Value (pValue)**	**Conclusion**
Intercept	9194.70	1283.9	7.1617	1.59E-12	Significant
X1 (Crude Oil Production)	-1.4175	0.77133	-1.8378	0.066409	**Not Significant**
X2 (Crude Oil Export)	0.0044839	0.00049127	9.1271	4.12E-19	Significant
X3 (Crude Oil Import)	0.0088036	0.0014103	6.2425	6.48E-10	Significant
X4 (Other Petroleum Products Export)	-0.009422	0.0014862	-6.3395	3.55E-10	Significant
X5 (Other Petroleum Products Import)	0.0040507	0.00051655	7.842	1.19E-14	Significant
X6 (Natural Gas Export)	0.023104	0.005333	4.3323	1.63E-05	Significant
X7 (Natural Gas Import)	-0.0017954	0.010388	-0.17283	0.86282	**Not Significant**

X8 (Total Energy Used)	0.279	0.021781	12.809	9.08E-35	Significant
X9 (Oil Electricity)	-1.3573	0.41557	-3.2662	0.001129	Significant
X10 (Gas Electricity)	4.9816	0.55023	9.0536	7.66E-19	Significant
Number of Observations	962				
Error Degree of Freedom	951				
Root Mean Squared Error	1.65E+04				
R-Square	**46.50%**				
R-Square Adjusted	**46.00%**				
Level of Significance	**5.00%**				

At 5% level of significance (critical level), the output of the panel regression of the dependent variable Y (Gross Domestic Product per Capita) on ten independent variables for the Developed Country category showed that eight variables including X_2 -Crude Oil Export Per Capita, X_3- Crude Oil Import per Capita, X_4-Other Petroleum Products Export Per Capita, X_5-Other Petroleum Products Import Per Capita, X_6Natural Gas Export Per Capita, X_8-Total Energy Used Per Capita, Oil Electricity Per Capita, and Gas Electricity Per Capita were statistically significant in influencing the per capita GDPs of the developed countries. On the other hand, two variables X_1(Crude Oil Production per capita) and X_7 (Natural Gas Import per Capita) were found to have no significant impact on the per capita GDPs of the Developed Countries. The analysis also demonstrated that the adjusted coefficient of determination, R^2 is 46%, indicating that the significant variables jointly account for about 46% of the variations in the per capita GDP of developed nations within the limits of this study. The unexplained variations may be ascribed to potential sources of observation error, such as qualitative and quantitative factors which were not taken into consideration in this study. Additionally, limitations as discussed in Chapter One, may have contributed to these differences.

Accordingly, the regression model (Regression 1) of the per capita GDPs of the Developed Countries is presented below.

Model 1:

$$Y = 9{,}194.70 + 0.0044839X_2 + 0.0088036X_3 - 0.009422X_4 + 0.0040507X_5 + 0.023104X_6 + 0.279X_8 - 1.3575X_9 + 4.9816X_{10} + u_i$$

Below is the presentation of the regression output for each of the variables.

X_1 - Crude Oil Production.

The regression analysis output revealed that crude oil production did not exhibit statistical significance, indicating that it does not have a discernible effect on the per capita GDPs of developed nations. This suggests that there is no statistically significant relationship between the per capita GDPs of developed nations and the value of crude oil output per capita.

X_2 - Crude Oil Export Per Capita

Crude Oil Export was significant and positive on the per capita GDPs of Developed Nations. This means that a unit increase in per capita crude oil export of developed countries will lead to 0.0044839 units increase in their per capita GDP, provided other variables are held constant. In other words, for every 1% increase in the per capita oil export variable, there will be a corresponding 0.4484% increase in the per capita GDPs of the developed nations, when all other variables are fixed.

X_3 - Crude Oil Import Per Capita

Crude oil import per capita was significant and positive for the developed countries group. This implies that a unit increase in per capita crude oil export value will result in 0.0088036 unit increase in the per capita GDPs of developed countries, when all other variables are constant. Put differently, for each 1% rise in per capita crude oil import variable, there will be a corresponding 0.8804% increase in the per capita GDPs of the developed nations, provided that all other variables are kept constant

X_4 - Other Petroleum Product Export (Excluding crude oil)

The variable - other petroleum products export per capita was significant but negative for the Developed Countries. This shows that, if all other variables are held constant, a unit increase in other petroleum products export value will result in a 0.009422 decrease in the per capita GDPs of the developed countries. This also means that for every 1% increase in per capita export of other petroleum products variable, there will be a resultant 0.9422% decrease in the per capita GDPs of the developed nations, if all other variables are kept constant.

X_5 - Other Petroleum Product Import per Capita (Excluding crude oil) The importation of other petroleum products into the developed countries proved significant and positively affects their GDPs per Capita. Accordingly, a one-unit increase in the value of other petroleum products imported into the developed countries results in an increase in their per capita GDP by 0.0040507 units, if all other variables are held constant. Thus, for every 1% increase in the import value of other petroleum products, there will be a corresponding 0.4051% increase in the per capita GDPs of developed nations, all other variables remaining constant.

X_6 Natural Gas Export Per Capita

The Natural Gas Export per capita variable was found significant and positive in explaining changes in the per capita GDPs of developed countries. Thus, a unit increase in the value of Natural Gas exports per capita will result in a 0.023104 units increase in the per capita GDPs of developed countries if all the other variables are kept constant. In effect, for every 1% increase in natural gas export value, there will be an associated 2.3104% increase in the per capita GDPs of developed nations.

X_7 Natural Gas Import Per Capita

The natural gas import per capita variable was not significant in explaining the changes in the per capita GDPs of developed nations within the scope of this study. This means that the values expended to import natural gas in the developed nations are of no statistical significance on their per capita GDPs.

X_8 - Total Energy Used Per Capita

The total energy used per capita was significant and positive at a 5% critical level. This implies that a unit increase in per capita energy consumption (KWH) will result in a 0.279 increase in the per capita GDPs of developed nations if all other variables are kept constant. Accordingly, for every 1% increase in the total energy use per capita, there will be a corresponding 27.9% increase in the per capita GDPs of developed nations if all other variables are held constant.

X_9 (Oil Electricity Per Capita)

The Per Capita Oil Electricity variable was significant but negative. This means that a unit increase in the electricity generated from crude oil will result in a 1.3575 units decrease in the per capita GDPs of the developed countries. In other words, a 1% increase in per capita oil electricity will result in a 135.75% decline in the per capita GDPs of developed nations, as long as other variables are kept constant.

X_{10} (Gas Electricity Per Capita)

Gas electricity was both significant and positive in the model indicating that it positively influences the per capita GDP of developed nations. Hence, provided all other variables are kept constant, a unit increase in the gas electricity generated per capita will result in a 4.9816 unit increase in the per capita GDPs of the developed nations. Hence, for every 1% increase in gas electricity generation per capita, there will be an accompanying 498.16% increase in the per capita GDPs of developed nations.

4.3.2 Model 2: Regression Model for the GDP of Developing Countries Category

Table 12: Panel Regression Analysis Output for Developing Countries

Table of Coefficients for Regression 2 (Developing Countries)					
Variables	**Parameter Estimate**	**Standard Error (SE)**	**Test Statistic (tStat)**	**Probability Value (pValue)**	**Conclusion**
Intercept	2557.8	211.37	12.101	3.44E-32	Significant
X1 (Crude oil Production)	-0.0058739	0.0038996	-1.5063	0.13221	**Not significant**
X2 (Crude oil Export)	0.001104	9.47E-05	11.663	4.07E-30	Significant
X3 (Crude oil Import)	-0.0003036	0.0003435	-0.88388	0.3769	**Not significant**
X4 (Other Petroleum product Export)	-0.0006198	0.00027374	-2.2641	0.023714	Significant
X5 (Other Petroleum product Import)	0.0031679	0.00023569	13.441	6.53E-39	Significant
X6 (Natural Gas Export)	0.001656	0.00010368	15.972	4.81E-53	Significant
X7 (Natural Gas Import)	0.030472	0.0028024	10.874	1.56E-26	Significant
X8 (Total Energy Used)	0.12428	0.0067165	18.504	7.84E-69	Significant
X9 (Oil Electricity)	0.57904	0.18616	3.1104	0.0019045	Significant
Number of Observations	1468				
Error Degree of Freedom	1458				
Root Mean Squared Error	5.88E+03				
R-Square	**76.90%**				
R-Square Adjusted	**76.70%**				
Level of Significance	**5.00%**				

At 5% critical level, the panel regression of Y - (Gross Domestic Product per Capita) on nine independent variables for the Developing Country category showed that eight variables including X_2 - (Crude Oil Export Per Capita), X_4 – (Other Petroleum Products Export Per Capita), X_5 (Other Petroleum Product Import per Capita), X_6 (Natural Gas Export per Capita), X_7 (Natural Gas Import per Capita), X_8 (Total Energy Used Per Capita), X_9 (Oil Electricity Per Capita), and X_{10} (Gas Electricity Per Capita) were statistically significant in influencing the per capita GDPs of developing countries. On the other hand, X_1 - (Crude Oil Production Per Capita), and X_3 – Crude Oil Import Per Capita) were found to be insignificant in explaining changes in the GDPs of the Developing Countries.

The analysis also revealed that the adjusted coefficient of determination, R^2 is 76.70% signifying that all the significant variables collectively explain about 76.70% of the changes in the GDP of developing countries within the scope of this research. The unexplained variations could be attributed to observation error-like variables (qualitative and quantitative) that were not considered in this study, as well as other limitations as highlighted in Chapter One.

Therefore, the regression model (Regression 2) for the GDPs of the Developing Countries Group is presented below.

$$\mathbf{Y = 2{,}557.8 + 0.001104X_2 - 0.00061977X_4 + 0.0031679X_5 + 0.001656X_6 + 0.030472X_7 + 0.12428X_8 + 0.57904\, X_9 + u_i}$$

Below is a detailed analysis of the variable contribution to the GDP of the Developing Countries category.

X_1 - (Crude Oil Production per Capita)

Per capita crude oil production value was not significant for the developing countries. This implies that the value of crude oil production per capita does not have any statistically proven effect on the per capita GDPs of Developing Nations. This also means that, in relation to the per capita GDPs of the Developing Nations, the value of per capita crude oil production is very small or negligible to cause a significant effect.

X_2 - (Crude Oil Export Per Capita)

The crude oil export per capita variable was significant and positive for Developing Countries. This means that a unit increase in the value of per capita crude oil export in the developing nations will result in 0.001104 units increase in their per capita GDPs, if all other variables are held constant. It also implies that for every 1% increase in crude oil export value per capita, there will be a corresponding 0.1104% increase in the per capita GDPs of developing nations when all other variables are kept constant.

X_3 - (Crude Oil Import per Capita)

The crude oil import per capita variable was insignificant for the per capita GDPs of the developing countries. This indicates that the variable has no statistically proven impact on the per capita GDPs of the developing country group.

X_4 - (Other Petroleum Product Export per Capita)

The variable 'other petroleum products per capita' was significant but negative in influencing the per capita GDPs of the developing countries. Accordingly, a unit increase in the value of other petroleum products exported (excluding crude oil) will result in 0.00061977 unit decrease in the per capita GDPs of the developing countries. In other words, for every 1% increase in the export of other petroleum products, there will be a corresponding 0.06198% decrease in the per capita GDPs of developing nations, if all other variables are kept constant.

X_5 - (Other Petroleum Product Import per Capita)

Other petroleum products proved significant and positive towards the per capita GDPs of developing countries. This implies that an increase in the value of per capita petroleum products importation by one unit will result in 0.0031679 unit increase in the GDP per capita of this country group, provided all other variables remain unchanged. Accordingly, for every 1% increase in the import of other petroleum products, there will be an associated 0.3168% increase in the per capita GDPs of developing nations, when all other variables are held constant.

X_6 - (Natural Gas Export per Capita)

Natural Gas Export per Capita was significant and positively affects the GDP of developing countries. In other words, a unit increase in the value of natural gas exports from developing countries leads to an increase in their per capita GDP by 0.001656 units, if all other variables are held constant. Thus, every 1% rise in natural gas export value will result in a 0.1656% increase in the per capita GDPs of developing nations when all other variables are kept constant.

X_7 - (Natural Gas Import per Capita)

Just like the natural gas export variable, the natural gas import per capita variable was also significant and positive towards the per capita GDPs of developing countries category. Thus, a unit increase in natural gas import value per capita increases the per capita GDP per capita of the developing countries by 0.030472 when all the other variables are fixed. This also means that a 1% increase in the import value of natural gas will lead to a corresponding 3.0472% increase in the per capita GDPs of developing nations.

X_8 - Total Energy Used Per Capita

The total energy used per capita was significant and positive at a 5% critical level. This indicates that for every one-unit increase in per capita energy consumption (KWH), there will be a 0.12428 increase in the per capita GDPs of developing nations if all other variables are kept constant. Thus, for every 1% rise in per capita energy use, there will be a corresponding rise in the per capita GDPs of developing nations by 124.28%, if all other variables are kept constant. This outcome highlights that energy use in developing countries leads to economic growth.

X_9 - Oil Electricity Per Capita

The oil electricity per capita variable which represents the value of crude oil used to generate electricity was found significant and positive towards the per capita GDPs of the developing countries category. In other words, a unit increase in the electricity generated from crude oil will result in a 0.57904 increase in the per capita GDP of developing nations. That means that a 1% increase in the oil electricity per capita will result in a 57.904% increase in the per capita GDPs of developing nations.

4.3.3 Model 3: Regression Model for the GDP of Least Developed Countries

Table 13: Panel Regression Analysis Output for Least Developed Nations

Table of Coefficients for Regression 3 (Least Developed Countries)					
Variables (per Capita)	**Parameter Estimate**	**Standard Error (SE)**	**Test Statistic (tStat)**	**Probability Value (pValue)**	**Conclusion**
Intercept	486.91	24.118	20.188	1.5571E-75	Significant
X1 (Crude Oil Production)	0.0013421	0.00036018	3.7263	0.00020596	Significant
X2 (Crude Oil Export)	-3.326E-07	0.00000065	-51094.00	0.60952	**Not Significant**
X3 (Crude Oil Import)	1.0833E-05	3.50120E-06	3.094	0.0020334	Significant
X4 (Other Petroleum Products Export)	-1.261E-05	4.06120E-06	-3.1059	0.0019544	Significant
X5 (Other Petroleum Products Import)	1.2622E-06	5.3286E-07	2.3688	0.018049	Significant
X6 (Natural Gas Export)	-1.702E-06	3.2469E-06	-5.5241	0.60033	**Not Significant**
X7 (Natural Gas Import)	-0.0003704	0.00056438	-0.6564	0.51176	**Not Significant**
X8 (Total Energy Used)	0.10361	0.0050317	20.5920	5.1455E-78	Significant
X9 (Oil Electricity)	2.9398	0.23233	12.6530	5.4198E-34	Significant
X10 (Gas Electricity)	2.2127	0.5142	4.3032	1.8607E-05	Significant

Number of Observations	948				
Error Degree of Freedom	937				
Root Mean Squared Error	5.31E+02				
R-Square	**41.80%**				
R-Square Adjusted	**41.20%**				
Level of Significance	**5.0%**				

From Table 13 above, at a 5% level of significance, the panel regression output of the Y (Gross Domestic Product per Capita) on ten independent variables for the Least Developed Country category showed that seven variables were statistically significant towards the per capita GDPs of Least Developed Country. These significant variables include: X_1 – Crude Oil Production, X_3 -(Crude Oil Import Per Capita), X_4 - (Other Petroleum Product Export per Capita), X_5 - (Other Petroleum Product Import per Capita), X_8 - (Total Energy Used Per Capita), X_9 - (Oil Electricity Per Capita), and X_{10} - (Gas Electricity Per Capita). Conversely, three variables including X_3 - (Crude Oil Export per Capita), X_6 - (Natural Gas Export per Capita), and X_7 - (Natural Gas Import per Capita) were found insignificant in explaining variations in the GDP of the Least Developed Countries.

The analysis further showed that the adjusted coefficient of determination, R-square is 41.20% indicating that, collectively, the significant variables only explain about 41.20% of the total variation in the GDPs of Least Developed Countries within the scope of this research. The remaining unexplained variations could be attributed to error and other variables (qualitative and quantitative) not considered in this study. Accordingly, the regression model (Regression 3) of the per capita GDP of the Least Developed Countries Group is presented below.

$$\mathbf{Y = 486.91 + 0.0013421X_1 + 0.000010833X_3 - 0.0000012614X_4 + 0.00000012622X_5 + 0.10361X_8 + 2.9398X_9 + 2.2127 + u}$$

Below is the interpretation of the regression output for each of the variables.

X_1 - Crude Oil Production Per Capita

Crude oil production per capita was significant towards the per capita GDPs of Least Developed Nations. This implies that a unit increase in crude oil production value will result in 0.0013421 unit increase in the per capita GDPs of Least Developed Nations, provided all other variables are fixed. Put differently, for every 1% increase in the value of crude oil produced in LDNs, there will be a 0.1342% increase in their per capita GDPs if other variables are kept constant.

X_2 - Crude Oil Export Per Capita

The crude oil export variable was not significant for the least developed countries. In other words, the effect of per capita crude oil exports on the GDP per capita of the least developed countries was insignificant. This indicates that the value of LDCs' exports of crude oil has no demonstrable impact on their GDP per capita. Put differently, the value of LDCs' per capita crude oil export is too low to have a meaningful impact on those countries' GDPs.

X_3 - Crude Oil Import Per Capita

The per capita crude oil imports variable exhibited a statistically significant and positive impact on the per capita gross domestic product (GDPs) of the least developed nations. Consequently, a marginal increase of one unit in crude oil imports per capita in the least developed nations is associated with a corresponding rise of 0.000010833 units in their per capita GDP. To clarify, it might be said that a 1% rise in crude oil import per capita is associated with a proportional increase of 0.00108% in the per capita GDPs of the least developed nations.

X_4 - Other Petroleum Product Export (Excluding crude oil)

Other petroleum products export variable was shown to be a statistically significant variable. However, its effect on the per capita GDP of LDCs was negative. This means that the per capita gross domestic product (GDP) of LDCs will decrease by 0.0000012614 units for every one-unit rise in the value of other petroleum products exported. In other words, the per capita GDPs of LDCs will decline by 0.000126% for every 1% increase in the export values of other petroleum products, provided all other variables are held constant.

X_5 - Other Petroleum Product Import (Excluding crude oil)

Other petroleum product imports variable X_5 was significant and positive for the per capita GDPs of the least developed countries. This outcome implies that a unit increase in value of other petroleum products imported in the least developed countries will result in a 0.00000012622 units increase in their per capita GDPs. In other words, for every 1% increase in the value of other petroleum products imported, there will be a corresponding 0.0000126% increase in the per capita GDPs of the least developed nations.

X_6 – Natural Gas Export per Capita

The insignificance of the per capita Natural Gas Export variable was observed. This outcome suggests that there is no statistically significant relationship between the value of natural gas exports in least developed nations and their respective GDPs. Given the scarcity of data originating from the least developed nations, it is conceivable that the available information may be insufficient to ascertain the significance of natural gas exports in these countries. This indicates that the value of LDCs' natural gas exports has no demonstrable impact on their GDP per capita. Put differently, the value of LDCs' per capita natural gas exports is too low to have a meaningful impact on their GDPs.

X_7 – Natural Gas Import per Capita

The statistical analysis revealed that the variable representing Natural Gas Import per capita was not statistically significant in the context of the least developed nations. This outcome suggests that there is no discernible relationship between the monetary values of natural gas imports in Least Developed Countries (LDCs) and their per capita Gross Domestic Product (GDP). In alternative terms, the per capita natural gas import value of Least Developed Countries (LDCs) is insufficient to significantly influence their per capita Gross Domestic Products (GDPs).

X_8 - Total Energy Used per Capita

For the Least Developed Countries, the variable X_8 pertaining to the total energy used per capita proved to be statistically significant and positively impacts the nations' gross domestic product (GDP). Thus, a one-unit increase in the per capita energy consumed in Least Developed Countries (LDCs) will lead to a corresponding 0.10361 units

(TeraWatt Hour) rise in their Gross Domestic Product (GDP), as long as other variables are held constant. In other words, for every 1% increase in the per capita energy consumption in the least developed countries, there will be a corresponding 10.361% rise in their GDPs if all other variables are kept constant.

X_9 - Oil Electricity per Capita

The study revealed a significant and positive relationship between the expenditure on oil for electricity generation in the least developed countries. Consequently, a unit rise in the per capita oil electricity generated will result in a corresponding 2.9398 units rise in the per capita GDPs of the least developed nations. Accordingly, for every 1% increase in oil electricity, there will be a corresponding 293.98% increase in the per capita GDPs of the least developed countries, if all other variables are kept constant.

X_{10} - Gas Electricity per Capita

Gas electricity per capita variable was significant and positive towards the per capita GDPs of the least developed countries. This result implies that each unit increase in gas generated electricity will result in a corresponding increase in the per capita GDPs of least developed countries by 2.2127 units. That is to say that a 1% increase in gas electricity will result in a 221.27% increase in the per capita GDPs of least developed countries, all the other variables kept constant.

4.4 Residual Analysis

A residual plot is a graphical representation, specifically a scatter plot, that displays the residuals on the vertical axis and the independent variable on the horizontal axis (Park & Dereche, 2021). It serves as a valuable tool for assessing the suitability of a linear model in representing the provided dataset. Figure 5,6,7 represent the residual plots for models 1,2 and 3 respectively. The shape of the residual plots show that the datasets used for the panel regression are all suitable for linear regression analysis. The balanced scattered data points along the zero mark on the horizontal axis indicate the linearity of the dataset, hence the use of a linear panel model.

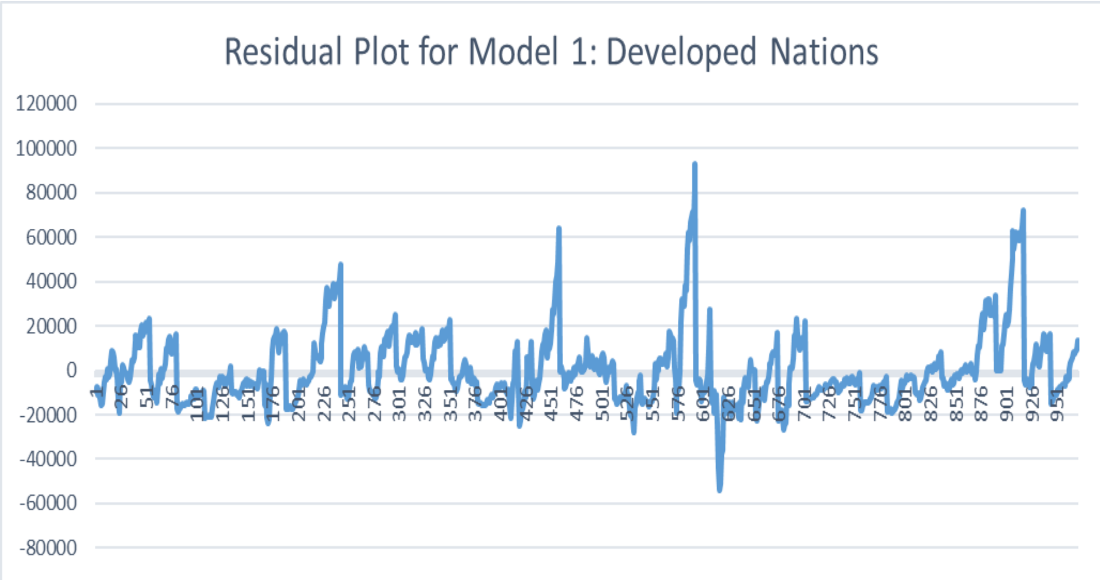

Figure 5: Residual Plot for Model 1: Developed Nations

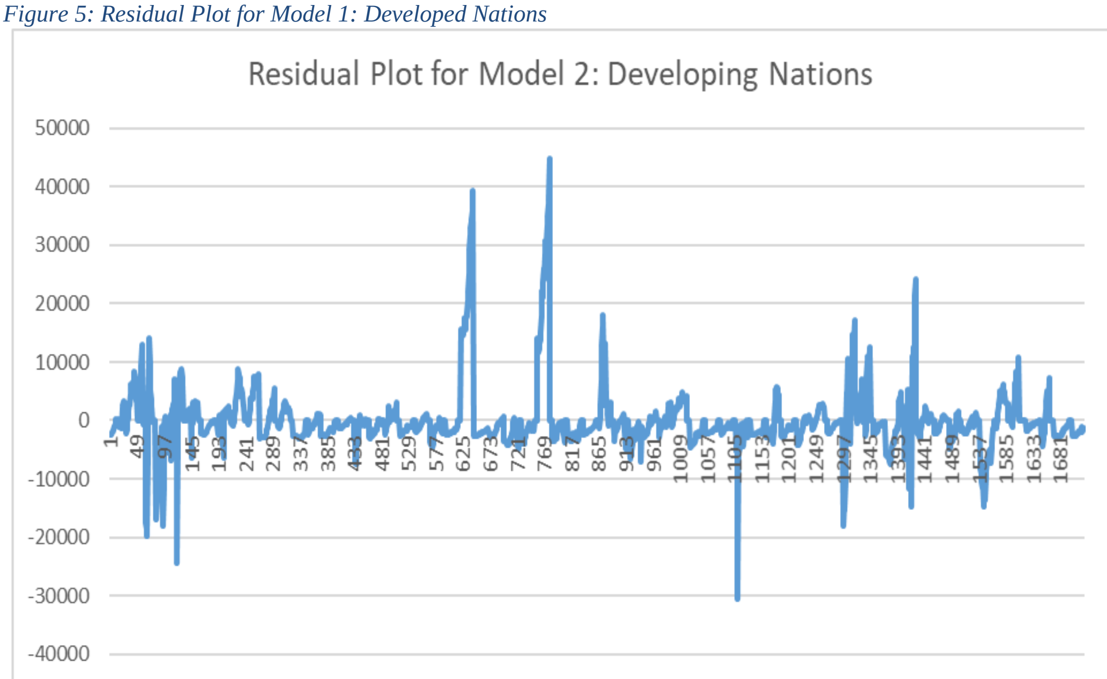

Figure 6: Residual Plot for Model 1: Developing Nations

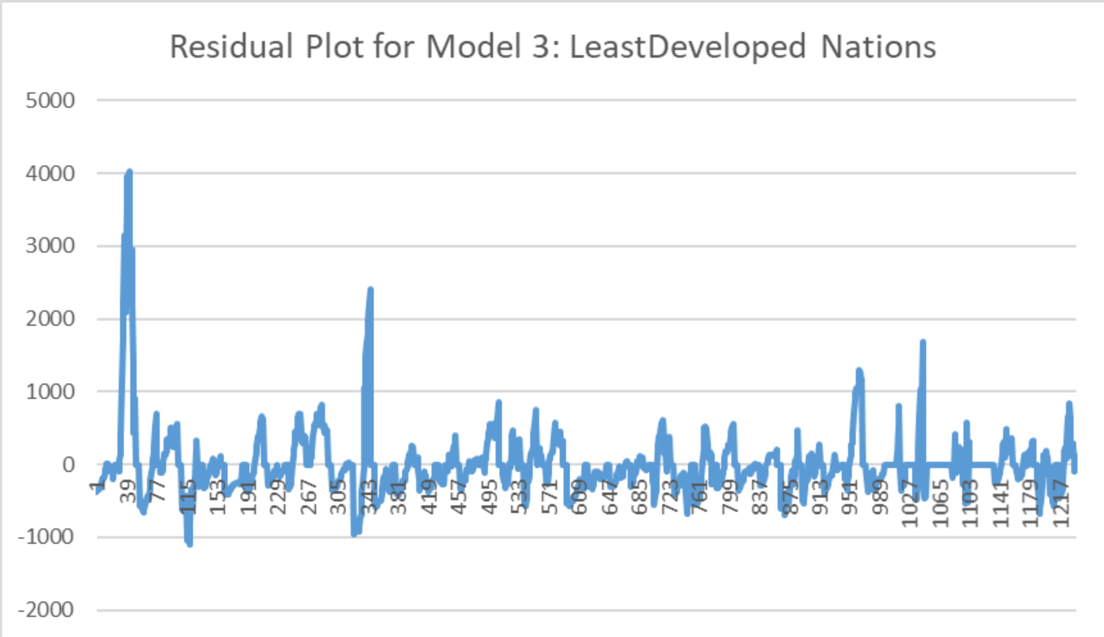

Figure 7: Residual Plot for Model 1: Least Developed Nations

Chapter 5 - Analysis And Discussion

5.1 Comparative Analysis And Discussion Of The Research Findings

This chapter unravels the economic implications of the research findings on the various country classifications. The table below shows, at a glance, the regression results for all categories of countries for ease of comparison.

Table 14: Comparative Table of Regression Analysis Results of Country Classifications

Comparative Table of Regression Coefficients Across Country Groups									
	DEVELOPED COUNTRIES			DEVELOPING COUNTRIES			LEAST DEVELOPED COUNTRIES		
Variables	**Parameters**	**P-Value**	**Significance**	**Parameters**	**P-Value**	**Significance**	**Parameters**	**P-Value**	**Significance**
Intercept	9194.70	1.59E-12	Significant	2557.8	3.44E-32	significant	486.91	1.5571E-75	Significant
X1 (Crude Oil Production per Capita)	-1.4175	0.066409	**Not Significant**	-0.0058739	0.13221	**Not significant**	0.001342100	0.00020596	Significant
X2 (Crude Oil Export per Capita)	0.0044839	4.12E-19	Significant	0.001104	4.07E-30	Significant	-0.000000333	0.60952	**Not Significant**
X3 (Crude Oil Import per Capita)	0.0088036	6.48E-10	Signifucant	-0.0003036	0.3769	**Not significant**	0.000010833	0.0020334	Significant
X4 (Other Petroleum Products Export per Capita)	-0.009422	3.55E-10	Significant	-0.0006198	0.023714	Significant	-0.000012614	0.0019544	Significant
X5 (Other Petroleum Products Import per Capita)	0.0040507	1.19E-14	Significant	0.0031679	6.53E-39	Significant	0.000001262	0.018049	Significant
X6 (Natural Gas Export per Capita)	0.023104	1.63E-05	Significant	0.001656	4.81E-53	Significant	-0.000001702	0.60033	**Not Significant**
X7 (Natural Gas Import per Capita)	-0.0017954	0.86282	**Not Significant**	0.030472	1.56E-26	Significant	-0.000370430	0.51176	**Not Significant**
X8 (Total Energy Use per Capita)	0.279	9.08E-35	Significant	0.12428	7.84E-69	Significant	0.103610000	5.1455E-78	Significant
X9 (Oil Electricity per Capita)	-1.3573	0.001129	Significant	0.57904	0.001905	Significant	2.939800000	5.4198E-34	Significant
X10 (Gas Electricity per Capita)	4.9816	7.66E-19	**Significant**	**Variable Dropped due to Multicolinearity**			2.212700000	0.000018607	Significant
Number of Observations	962			1468			948		
Error Degree of Freedom	951			1458			937		
Root Mean Squared Error	16500			5880			531		
R-Square	46.50%			76.90%			41.80%		
R-Square Adjusted	46.00%			76.70%			41.20%		
Level of Significance	**5.00%**			**5.00%**			**5.00%**		

Source: Created by the authors

5.2 Energy Trade (crude oil, natural gas, and other petroleum products)

With per capita GDP representing the economic growth of countries, this section answers the question: how does international trade of energy affect the per capita GDPs of developed, developing, and least developed nations classifications? Our research findings showed diverse kinds and degrees of impact of trade in energy (crude oil and natural gas) on the per capita GDP across categories. Though the impact level varies amongst classifications, the responses of per Capita GDP to Export and Import dimensions of international energy trade were also observed. Thus, the analysis of the variables: crude oil export per capita, crude oil import per capita, other petroleum products export per capita, other petroleum products import per capita, natural gas export per capita, and natural gas import per capita enabled us to provide answers to this research question.

5.2.1 Impacts of Crude Oil Trade on Per Capita GDP

Comparing the behaviours of crude oil export variables across all country groups, it was found to be significant and positive for both developed and developing countries but not significant for least developed countries. It also showed that developed countries profit more from crude oil export than developing and least developed countries when the magnitude of impact on their respective per capita GDPs was compared. The panel regression output revealed that for every 1% increase in crude oil export value per annum, there will be corresponding 0.4484% and 0.1104% increases in the per capita GDPs of developed and developing countries respectively, provided that all other variables are kept constant. Consequently, the more developed and developing nations increase their earnings from crude oil export trade, the more economic growth per capita they will experience.

Related to the above is a study conducted by Osintseva (2022) in which statistical and regression techniques were employed to validate the positive link between variations in oil prices and economic development, emphasising the increasing impact of the scale effect. This implies that countries with bigger absolute GDP and higher hydrocarbon export may see more significant economic growth as a result of favourable fluctuations in oil prices compared to smaller economies. This relates to the positive impact of crude oil export on developed and developing countries' per capita GDPs on one hand and the insignificance of crude oil export on least developed countries' per capita GDPs on the other hand, based on the findings of our study. The economic growth of oil-exporting countries is heavily reliant on fluctuations in oil prices and alterations in oil production levels (Osintseva, 2022). Contrary to the prevailing views, during economic downturns, nations do not necessarily restrict oil exports in response to falling global oil prices, instead, there is a shift in the function of the price component, where maintaining an income-balance strategy becomes a crucial instrument for determining optimal production levels (Osintseva, 2022). Furthermore, Osintseva (2022), observed that a 1% rise in oil production may potentially lead to varying levels of GDP growth for different nations. Specifically, the considered OPEC countries may experience a GDP growth of about 0.0367% upwards. On the other hand, non-OPEC member countries like Russia could potentially achieve a higher GDP growth of up to 1.559%. The above is consistent with the findings of this research as all OPEC member nations are either developing or least developed nations.

However, the experience of least developed nations is different because the crude oil trade variable was not significant for their per capita GDP. It might be that the least developed countries' export levels is relatively small to have a significant impact on their per capita GDPs. It might also be due to limited trade data received for least developed countries as earlier highlighted in the limitations of this study in chapter one.

There is also a school of thought on the 'resource curse' which posits that several nations endowed with abundant natural resources are unable to fully capitalise on their resource richness for economic development as well as the inadequate response of governments in these nations in addressing the welfare requirements of their populace (Natural Resource Governance Institute, 2015). This is a probable reason crude oil export was insignificant for the Least Developed Countries' per capita GDPs even though a number of them have crude oil resources. It might as well be that the large populations of the least developed countries relative to their crude oil export earnings make their crude oil export trade infinitesimally small that it has no impact on their per capita GDP, even though it might impact their Gross National Product when considered as net export earnings. It will be noted that the population effect is one of the reasons this study focuses on the 'per capita values' of all the variables.

According to the Centre on Global Energy Policy (CGEP), a major problem of the least developed countries is their inability to convert revenues from crude oil exports into real economic growth. This position is strengthened by the CGEP, (2019) report which noted that throughout history, a significant portion of the discourse around energy and emerging nations has been on the formidable task these countries have had in effectively channeling the proceeds derived from their exports of crude oil and natural gas into sustainable economic development. The aforementioned issue continues to pose a significant difficulty for several emerging nations that rely on energy exports.

Crude oil import on the other hand shows a significant and positive correlation for the developed and least developed countries. It was however not significant for developing countries. Again, the level of impact varies considerably between developed and least developed nations. While every 1% increase in the per capita crude oil import value per annum leads to a 0.88% increase in the per capita GDPs of developed nations, it results in a 0.00108% per capita GDP increase for the least developed nations. The fact that crude oil export and import are all significant and positive for developed countries tells a lot about their involvement in international energy (oil and natural gas) trade and consequent economic development. Their ability and capability to add value to their crude oil further justifies the significance of crude oil import for developed countries.

As noted by Sahoo et al. (nd), the importation of crude oil has a positive impact on India's current account balances because India engages in the importation, refining, and selling of petroleum products on the global market to generate foreign exchange earnings, hence contributing to the enhancement of India's current account balances. One further rationale provided by Sahoo et al. (nd) for the favorable influence of crude oil imports on India's economy was the capacity to utilise the crude oil imports for energy generation to enhance production output and bolster foreign exchange earnings of India. Accordingly, developed countries much more engage in value addition and crude oil utilisation for energy, hence the significant contribution of both crude oil export and import to their economies. The significance of crude oil import in the least developed countries suggests their reliance on oil for energy. This is corroborated by the positive significance of oil electricity for this country category earlier highlighted in chapter four.

The contribution of crude oil imports to the per capita GDP of least developed nations is trivial relative to the developed nations and this may be a reflection of both their energy demand and consumption and their involvement in international energy trade. The narrow impact of crude oil imports on the economies of the least developed countries may also be attributed to their insufficient ability to enhance the value of crude oil, as well as the influence of price fluctuations and low levels of industrial activity that wouldn't generate a favourable return on investment for the economy when compared to developed nations.

The situation for developing nations is however different. Huntington, (2015) observed the absence of impact of crude oil importation on the current account balances of developing nations. It was noted that a good number of oil-producing and exporting nations fall within the developing countries category and this partly explains the significance of crude oil export trade on their economies. Also, a good number of developing countries cannot refine crude oil and are dependent on the importation of refined products. This development further compounds the chances of making economic gains from crude oil importation. Hence, the importation of crude oil in developing nations is not an economic priority as indicated by the findings of this study. It also suggests that they are largely self-sufficient in crude oil production and export given that the export trade of crude oil was significant and positive for them just as the import of petroleum products was significant and positive.

In furtherance of the discussion on energy trade across country categories, it is also found that the export of other petroleum products variable was significant but negative for all county categories. The negative coefficients of the Other Petroleum Products export variable show that the more petroleum products are exported, the more the per capita GDPs of all country categories decline, thus supporting the need to satisfy domestic energy requirements especially for the industrial production sector. In effect, for every 1% increase in the export of other petroleum products by developed, developing, and least developed country groups, there are corresponding per capita GDP declines of 0.942%. 0.06198% and 0.00126% respectively. Economically speaking, it costs the various country categories more to export petroleum products especially if local demand has not been sufficiently met. In effect, developed countries lose more to petroleum products export, followed by the developing and the least developed countries. It is seemingly more beneficial to use petroleum products to satisfy domestic energy needs for production and stimulation of value-adding economic activities than relying on revenues from petroleum product exports, which are subject to price volatilities with possible consequent negative impacts on the per capita GDPs. This is because not fulfilling domestic requirements entails sourcing for energy sources externally which may impact adversely the economy.

Generally, the reliance on oil hurts the GDP per capita in the long term, hence substantiating the resource curse argument. In the long term, there is a negative correlation between a 10-percentage point rise in the oil export share and a 7% decrease in GDP per capita (Kakanov et al., 2018). The study by Kakanov et al., (2018) also presented empirical data supporting the presence of a non-linear relationship between oil dependency and its harmful effects on the GDP. Specifically, as oil dependence increases, the magnitude of its negative impact on the GDP also deepens. Therefore, all country classifications should be cautious over inordinate reliance on crude oil and natural gas as a single means of earning foreign revenue, rather, should focus on their use to support economic activities for development. This study also found that there could be some connection between the negative impacts of other petroleum product exports and the positive significance of other petroleum products imported across all country categories. The positive impacts of other petroleum products exports may be a consequence of the efforts by nations to satisfy domestic energy deficits or a trade policy objective of gaining from international commodity trade by these nations. Accordingly, for every 1% increase in the value of other petroleum products imports by developed, developing, and least developed nations, there are corresponding 0.405%, 0.3168%, and 0.000126% increases in their per capita GDPs per annum respectively. The magnitude of impacts caused by the importation of other petroleum products across the three country categories differs and reflects their levels of energy need, energy consumption, or energy trade.

The findings of this study further underscore the point that nations' economies require energy and energy-related products to run efficiently and sustainably. Put differently, the value derivable from domestic consumption of other petroleum products is more than the value derivable from export of the same. That is, the opportunity cost of exporting other petroleum products was higher than that for locally consuming them within the three broad categories of nations.

Foreign revenues generated through increased exports enable the acquisition of capital goods and factors of production, consequently enhancing the productive capacity of a nation's economy (Ramos, 2001). However, most of the developing and least developed countries may be lacking in the ability to convert export revenues to enhance value addition to their economies as the majority of crude oil refineries in the world are owned and situated within the developed countries.

As suggested by the findings of Sahoo et al. (nd), it may be more beneficial for the developing and least developed countries to, like India, focus on using the available products (produced or imported) to support industrialization and production which may add more values to their GDPs than out rightly selling them in a volatile petroleum products price market.

5.2.2 Impacts of Natural Gas Trade on Per Capita GDP

International trade of natural gas exhibited a very diverse behaviour towards the per capita GDPs of the three country classifications both on the export and the import dimensions. While the natural gas export trade was significant and positive for developed nations, the import component was insignificant for them. For the developing countries, both export and import trade of natural gas were significant and positive while there was no statistically significant impact of natural gas export and import trade on the per capita GDPs of the least developed countries. These outcomes have implications for the energy trade of the various country groups. For instance, every 1% increase in value per annum of natural gas export has a corresponding 2.31% and 0.1656% increase in the per capita GDPs of the developed and developing nations respectively. While we may consider that developed countries have attained selfsufficiency in their domestic natural gas requirement leading to the positive significance of its export trade, we note that for developing countries, this may not be about self-sufficiency but the fact that huge natural gas deposits are found in some of their countries, and as revealed by Ramos (2001), foreign exchange earnings from export trade enables the acquisition of capital goods and factor inputs which consequently supports the productive capacity of a nation's economy.

Moreover, the use of cleaner fuels such as natural gas - which releases about half of the CO_2 footprints of other fossil fuels - has been on the global agenda in recent times as a bridge gas heralding the transition to more clean and renewable energies (World Population Review, 2023). This is especially so within the time scope of this research, in the wake of severe health and environmental concerns regarding carbon emissions. Developed countries are top in the achievement of this energy transition agenda among the three country categories. 50% of the top ten consumers of natural gas fall within the developed countries category with the USA, Canada, Japan, Germany, and United Kingdom ranking highest in that order (World Population Review, 2023). However, for the developing countries, while ranking next to developed countries in the use of natural gas as an energy source, their huge export of natural gas as an important primary means of national revenue could be a contributing factor to the significance of the natural gas export variable to their economies. This is because about 60% of the top ten producers of natural gas are within the developing countries category (Pistilli, 2022).

Furthermore, the result showed clearly that Least Developed Countries are not significantly engaged in natural gas trade as much as other country groups. We acknowledge that several Least Developed Countries have natural gas deposits and export the same, yet, their trade in natural gas was not sufficient to cause an effect on their per capita GDPs at a 5% level of significance.

In all, it suffices to conclude that least developed countries have no statistically significant and economically profitable natural gas trade and this may be connected with the lack of capacity and know-how to produce, store, and trade on this important but delicately volatile commodity - natural gas. Therefore, a clear strategy on gas energy trade and utilisation by the least developed countries is imperative, if they desire to profit from the gains of natural gas export like developed and developing countries, especially the natural gas reserve-owning LDCs.

From an import perspective, natural gas import was not significant for developed and least developed countries but was significant and positive for developing countries. Accordingly, for every 1% increase in the value expended on natural gas import per annum by developing countries, there is a corresponding 3.047% increase in their per capita GDPs. With the substantial production of natural gas in developed countries - about 40% of the top ten producers - (World Population Review, 2023), we may infer that the amount expended by developed countries to import natural gas is not substantial enough to cause an effect on their per capita GDP, hence its insignificant role in the model. Another consideration is the impact of alternative energies, especially greener and renewable energy sources which may diminish huge reliance on natural gas importation for domestic energy generation and use (Rezai & Van Der Ploeg, 2017). Furthermore, the volatile state of natural gas makes it difficult to store and trade natural gas when its price improves on the international market as most natural gas trades are from production sites to consumption locations.

On the part of developing countries, we can deduce that the positive significance of natural gas export, as well as natural gas import trade, is an indication of their ability to profit from their natural gas deposits for exports as well as the import of natural gas for energy generation to support economic activities and their large populations, especially those countries that are not endowed with natural gas deposits. Hence, by having both export and import natural gas variables significant and positive, we can conclude that developing countries' trade of natural gas impacted their economic development more than developed and Least Developed Countries whose natural gas trade within the time scope for this study did not reasonably count for their respective economies.

For the least developed countries, the non-significance of both natural export and import variables reveals their limited trade in natural gas. Therefore, governments of Least Developed Countries should put in place, policies and mechanisms that support trade in natural gas either by expanding their natural gas utilisation infrastructure for energy generation (which was significant for them) or by developing adequate natural gas capture, storage, and delivery infrastructure, especially countries that has natural gas deposits, considering that trade in natural gas was beneficial for both developed and developing countries in different ways. We consider that Least Developed countries may have more to learn from developing countries than developed countries due to the proximity or similarity of their economic circumstances to the developing countries than to developed countries.

5.3 Impact of Energy Consumption on Per Capita GDP

In an attempt to answer the research question: how does per capita energy consumption affect the GDPs of developed, developing, and least developed nations groups, the behaviour of three variables (total energy use per capita, oil electricity per capita, and gas electricity per capita) to the GDPs of the three country classifications were considered.

This research shows that at a 5% level of significance, energy consumption was significant and positive for all country classifications. Thus, energy use per capita positively influences the per capita GDPs of the three broad categories of nations considered in this study. However, herein as well the magnitude of impact varied across the classification.

Using the panel regression parameter estimates, it is established that energy use per capita in developed nations showed a higher impact on per capita GDP than in developing and least developed counterparts. In effect, for every 1% increase in per capita energy consumption (KWH) in developed countries, there is a corresponding 27.9% increase in their per capita GDP. On the other hand, per capita energy consumption in developing countries was more impactful than in the least developed countries. While a 1% increase in energy consumption per capita in developing countries results in a 12.43% rise in their per capita GDP, a 1% increase in per capita energy consumption results in a 10.36% increase in the per capita GDPs of least developed countries.

Hence, it can be concluded that energy use across country classifications reflects their respective levels of industrialization and development. Developed countries have attained a very high level of industrialization that requires huge energy consumption to operate effectively (Beenstock & Willcocks, 1981) Countries such as the United States of America, Germany, France, United Kingdom, Spain etc. which are huge energy users within the developed countries group have built huge energy consuming public infrastructures and equipment such as electric rails, electric cars besides industries and household energy consumptions (Soytas and Sari, 2003). Although some developed nations have resorted to offshoring some or most of their productions processes to developing and least developed countries to leverage cheap labour, government incentives, etc., (Koistinen & Lipartito, 2019), the result of this studies reveals that some developed nations still retained larger shares of the global energy consumption as noted by World Population Review, (2023). It may be inferred that developed nations have more economically viable energy deployment than developing and least developed nations. A long history of large-scale industrial activities, public infrastructure, and large populations (World Population Review, 2023) as well as heightened household energy requirements due to extreme weather conditions may have accounted for this high level of impact of energy consumption on developed countries' per capita GDP.

Conversely, developing nations are known as emerging economies given the high rate of upspring of industrial activities in those countries. Most Asian, South American, and African countries including China, India, Brazil, and South Africa are notable for huge industrial activities and consequent energy consumption within the developing countries group (CGEP, 2019). Also, the prevalence of small and medium-scale enterprises as well as large populations requiring energy at various levels of economic engagement could account for the substantial impact of energy consumption on the per capita GDPs of the developing nations.

The least developed nations also have significant energy requirements, especially for their moderate industrial activities, low-level productions, small and medium-scale enterprises, and household energy needs considering their increasing populations. In all, energy consumption and its impact on the per capita GDPs varies across the country groups in proportion to their energy demands predicated mainly on their level of industrial activities.

The findings deducted from the panel regression of the research are supported by various earlier studies, especially in the backdrop of the ongoing debate on the relationship between energy consumption and GDP among scholars, governments, and researchers. While some argue that energy is an important factor input alongside other factors of production like capital and labour, making it crucial for economic development (Huseyin Kalyoncu et al., 2013), others hold that energy consumption is only a small part of the GDP and does not have a significant impact on economic growth.

In their study, Narayan and Smyth (2008) employed a multivariate panel Vector Error Correction Model (VECM) to analyse the relationship between energy consumption and economic growth in the G-7 nations. Their findings indicated that energy use had a positive impact on economic development within the G-7 countries. In a similar study conducted by Ozturk et al. (2010), panel causality was employed to examine the relationship between economic growth and energy use across 51 countries categorised as low-income, lower-middle-income, and upper-middle-income. The findings revealed that in low-income countries, economic growth positively influences energy use. In middle-income countries, a two-way causality was observed between economic growth and energy use. However, no significant relationship between energy use and economic development was found in upper-middle-income countries.

Apergis and Payne (2009) also employed a multivariate panel Vector Error Correction Model (VECM) to examine the causative relationships in 11 nations belonging to the Commonwealth of Nations. Their findings indicated the presence of a bidirectional causation between energy consumption and economic development within these countries.

Masih and Masih (1996) used the Sims Causality and Granger Causality frameworks to examine the association between economic growth and energy consumption in several countries, namely Malaysia, Singapore, Philippines, India, Indonesia, and Pakistan. The findings of their analysis revealed that, in the case of India and Indonesia, energy consumption was found to have a unidirectional impact on economic growth. Conversely, in Pakistan, the relationship between energy consumption and economic growth was found to be bidirectional. A study by Yu and Choi (1985) utilised the Granger Test to examine the causal relationship between energy consumption and economic growth in several countries. They found evidence suggesting that energy consumption leads to economic development in South Korea and the Philippines.

Moreover, Glasure and Lee (1998) employed the Bivariate Vector Error Correction Model (VECM) to demonstrate the presence of bidirectional causation between economic growth and Gross Domestic Product (GDP) in South Korea and Singapore. Similarly, Cheng (1999) demonstrated that in the context of India, there exists a positive relationship between economic growth and energy use. Asafu-Adjaye (2000) used the Trivariate Vector Error Correction Model (VECM), to show that energy consumption in India and Indonesia has positive and unidirectional effects associated with economic growth. However, in the case of Thailand and the Philippines, a bidirectional causal relationship was seen between economic growth and energy consumption. Similarly, Soytas and Sari (2003) employed a Bivariate Vector Error Correction Model (VECM) to demonstrate the causal effects from economic growth on energy usage in Turkey and South Korea. Conversely, their findings indicate that in Argentina, Canada, the USA, and the United Kingdom, there exists a mutual impact between energy use and economic growth. Moreover, a scholarly investigation conducted by Lee and Lee (2010) employed a multivariate panel Vector Error Correction Model (VECM) to demonstrate the existence of bidirectional causation between economic development and energy consumption across 25 member nations of the Organization for Economic Co-operation and Development (OECD). In a similar vein, Bekle et al. (2010) employed the Granger Causation Test to demonstrate the presence of bidirectional causation between economic development and energy consumption across a sample of 25 OECD nations.

5.4 Impact of Oil Electricity on Per Capita GDP

The result of the panel regression analysis showed that oil electricity and gas electricity variables were significant across all country categories. This shows that all countries are still largely dependent on oil and gas resources for their energy requirement. However, while oil electricity was positively significant for developing and least developed nations, it was negative for the developed countries. In other words, in the developing nations and least developed nations, an increase in oil electricity increases their per capita GDP (economic development) but at different rates with least developed nations experiencing more impact from oil electricity than developing nations. Accordingly, in developing nations, a 1% increase in the oil electricity per capita will result in a 57.904% increase in their per capita GDPs while for the least developed nations, every 1% increase in oil electricity generation results in a corresponding 293.98% increase in the per capita GDPs of the least developed countries, if all other variables are kept constant. However, for the developed nations, a 1% increase in per capita oil electricity will result in a 135.75% decline in the per capita GDPs of developed nations, as long as other variables are kept constant.

These disparities in the rate of impact between developing and least developed countries could be attributed to several reasons. Firstly, the developing countries may be investing in alternative clean and renewable energies more than least developed countries. This switch could be the diminishing factor for their dependence on oil electricity, hence its impact on their per capita GDP. On the other hand, the huge impact of oil electricity on the economies of least developed countries suggests their massive dependence on oil, due to their low usage of renewable energies (Ritchie et al., 2022). UNCTAD, (2021) revealed that numerous LDCs possess substantial but underutilised reservoirs of renewable energy sources, such as solar energy, wind power, geothermal energy, and biomass.

For the developed nations, the negative effect of oil electricity on their per capita GDP may be as a result of the de-emphasis on fossil fuels which could make oil electricity unattractive because of environmental concerns. For instance, in 2022, the European Union generated a total of 2,641 terawatt-hours (TWH) of electricity, and about 40% of this was derived from renewable sources (Council of the European Union, 2019). Furthermore, possible oil energy subsidies may increase the total cost of oil electricity vis-à-vis its economic contribution to developed nations. As reported by the International Energy Agency (IEA), has documented an excess expenditure in the form of oil subsidy of over USD 500 billion in the year 2022, primarily within developed countries, aimed at diminishing energy costs, especially in Europe which accounts for around USD 350 billion of this figure (International Energy Agency, 2023). On a global scale, the subsidies allocated to fossil fuels amounted to $7 trillion, equivalent to 7.1 percent of the GDP in the year 2022. This figure represents a notable rise of $2 trillion compared to the year 2020, mostly attributable to government funding to mitigate the impact of escalating energy costs (International Monetary Fund, 2022).

However, the positive significance of crude oil export in this study is an indication that although oil electricity negatively influences developed countries' GDP per capita, they profit more from trading in crude oil than using it as a major source of electricity. This could also justify the investments of developed countries on alternative renewable energies.

Accordingly, it can be deduced that the developed countries are deeper into alternative/renewable energy sources and are closely followed by developing countries before least developed countries as seen in the respective levels of impacts oil and electricity had on their GDPs. However, with the continued global de-emphasis on fossil energies which is dominated by oil and gas, a decrease in the trade in crude oil is expected in the future, and this has implications for global energy trade (IEA, 2023)

As stated by the International Energy Agency (IEA, 2023), there is an increasing momentum in the transition towards an economy powered by clean energy. It is anticipated that the worldwide use of oil will reach its highest point before the end of this decade, as a result of advancements in electric cars, energy efficiency, and other associated technologies. IEA (2023) also noted that beyond 2026, the use of oil as a source of fuels for transportation is projected to diminish due to the increasing prevalence of electric cars, the advancement of biofuels, and the enhancement of fuel efficiency, all of which contribute to a reduction in oil consumption. Accordingly, it is crucial for oil producers to closely monitor the increasing speed of change and make informed choices regarding oil investments to facilitate a smooth transition. (IEA, 2023).

Generally, crude oil electricity generation has more impact on the economies of least developed countries than developing countries, while it negatively affects the developed countries' economies.

5.4 Impact of Gas Electricity

Comparatively, gas electricity had more impact on the per capita GDPs of developed nations than in least developed nations while it was not featured in the model for developing nations due to multicollinearity with energy use per capita variable. The outcome of the panel regression proved that, with a 1% increase in per capita gas electricity in developed nations, there will be about a 498.16% increase in their per capita GDPs whereas the same 1% increase in per capita gas electricity in least developing nations leads to 221.27% increase in their per capita GDPs. With per capita energy use substituting for gas electricity in developing nations, it can be inferred that the outcome of the energy use per capita holds for gas electricity for the developing nations for at least 80% of the time. Hence, proving its impact on GDPs across all country groups.

Also, the magnitude of the impact of gas electricity on the economies of the developed and least developed countries may be an indication of their various levels of industrialization which contributes to their energy demand and consumption.

Mashayekhi, (1988) noted that 45 percent, or 47 trillion cubic meters, of the world's gas reserves in 1987 were located in developing nations, ten of which accounted for around 36% of global reserves, with the LDCs accounting for 10%. Despite this, LDCs are responsible for just 13% of global natural gas usage (Mashayekhi, 1988). A report by Ritchie et al., (2022b) revealed also that of the top 9 consumers of fossil energy, six (USA, Australia, Germany, EU, UK, France) are developed countries while 3 (China, South Africa, and India) are developing countries. Furthermore, the primary source of fossil fuel utilised for power generation in Europe in 2022 was natural gas, accounting for 19.6% of the total, with coal following closely at 15.8% (Council of the European Union, 2019). Globally, of the 29,165TWH of electricity generated in 2022, 22% came from gas, (Statista, 2023), an amount that underscores the importance of gas electricity to the GDPs of all the country groups.

Chapter 6 - Summary, Policy Implications and Conclusion

6.1 Summary of the Findings

The findings of this study hold considerable Economic implications for international energy trade for the developed, developing, and least developed nations particularly for policy decisions and trade strategy.

From the onset, it was our objectives as follows:

a. To determine the implications of international energy trade on the economies of developed, developing, and least developed nations.
b. To determine the implications of energy consumption on the economies of developed, developing, and least developed nations.

Although there have been similar studies on the impact of international energy trade as presented in the literature review in chapter two, there is no known existing literature that focused on the three-country classification by the World Bank, thus, the focus of this research. This research aims to evaluate the economic implications of international energy trade (vis-à-vis crude oil and natural gas) on the economies of developed, developing, and least developed countries which can lead towards viable policy decisions and adjustments.

To achieve this, secondary time series data related to international energy trade (Crude Oil and Natural gas) on some identified variables was considered, and a panel data set up. To analyse the data set, a panel regression approach was chosen. The choice of panel regression was based on some outstanding advantages earlier highlighted in chapter three. To address the research questions of this study which borders on how international energy trade impacts the economic development of nations vis-à-vis developed, developing, and least developed nations, and how per capita energy consumption impacts the economic development of nations vis-à-vis developed, developing, and least developed nations, the following findings were made.

6.1.1 International trade of energy per capita GDPs

The panel regression output was very revealing. It established that causal relationships flowing from international energy trade to per capita GDPs of developed, developing, and least developed nations exist. The analysis revealed diverse behaviours of per capita GDP (as the dependent variable) to the various dimensions of international trade of energy expressed in terms of crude oil production, crude oil export/import trade, other petroleum export/import trade, natural gas export/import trade, the total energy used, oil electricity as well as gas electricity as explanatory variables all expressed per capita. All the variables were denominated in per capita to account for the relativity of the populations of the various country groups to their GDPs for more objective comparisons.

The panel regression output showed different behaviours of per capita GDP to international trade of energy across the three country categories and these variations provided answers to the research questions. It showed improvements in the economies of developed and developing nations as they increased their crude oil export trade earnings. Specifically, assuming that all other variables remain unchanged, a 1% annual rise in the value of crude oil exports would lead to a 0.4484% and 0.1104% increase in the per capita GDPs of developed and developing nations, respectively. The export of crude oil however has an insignificant effect on the GDP per capita of the least developed countries.

The study also revealed that the developed and least developed nations both benefited significantly and favourably from increased per capita crude oil importation. Again, the influence differs greatly across the developed and the least developed countries. For the developed countries, a 1% annual rise in the value of crude oil imported per capita corresponds to a 0.88% annual increase in GDP per capita, whereas for the least developed countries, the same factor leads to a 0.00108% increase in GDP per capita. However, the per capita crude oil importation had no significant impact on the per capita GDPs of the developing nations.

Furthermore, it was observed that the export of other petroleum products exhibited significant but negative trends across all country categories. This observation indicates a negative association between the exportation of petroleum products and the per capita GDPs across all nation categories. The findings indicate that a 1% rise in the export of other petroleum products by developed, developing, and least developed nation groups leads to a commensurate decrease of 0.942%, 0.06198%, and 0.00126% in per capita GDP respectively. Put simply, from the perspectives of overarching international trade and economic benefits to nations, it costs more to export other petroleum products than import, hence underscores the importance of fulfilling domestic energy needs for improved economic activities and per capita GDP growth across all three nations categories.

In the same vein, it is observed that there may exist a correlation between the negative effects of exporting other petroleum products in various country groups and the positive impacts of importing other petroleum products in all nations groups. Thus, this research considers import trade important in addressing the deficit in local petroleum products requirements. Consequently, it can be shown that a 1% rise in the value of various petroleum products imported by developed, developing, and least developed nations is associated with respective annual increases of 0.405%, 0.3168%, and 0.000126% in their per capita GDPs. The varying magnitude of impacts of other petroleum products on their respective GDPs may be a reflection of the energy requirement, consumption, and trade across the three broad nations groups.

The international trade of natural gas showed significant variation about the per capita GDPs of the three country groups, both in terms of exports and imports. Although the export trade of natural gas had a significant and positive impact on developed nations, the import aspect of this trade was insignificant for the developed country classifications. Conversely, in developing nations, the export and import trade of natural gas held significant and positive impacts on their per capita GDPs. However, the natural gas export and import trade had no statistically significant effect on the per capita GDPs of the least developed countries. The findings indicate that a rise of 1% in the annual value of natural gas exports is associated with a concurrent increase of 2.31% in the per capita GDP of developed countries and a 0.1656% increase in the per capita GDP of developing nations.

From an import standpoint, it can be observed that natural gas did not have considerable importance for both developed and least developed nations. However, it did exhibit a large and favourable impact on emerging countries. Consequently, it can be observed that developing nations experience a 3.047% rise in their per capita GDPs for each 1% increment in the expenditure allocated to natural gas imports on an annual basis. For developing nations, it can be inferred that the favourable implications of both natural gas exports and imports signify their capacity to capitalise on their natural gas reserves to export and import natural gas, respectively. This serves to facilitate energy generation for supporting economic endeavours.

The lack of significance in both the natural gas export and import variables for the least developed nations indicates their minimal involvement in natural gas trading. Hence, the governments of Least Developed Countries (LDCs) must implement policies and mechanisms that facilitate the trade of natural gas. This can be achieved through the expansion of their existing natural gas utilisation infrastructure for more energy generation, or by developing appropriate infrastructure for the capture, storage, and delivery of natural gas subsequently leading to economic growth. Countries with significant gas deposits need to prioritise such initiatives.

6.1.2 Energy consumption per capita GDPs

The demand, supply, and consumption of energy through manufacturing, electricity, transportation, cooking, and heating constitute the major drivers of international energy trade (Teba, 2018). The panel regression parameter estimates showed that the influence of energy usage per capita on per capita GDP is more pronounced in developed nations compared to developing and least developed nations. In essence, it can be shown that a rise of 1% in per capita energy consumption (KWH) in industrialised nations is associated with a proportional increase of 27.9% in their per capita GDP. Conversely, the per capita energy consumption of emerging nations had a greater influence on their per capita GDP compared to the least developed countries. The findings indicate that a 1% increase in energy consumption per capita in developing nations is associated with a corresponding 12.43% increase in their per capita GDP. Similarly, a 1% increase in per capita energy consumption is associated with a 10.36% increase in the per capita GDPs of least developed countries.

The findings from the panel regression analysis indicate that both the oil electricity and gas electricity variables exhibit statistical significance across all nation categories. However, whereas oil electricity had a significant and positive impact on the development of both developing and least developed nations, it had a negative effect on developed countries. In the context of developing and least developed nations, it can be observed that an increase in oil-generated electricity has a varying effect on their per capita GDPs. Specifically, Least Developed Countries tend to have a more pronounced influence from the utilisation of oil-generated electricity compared to developing nations.

In the context of developing nations, a 1% increase in per capita oil electricity expenditure is associated with a substantial 57.904% increase in per capita GDP. Similarly, for the least developed nations, a 1% increase in oil electricity expenditure corresponds to a significant 293.98% increase in per capita GDP, assuming all other variables remain constant. In the context of developed countries, it can be shown that a 1% rise in per capita oil electricity generation and consumption leads to a substantial loss of 135.75% in the per capita GDPs of these nations, assuming all other factors remain constant.

In developed nations, the adverse impact of oil-generated electricity on per capita GDP can be attributed to the reduced emphasis on fossil fuels, rendering oil-based electricity less appealing in these countries, particularly due to concerns about sustainability and the environment. Moreover, it is worth noting that possible subsidies for oil energy might potentially lead to an escalation in the overall expenses associated with oilgenerated power, relative to its economic impact on developed countries.

In a comparative analysis, it was shown that the influence of gas electricity on the per capita GDPs of developed nations was more significant than in least developed nations. However, it was not included in the model for developing nations due to multicollinearity issues with the energy usage per capita variable.

The results of the panel regression analysis indicate that a 1% increase in per capita gas electricity in developed nations is associated with an approximately 498.16% increase in their per capita GDPs. Conversely, a similar 1% increase in per capita gas electricity in the least developing nations is associated with a 221.27% increase in their per capita GDPs.

By replacing per capita energy usage for gas electricity in developing nations, it may be inferred that the findings about energy consumption per capita apply to gas electricity in developing nations at least 80% of the time. Therefore, the utilisation of natural gas for power generation could be said to have had a significant influence on the per capita Gross Domestic product (GDPs) of all categories of countries.

6.2 Establishing Trade Patterns

It is vital to establish the predominant trade patterns among the various classifications in determining the impact of international energy trade on their respective economies.

6.2.1. The Developed Nations

The per capita GDPs of developed nations reacted significantly to both positive and negative changes in energy trade. While crude oil and natural gas export trades positively influenced the per capita GDPs, only other petroleum products export trade variable was negative on the per capita GDPs. From the import perspective, crude oil imports and other petroleum products import variables were positive for the per capita GDPs of the developed nations while natural gas import was insignificant.

Therefore, in terms of energy trade impacts on the per capita GDPs of developed countries, we can see that both the export and import trade of energy made a substantial impact on the economic development of developed nations. Thus, it is imperative that developed nations focus on both import and export trade policies with special attention on other petroleum products import variables which had negative effects on the per capita GDP, as well as the natural gas import which had no significant effect on the GDP.

6.2.2 Developing Nations

Developing nations share similar trade patterns with developed nations but to different degrees. Both export and import energy trade influenced the per capita GDPs of developing nations. While crude oil and natural gas export trade variables had positive influences, other petroleum products export variables had a negative impact on the per capita GDPs of developing nations. From an import perspective, both other petroleum products and natural gas import trade variables had positive influences on the per capita GDPs of developing nations. However, the crude oil import trade variable was of no statistical significance.

Accordingly, developing nations should seek to sustain and improve their energy export and import trade but closely monitor and reengineer their crude oil import trade for positive contribution to economic development and this could be achieved through strategic value-adding activities such as crude refining or effective and profitable crude oil commodity trade.

6.2.3 Least Developed Nations

Energy trade pattern in the least developed nations was entirely different. Export trade variables such as crude oil and natural gas were not significant towards the per capita GDPs of LDCs. Notably, the only significant export trade variable (other petroleum products export) had a negative impact on the per capita GDPs of the least developed nations. Nevertheless, the import trade of energy was mostly significant and positive for the least developed nations. Crude oil and other petroleum products imports were significant and positive on the per capita GDPs while natural gas import was not statistically significant. Hence, developed countries could be said to be importdependent on energy trade.

6.3 Implications Of The Findings For Policy Making

International energy trade calls for continuous and comprehensive policy reviews that encompass several aspects of energy trade. The findings of this study afford policymakers the latitude to model the probable consequences of policy modifications, hence facilitating more informed decision-making about their countries' trade of energy (Greene, 2002). Accordingly, governments need to reassess their strategic priorities, encompassing a range of actions such as reformulating energy policy, diversifying economic revenue streams, and making adjustments to diplomatic relationships, especially for developing and least developed nations.

It is of utmost importance to consider and monitor the implications of fluctuations in crude oil and natural gas trade on the economic or social development of a nation (Battistin & Bertoni, 2023). The implementation of a policy adjustment or a sudden fluctuation in Crude oil or Natural Gas prices may not provide immediate consequences but rather exhibit themselves gradually over an extended period, spanning months or even years. Policymakers have the opportunity to customise actions that specifically address those concerns (Cameron & Trivedi, 2005) subsequently leading to positive economic implications. Policymakers can predict and make preparations for future consequences by drawing insights from previous occurrences (Wooldridge, 2010). The possibility for fiscal and monetary policy modifications arises when governments shift their focus away from oil and gas earnings, hence potentially resulting in transformations in economic policies. In contrast, the environmental agenda may have a greater inclination towards the promotion of green energy and the implementation of sustainable rules (Angrist & Pischke, 2009). Policymakers have the opportunity to use knowledge of the diverse effects of trade across different countries to facilitate coordinated multinational actions, like the establishment of trade agreements or the creation of shared reserves (Arellano, 2003).

The strategic imperatives of states may undergo adjustments, with a heightened focus on ensuring the security of supply lines and the possibility of altering defense postures. The prioritisation of research and development, particularly on sustainable energy security is expected to play a crucial role in driving future economic expansion thus attracting foreign investments through a favourable and competitive business environment. To effectively mitigate and navigate the fragile and evolving global energy trade, it is imperative for governments to focus on areas of comparative advantage, adaptability, and sustainability. Stakeholders' engagement will as well play a pivotal role in managing public expectations and facilitating a seamless transition among the various changes taking place. Policymakers will encounter a critical juncture, necessitating adaptability, strategic planning, and cooperative efforts to effectively navigate their respective countries among the complex circumstances of global energy trade.

Following from the findings of this study, the following suggestions may apply to various nations within the three broad categories considered in this study.

i. As noted by Bashiri Behmiri and Pires Manso (2013), since energy consumption is positively linked with economic development across all country categories, reductions in energy supply and consumption should be avoided, given its detrimental impact on the economic prospects of nations. Accordingly, national policies on energy should encompass a steady and competitive energy supply to a nation, especially for value-adding economic activities such as transportation and industrial production. Where inevitable, energy subsidies may be administered, such that the overall cost of energy should not offset the resulting economic benefits to the nations.

ii. Considering the negative effects of other petroleum products exported across all country groups, policymakers within these nations should cautiously navigate their energy policies away from an inordinate reliance on petroleum products as just a single means of earning foreign revenues, rather, they should also optimise their use to primarily support domestic economic activities for development.

iii. For the least developed countries, the non-significance of both natural gas export and import variables revealed their limited involvement in the natural gas trade. Therefore, a clear strategy for natural gas energy trade and utilisation by the least developed countries is imperative. Hence, governments of Least Developed Countries could put in place policies and mechanisms that support the trade of natural gas either by expanding natural gas utilisation infrastructure for energy generation (which was significant for them) or by developing adequate natural gas capture, storage, and delivery infrastructure, particularly nations that have natural gas deposits. This is imperative given that natural gas trade was beneficial for both developed and developing countries. Additionally, developed and developing nations could put strategies in place to sustain their gains from natural gas trade, especially by keeping a tab on the trade volatilities that could introduce negative influences on their natural gas export and import trade.

iv. Sequel to the projections of the International Energy Agency, beyond 2026, the use of oil as a source of fuels for transportation is projected to diminish due to the increasing prevalence of electric cars, the advancement of biofuels, and the enhancement of fuel efficiency, all of which contribute to a reduction in oil consumption, it is crucial for oil and gas dependent economies to closely monitor the increasing speed of change and make informed choices regarding oil investments to facilitate a smooth transition to cleaner fuels (IEA, 2023). Besides the projections of the IEA, the conflict in Ukraine exemplifies the substantial influence of political events on the energy supply chain and sustainability. In the same vein, the year 2020 witnessed a similar occurrence when the global pandemic of Covid-19 emerged. The global consumption of power experienced a significant decline as several countries implemented lockdown measures (IEA, 2022), developing and least developed economies that are solely dependent on oil revenues should take cogent steps to diversify their national revenue bases to forestall extreme shocks that may arise due to pandemic or geopolitical tensions that could hamper their international energy trade and economic stability.

6.5 Conclusion

Energy Trade in Developed and developing nations focuses on both the export and import of energy commodities. This has significant influences on their respective per capita GDPs. However, from the findings of this research, the magnitude of impact is higher in developed nations than in developing nations. Conversely, the least developed nations are mainly import concentrated in international energy trade, a situation that suggests a lack of requisite capacity to produce, utilise, or export energy on significant commercial scales. Most of the energy trade variables were too insignificant to have a substantial effect on their per capita GDPs and this is revealed on the level of energy demand, utilisation, and trade in the least developed nations.

Energy use showed significant and positive across all country Classifications with developed nations having more impact on per capita GDP from per capita energy use than developing and least developed nations respectively. On oil electricity, the least developed nations exhibited the highest level of impact followed by the developing nations, while developed nations showed a negative effect of oil electricity on per capita GDP. It is our considered thought that the negative influence of oil electricity in developed nations signals a move away from oil electricity in these nations whereas developing and least developed still highly depend on oil electricity. While we acknowledge that energy sustainability and environmental concerns could account for the negative effect of oil electricity in developed nations, it is notable that the concept of energy sustainability is not as pronounced in the developing and least developed nations, hence, their huge dependence on oil electricity and its impact on their per capita GDPs.

Gas electricity, on the other hand, showed the highest impact on the per capita GDPs of the developed and least developed nations. However, the magnitude of the impact of gas electricity on the per capita GDPs of the developing nations could not be ascertained due to its multicollinearity with per capita energy use.

In all, international energy trade across country classifications impacts their economies. However, enhancing the capabilities of governments, administrations, and economic management, together with promoting openness and accountability, which play a crucial role in facilitating inclusive development outcomes are imperative for improving the benefits derived from international energy trade. All three country classifications could consider policies that capture the future direction of global energy sources in respect of a possible decline in oil dependence and the promotion of renewable fuels for the future, especially in developing and least developed nations.

Future Research Focus

Given the current climate change concerns over fossil energy, future research endeavours may delve into the potential impacts of various forms of renewable energy on the economies of developed, developing and least developed nations.

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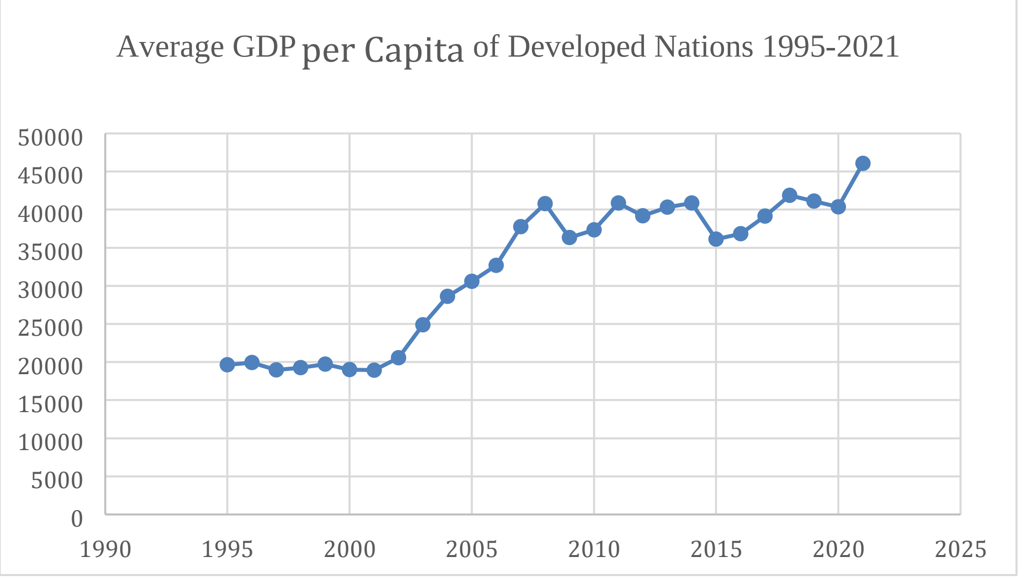
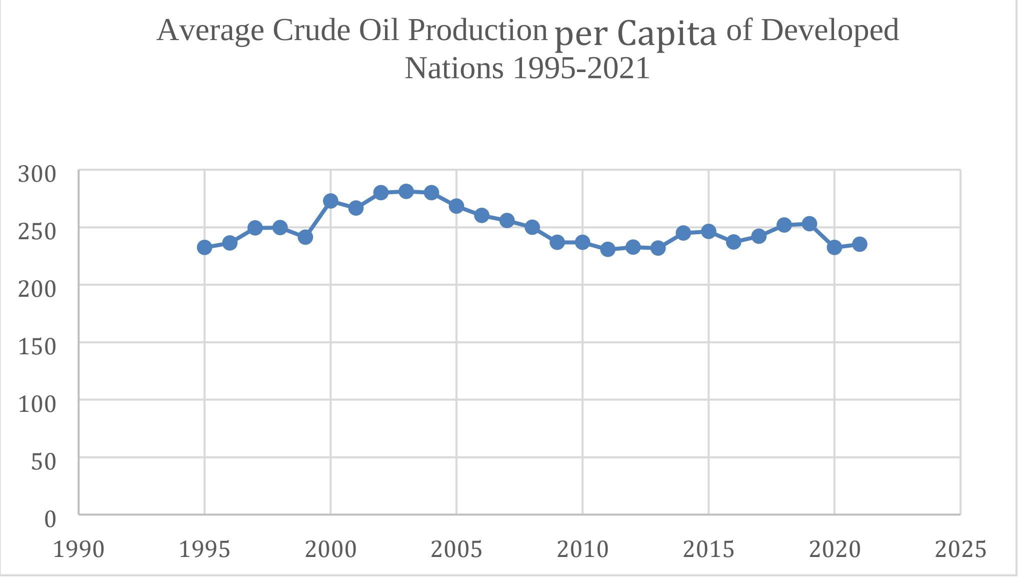
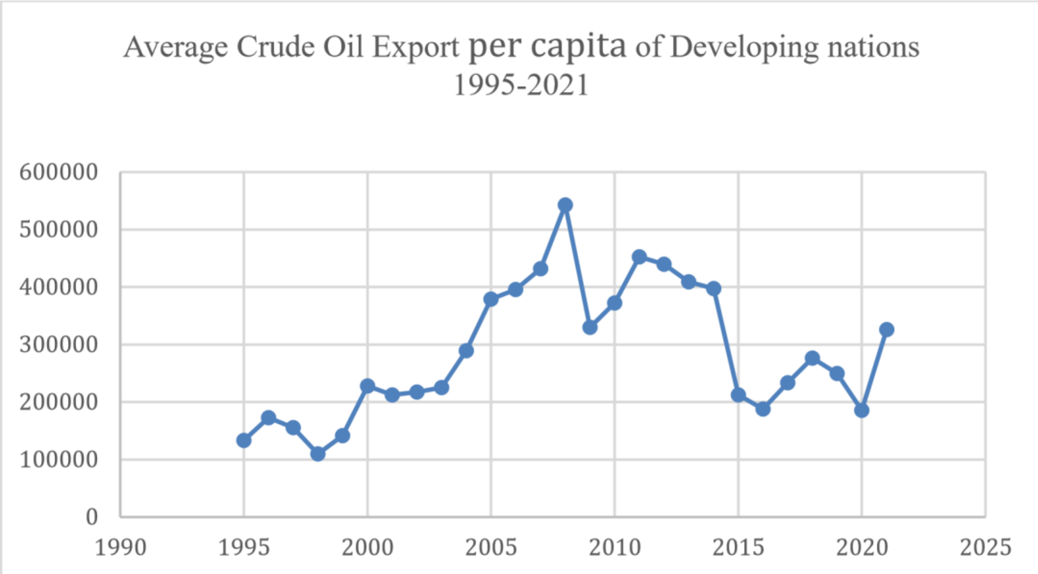
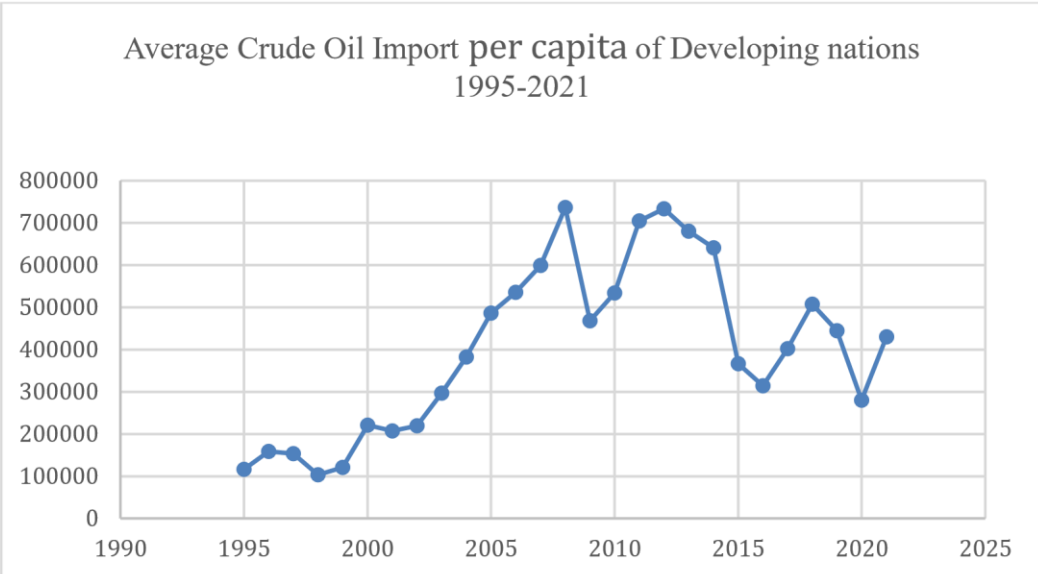
Appendices

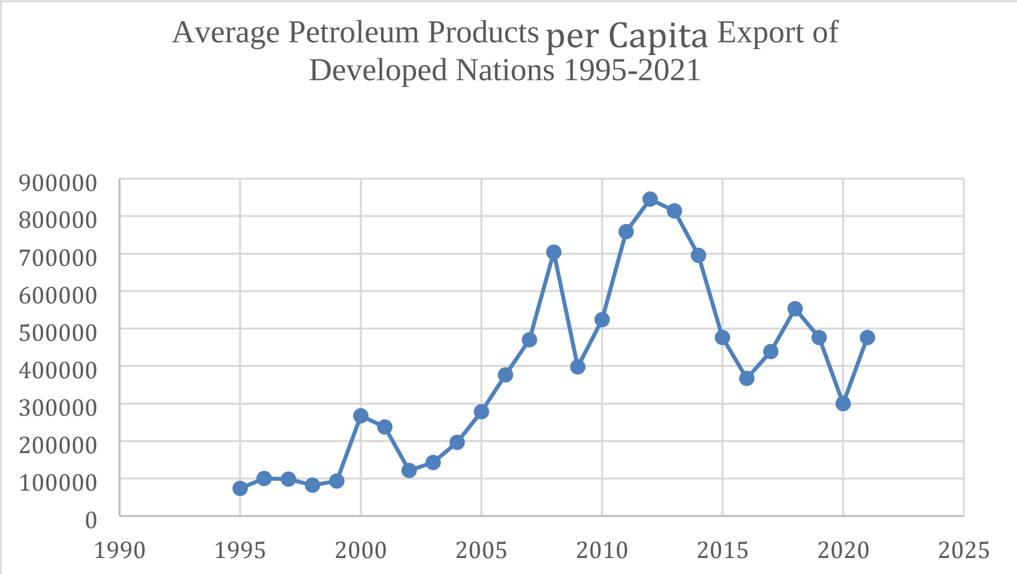
Appendix 1. Line Graphs for the Developed Nations Dataset

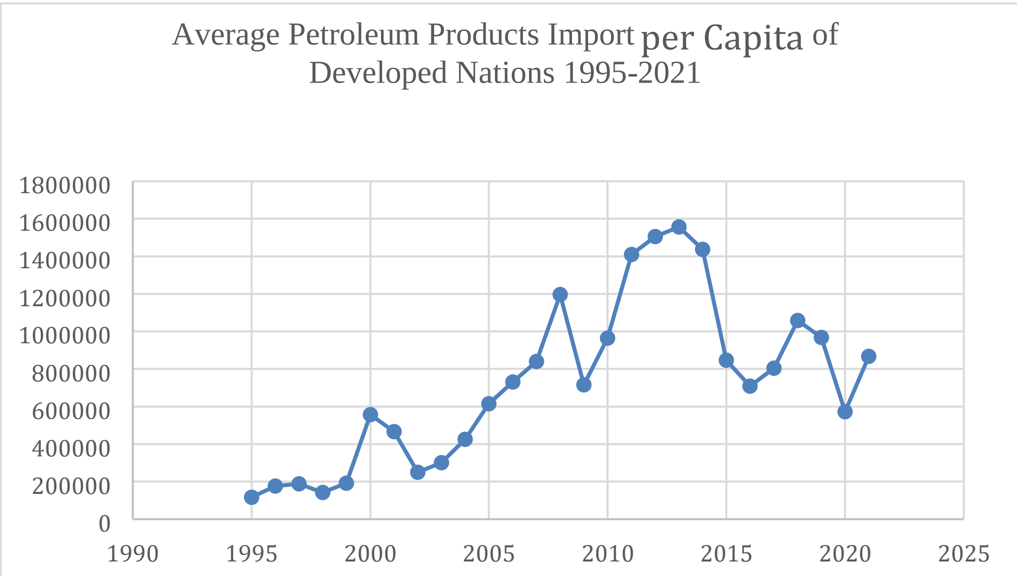


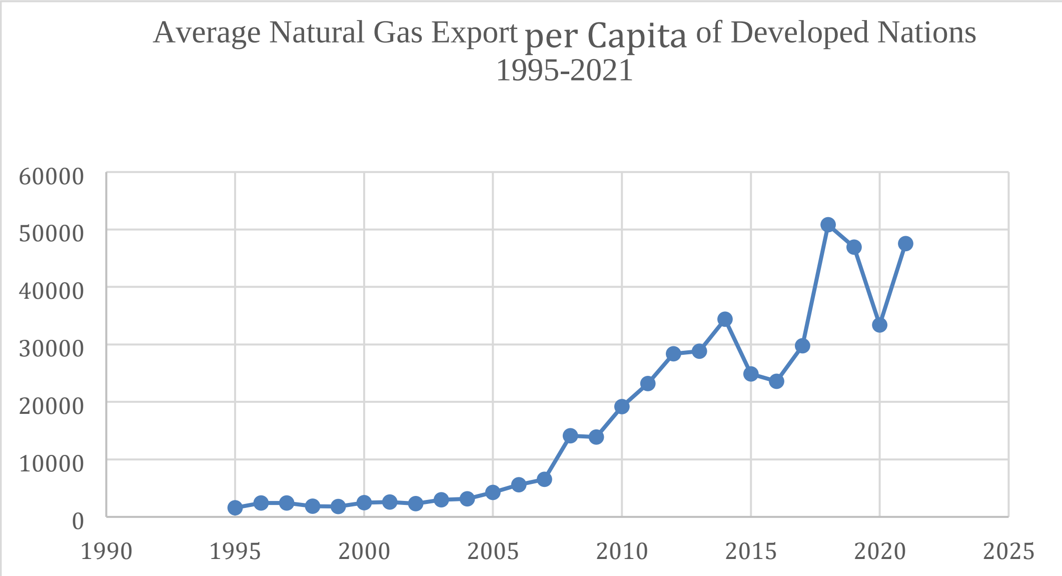



Average Crude Oil Export per capita of Developing nations
1995-2021
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025

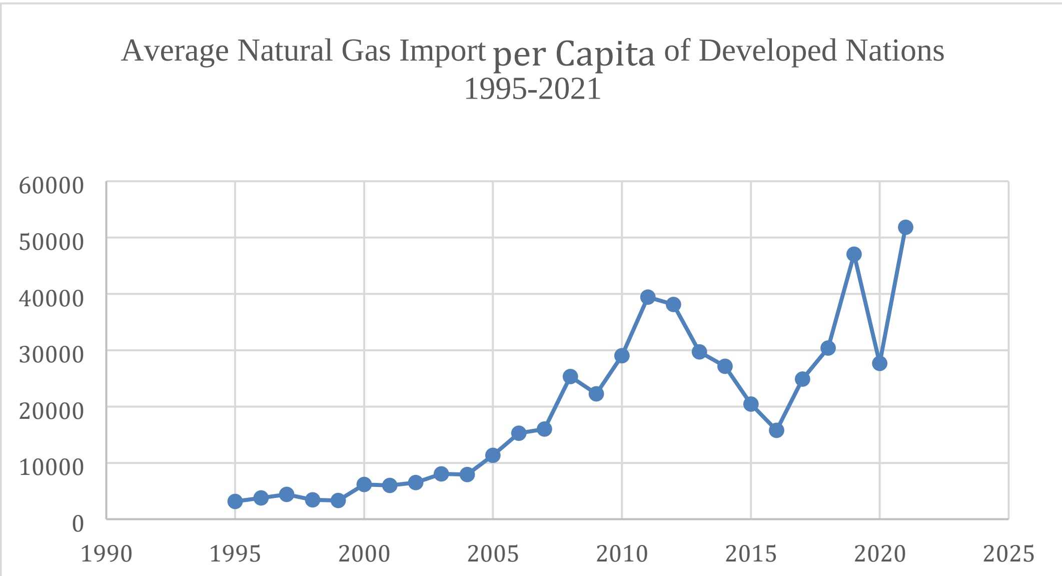

Average Crude Oil Import per capita of Developing nations
1995-2021
800000
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Petroleum Products per Capita Export of Developed Nations 1995-2021
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025

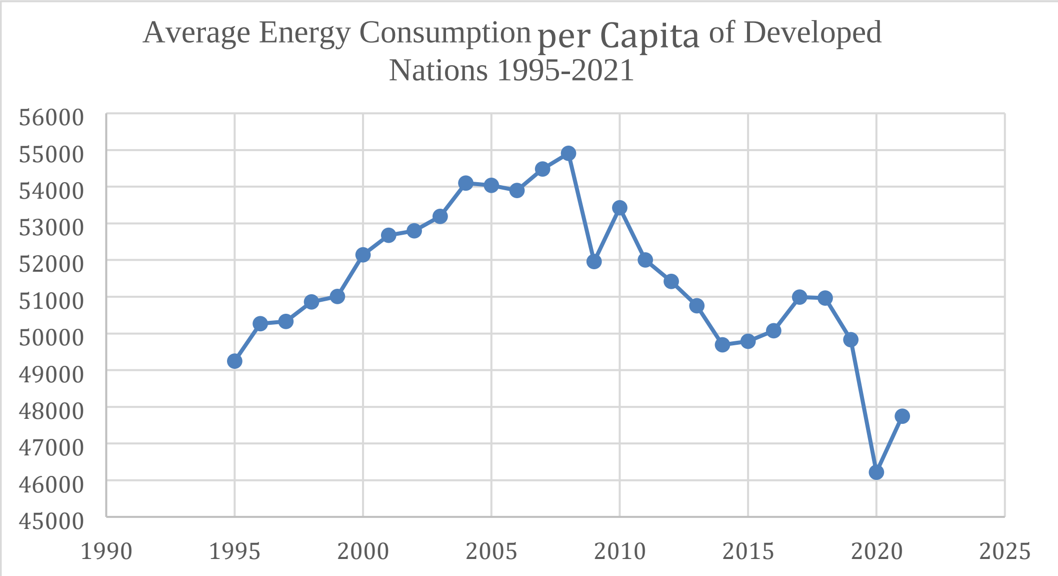

Average Petroleum Products Import per Capita of Developed Nations 1995-2021
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1990
1995
2000
2005
2010
2015
2020
2025

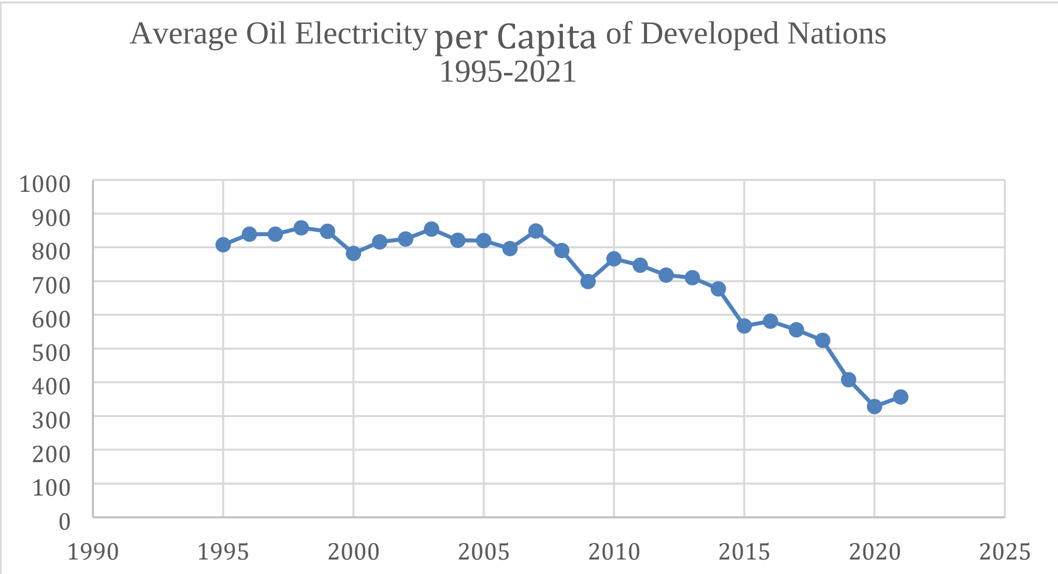


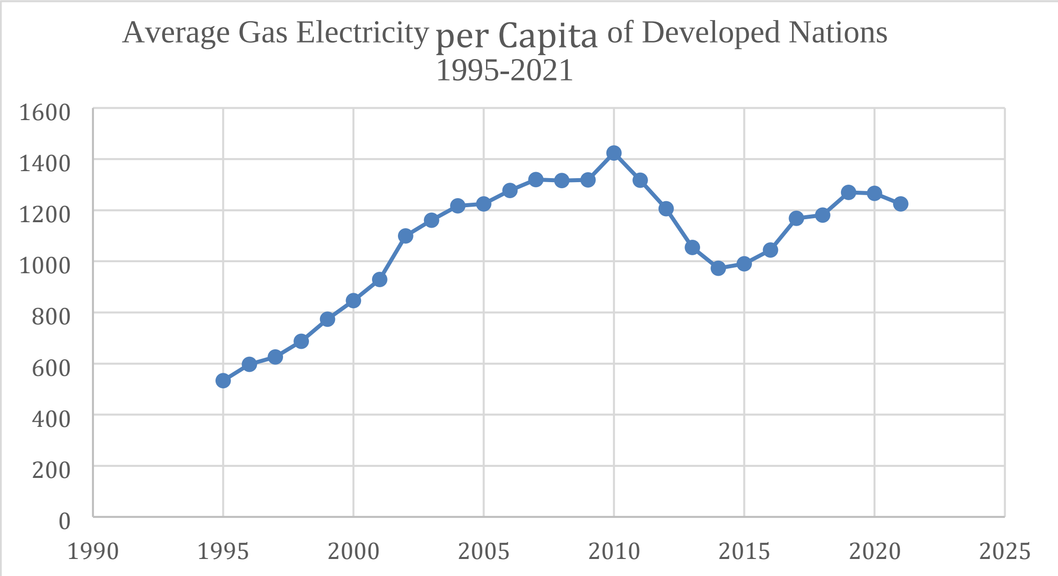
Average Natural Gas Export per Capita of Developed Nations
1995-2021
60000
50000
40000
30000
20000
10000
0
1990
1995
2000
2005
2010
2015
2020
2025



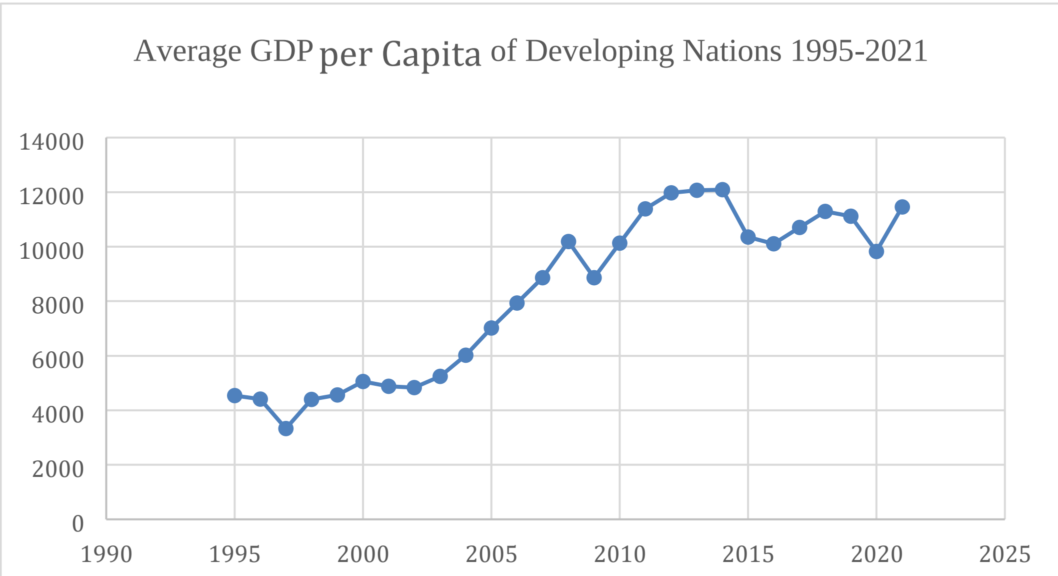
Average Natural Gas Import per Capita of Developed Nations
1995-2021
60000
50000
40000
30000
20000
10000
0
1990
1995
2000
2005
2010
2015
2020
2025

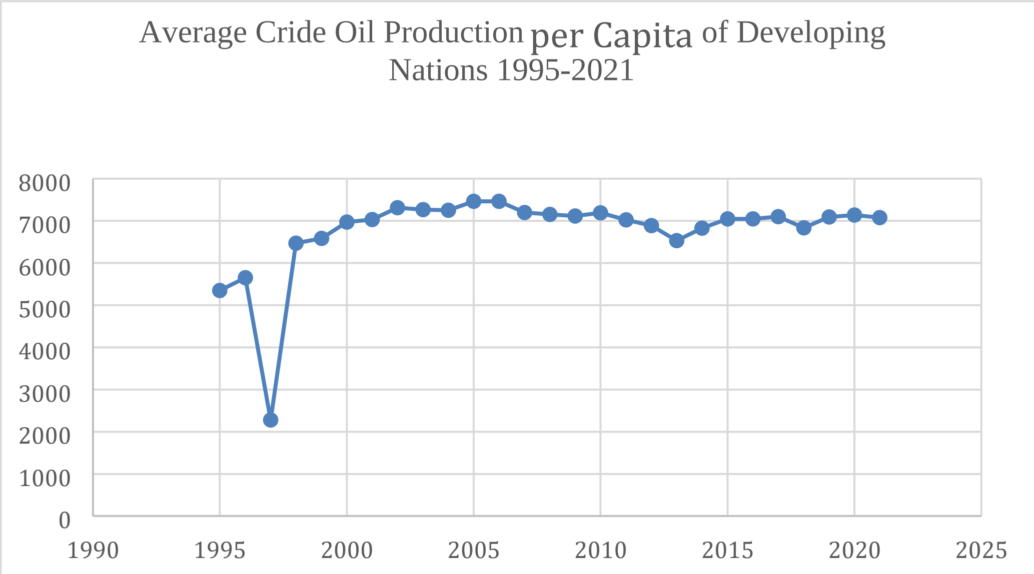

Average Energy Consumption per Capita of Developed Nations 1995-2021
56000
55000
54000
53000
52000
51000
50000
49000
48000
47000
46000
45000
1990
1995
2000
2005
2010
2015
2020
2025

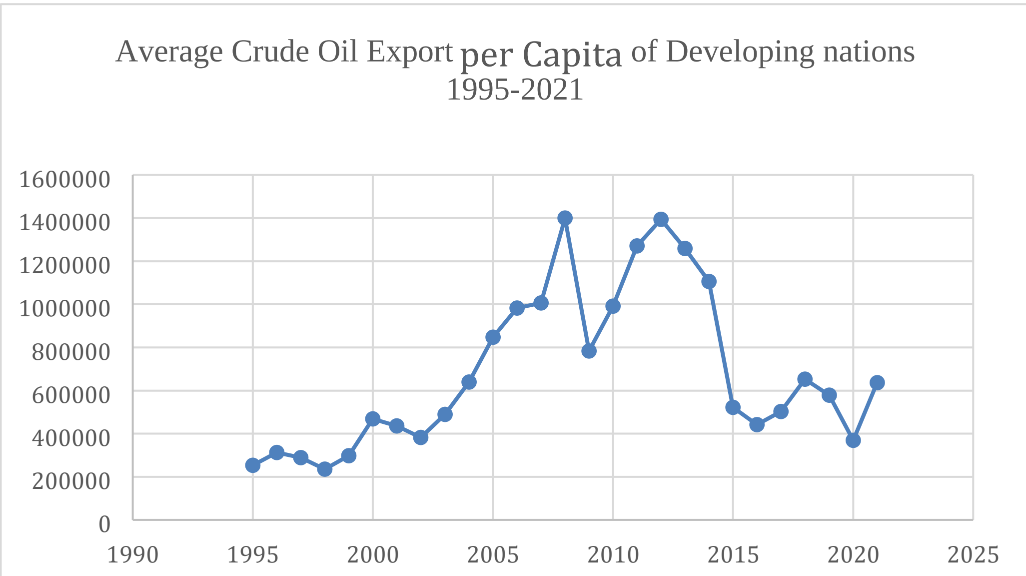

Average Oil Electricity per Capita of Developed Nations 1995-2021
1000
900
800
700
600
500
400
300
200
100
0
1990
1995
2000
2005
2010
2015
2020
2025

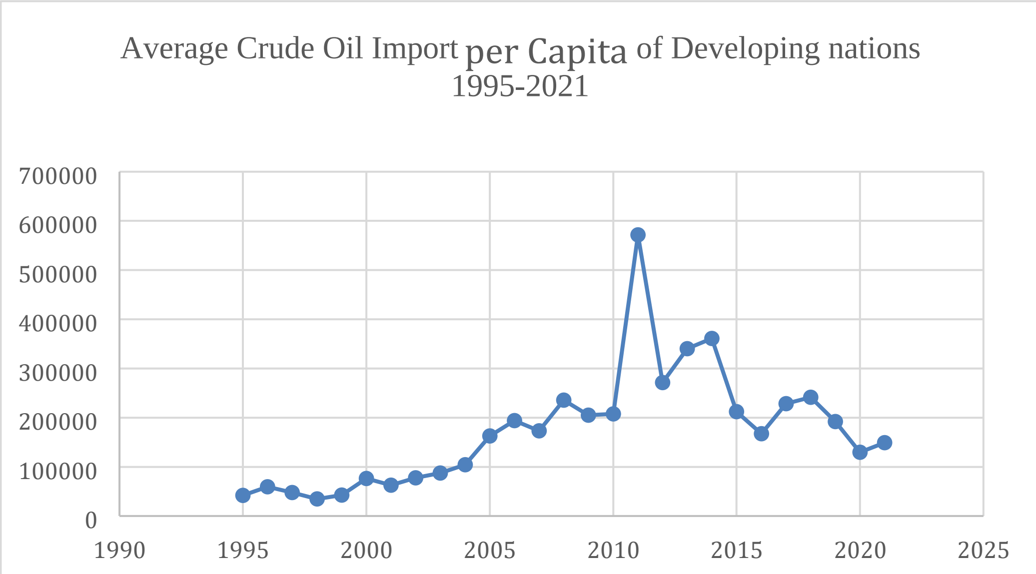


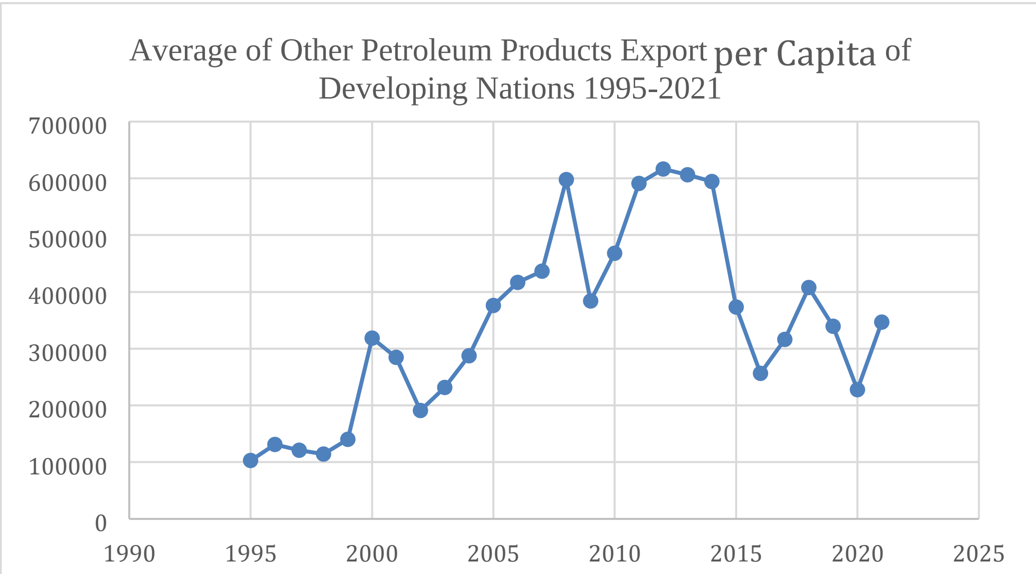
Appendix 2: Line Graphs of Developing Nations' Dataset

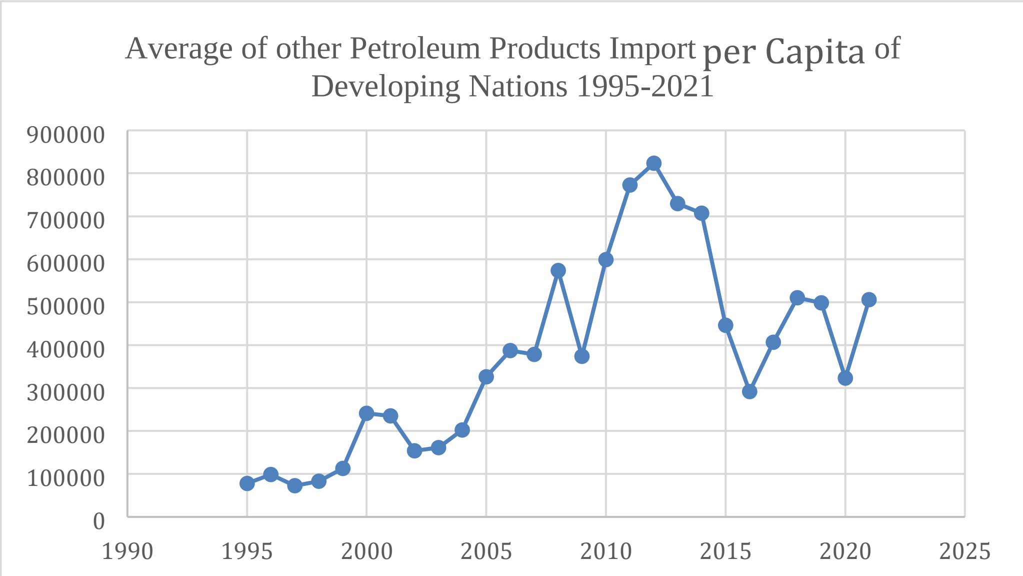


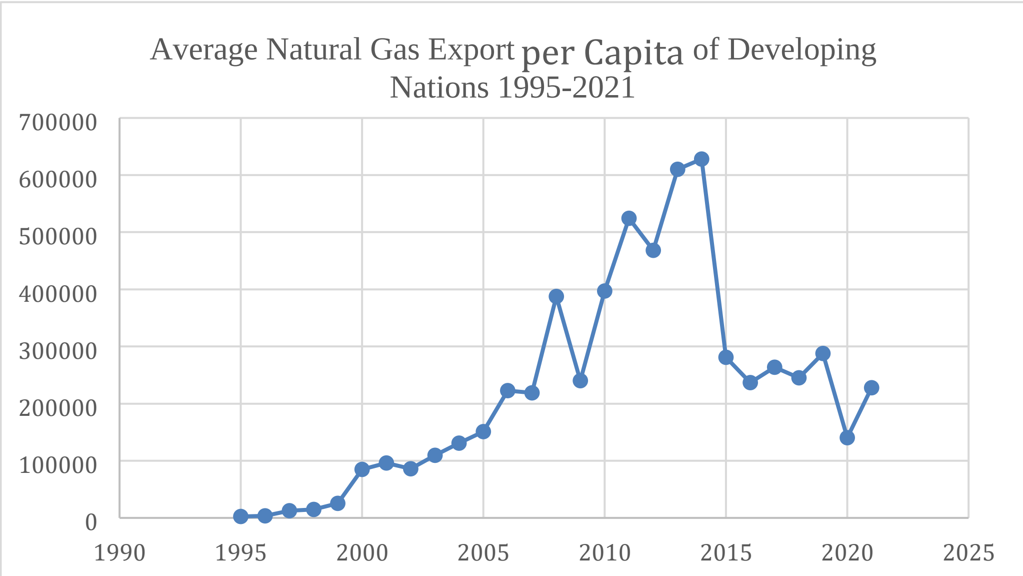

Average Cride Oil Production per Capita of Developing Nations 1995-2021
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1995
2000
2005
2010
2015
2020
2025

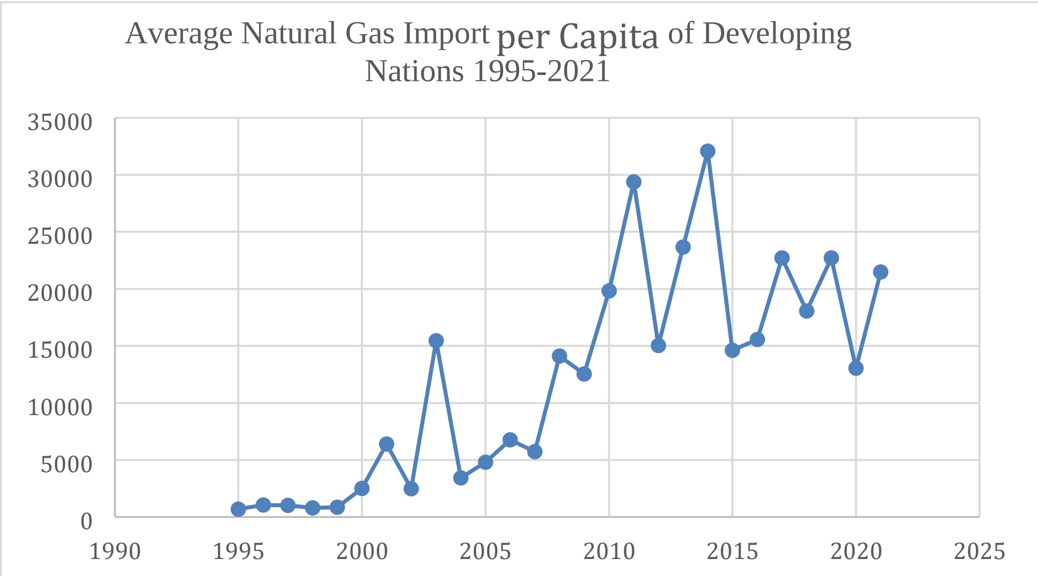

Average Crude Oil Export per Capita of Developing nations 1995-2021
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1990
1995
2000
2005
2010
2015
2020
2025

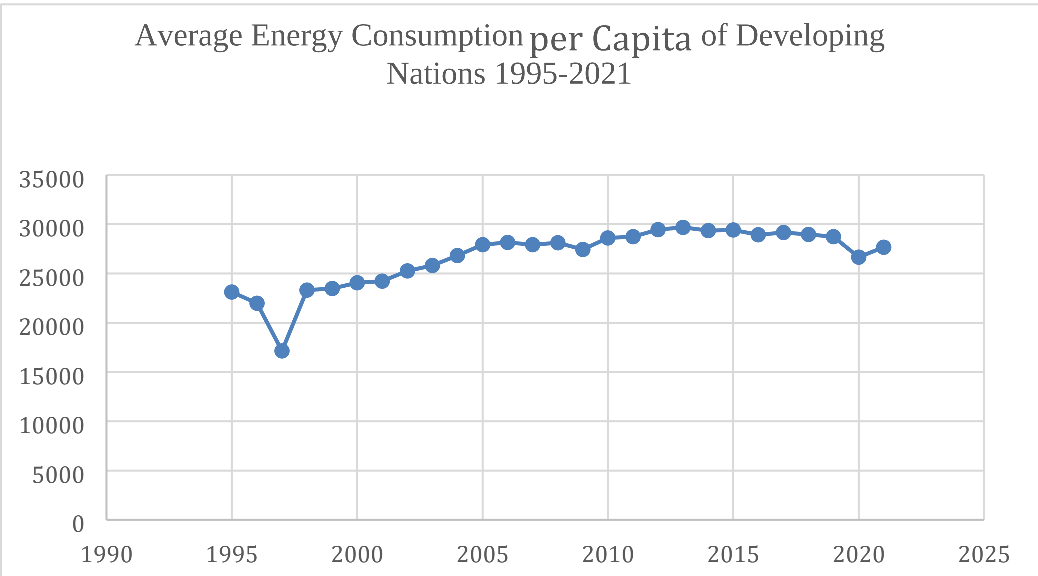

Average Crude Oil Import per Capita of Developing nations 1995-2021
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025

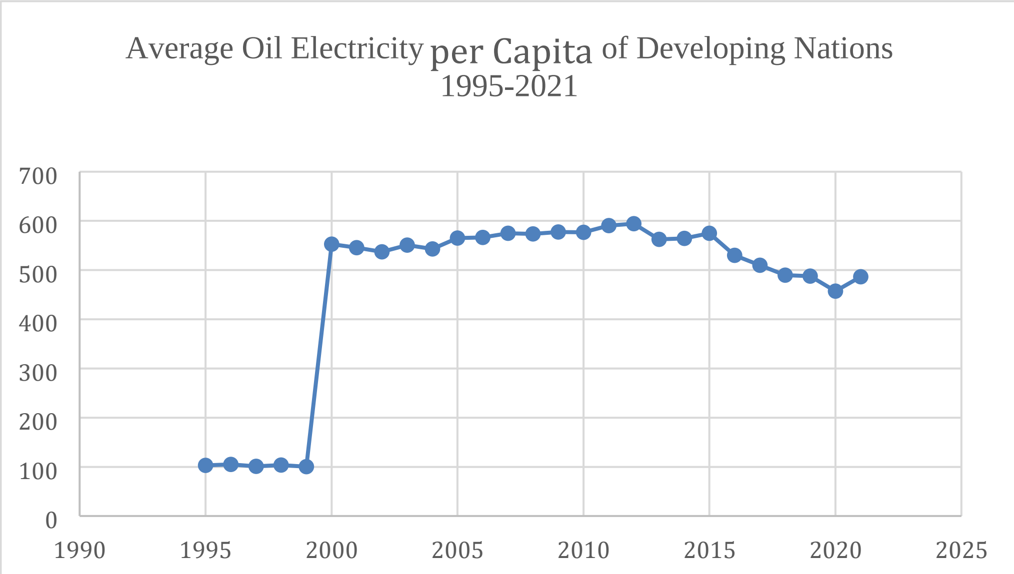

Average of Other Petroleum Products Export per Capita of Developing Nations 1995-2021
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025

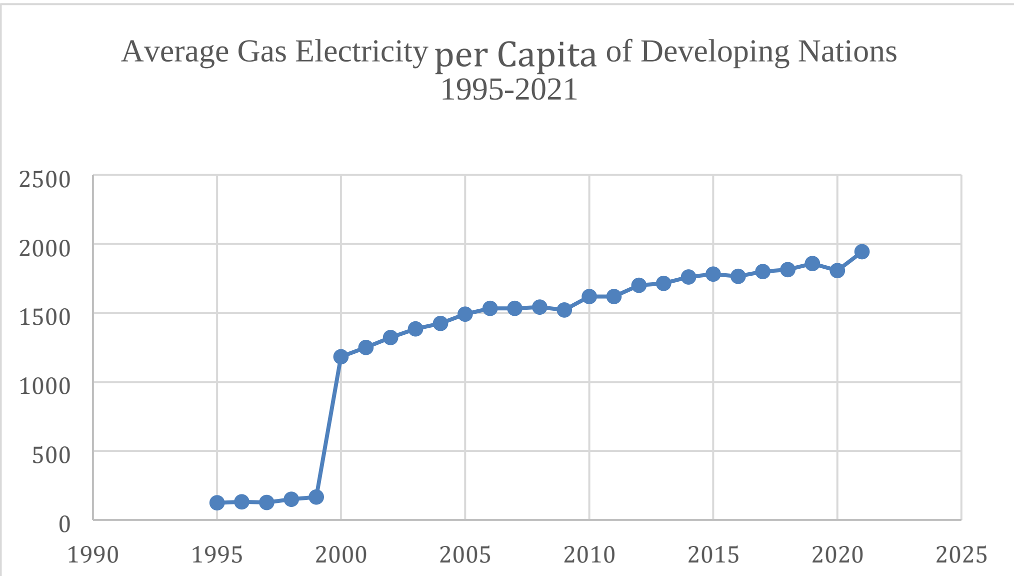

Average of other Petroleum Products Import per Capita of Developing Nations 1995-2021
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Natural Gas Export per Capita of Developing Nations 1995-2021
700000
600000
500000
400000
300000
200000
100000
0
1990
1995
2000
2005
2010
2015
2020
2025

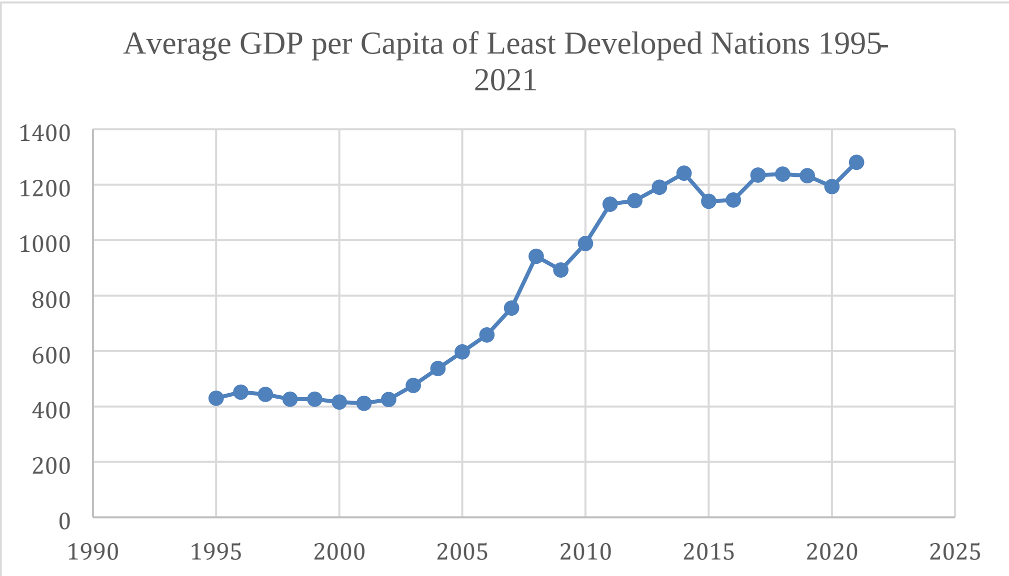

Average Natural Gas Import per Capita of Developing Nations 1995-2021
35000
30000
25000
20000
15000
10000
5000
0
1990
1995
2000
2005
2010
2015
2020
2025

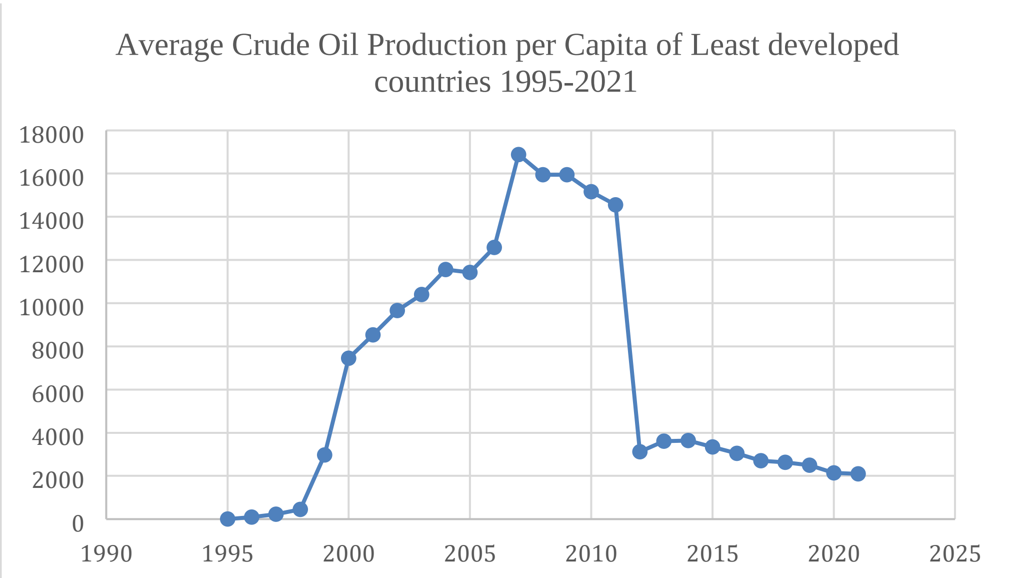

Average Energy Consumption per Capita of Developing Nations 1995-2021
35000
30000
25000
20000
15000
10000
5000
0
1990
1995
2000
2005
2010
2015
2020
2025

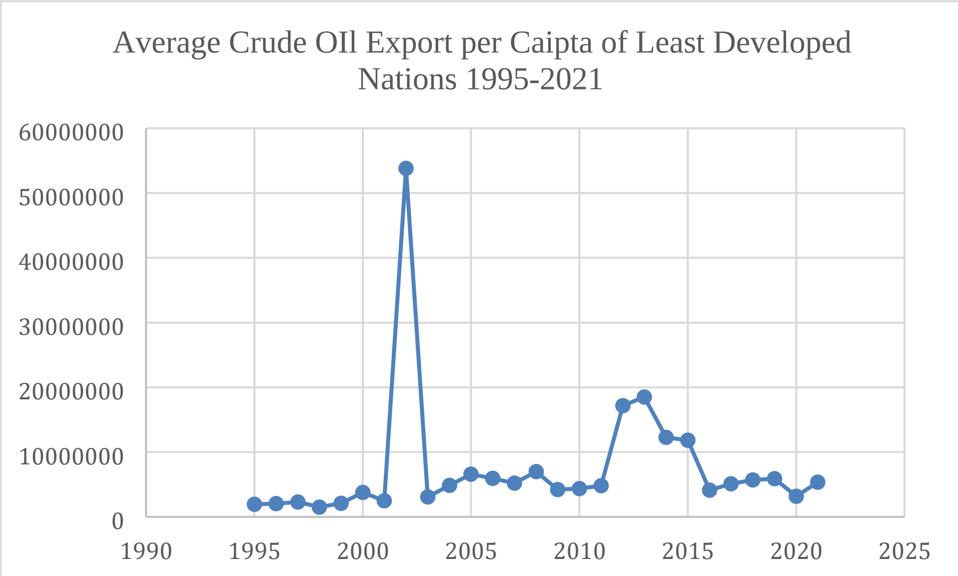

Average Oil Electricity per Capita of Developing Nations
1995-2021
700
600
500
400
300
200
100
0
1990
1995
2000
2005
2010
2015
2020
2025

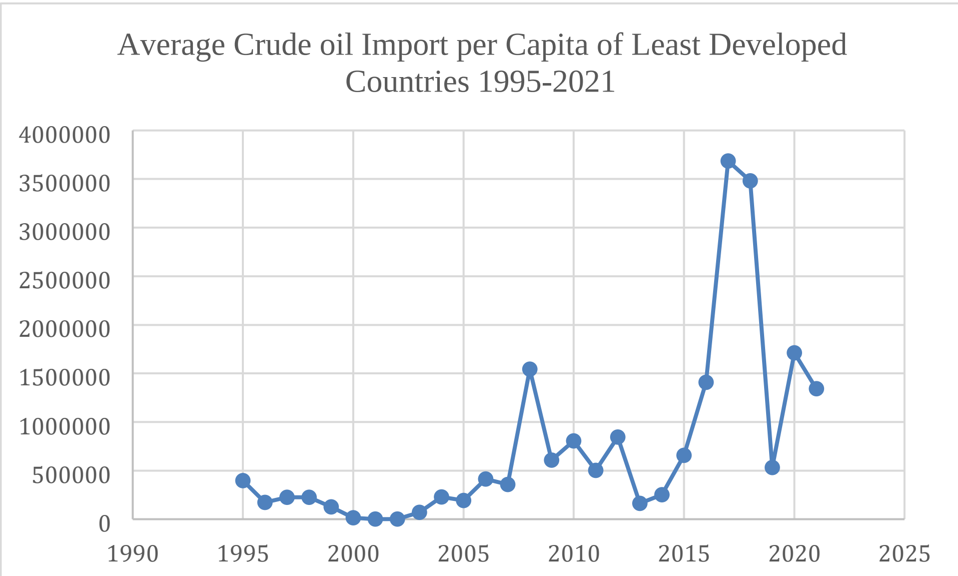

Average Gas Electricity per Capita of Developing Nations
1995-2021
2500
2000
1500
1000
500
0
1990
1995
2000
2005
2010
2015
2020
2025

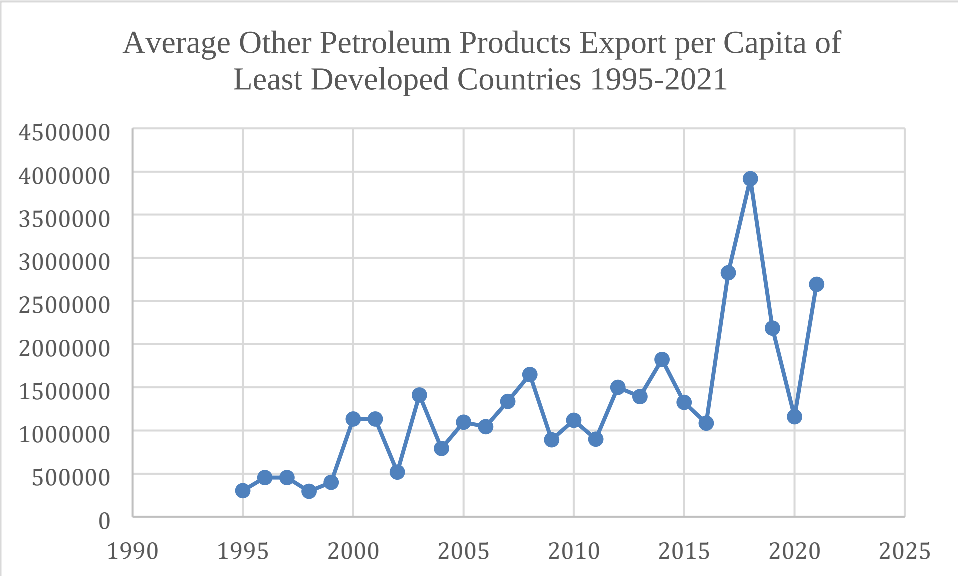
Appendix 3. Line Graphs for the Least Developed Nations Dataset

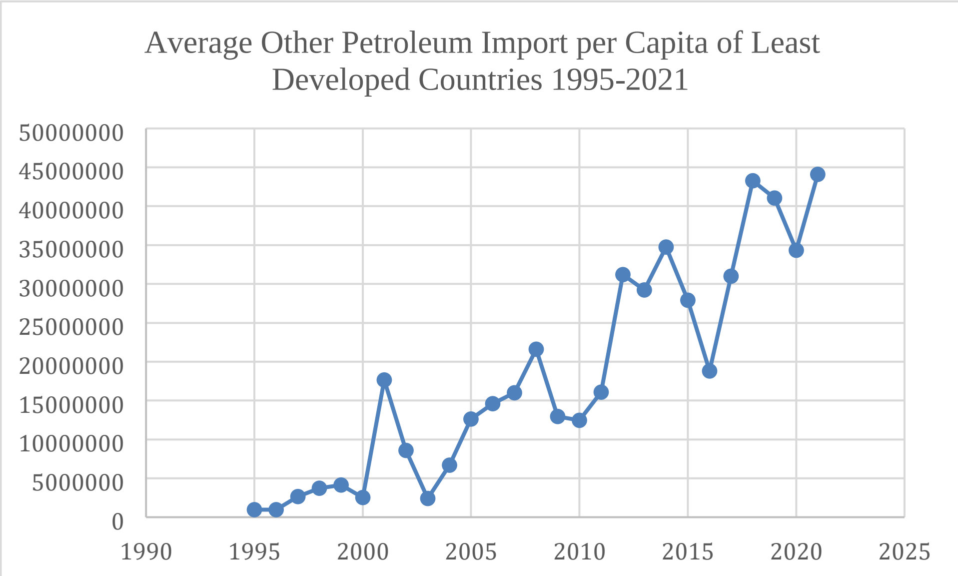


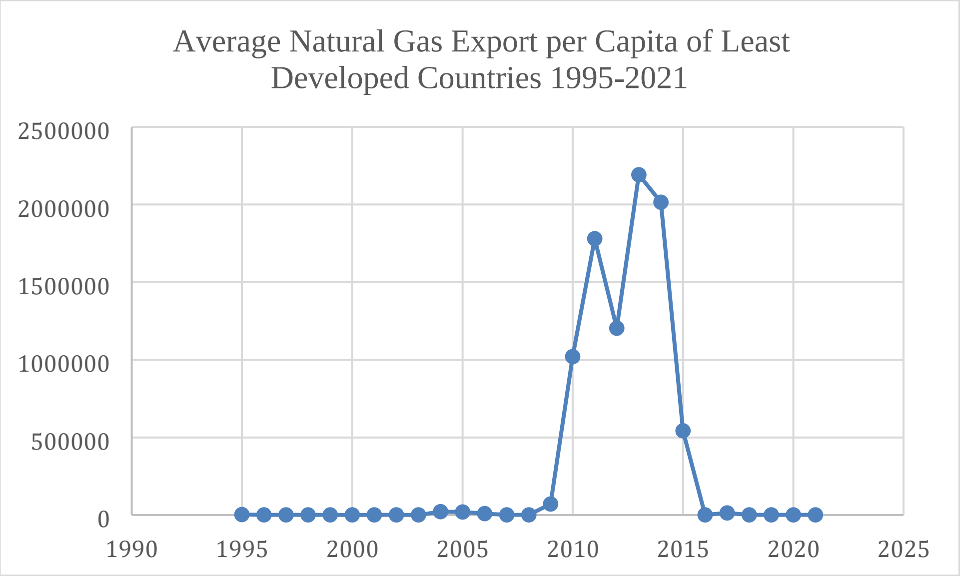


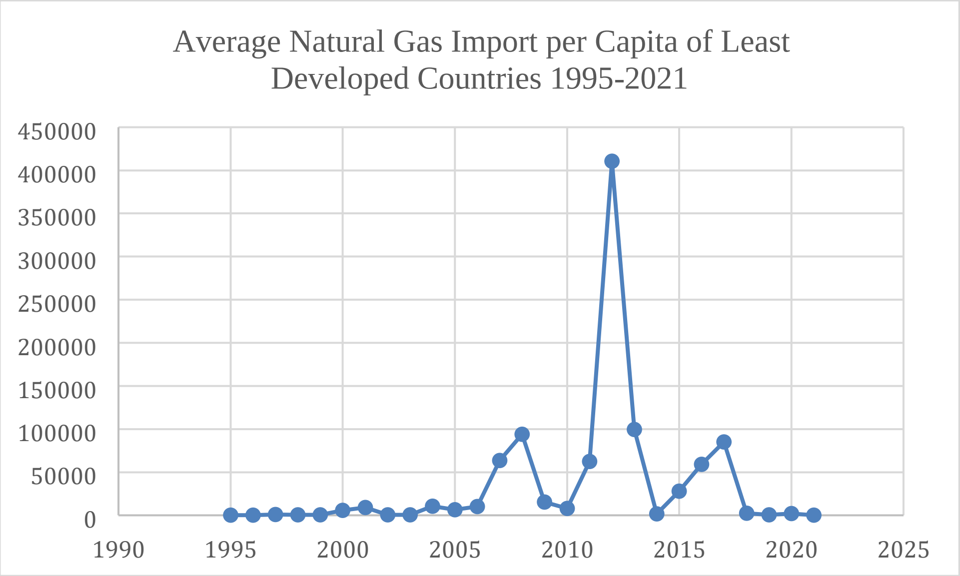

Average Crude OIl Export per Caipta of Least Developed Nations 1995-2021
60000000
50000000
40000000
30000000
20000000
10000000
0
1990
1995
2000
2005
2010
2015
2020
2025

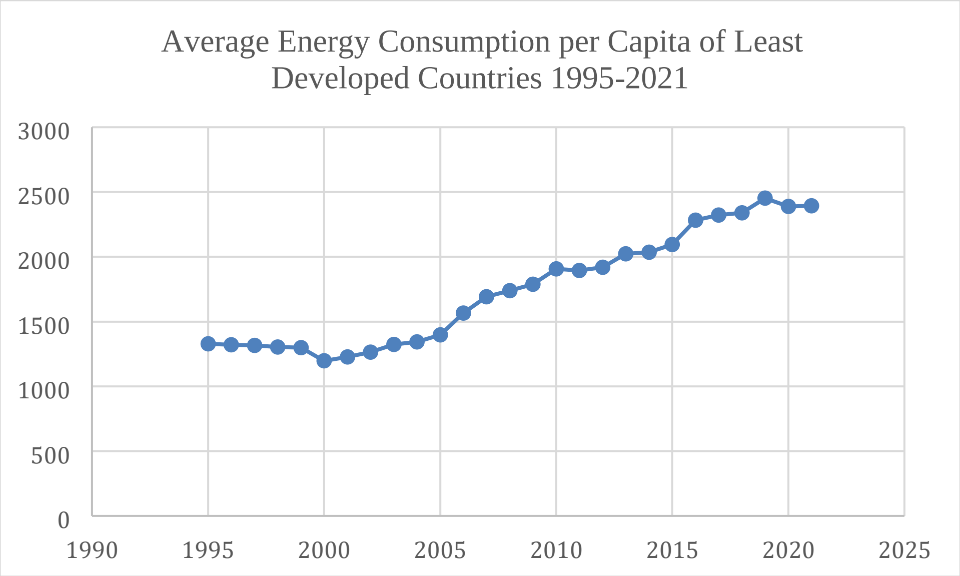

Average Crude oil Import per Capita of Least Developed Countries 1995-2021
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1990
1995
2000
2005
2010
2015
2020
2025

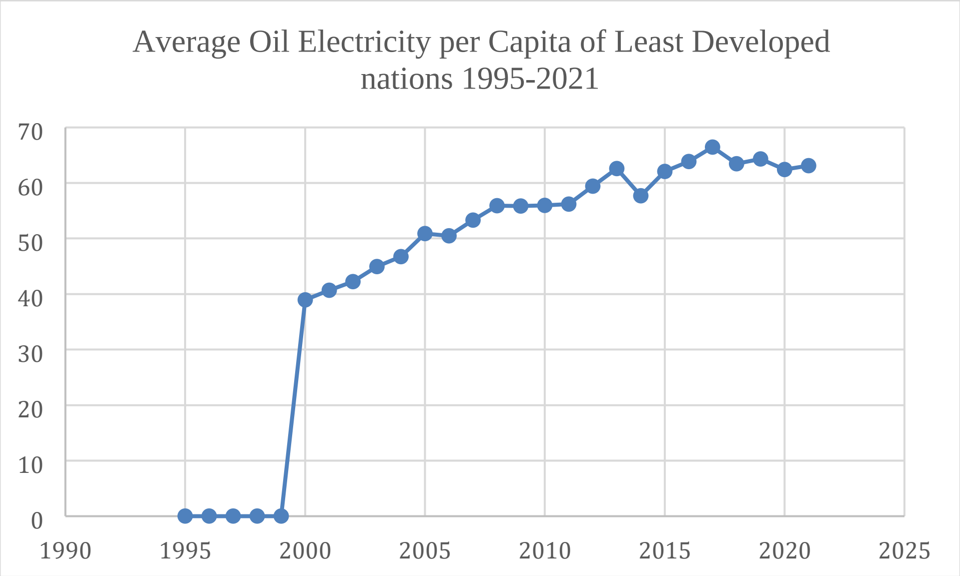

Average Other Petroleum Products Export per Capita of Least Developed Countries 1995-2021
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1990
1995
2000
2005
2010
2015
2020
2025

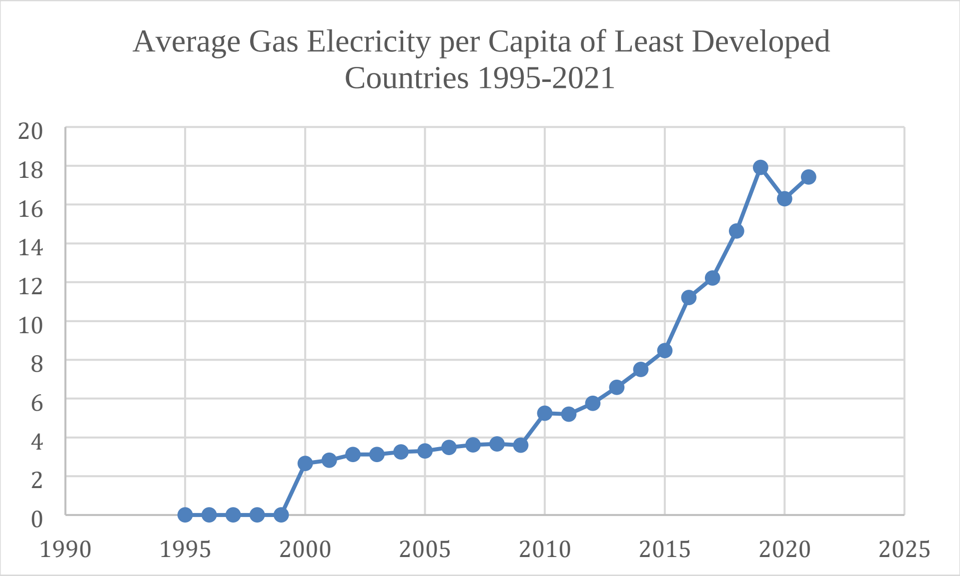

Average Other Petroleum Import per Capita of Least Developed Countries 1995-2021
50000000
45000000
40000000
35000000
30000000
25000000
20000000
15000000
10000000
5000000
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Natural Gas Export per Capita of Least Developed Countries 1995-2021
2500000
2000000
1500000
1000000
500000
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Natural Gas Import per Capita of Least Developed Countries 1995-2021
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Energy Consumption per Capita of Least Developed Countries 1995-2021
3000
2500
2000
1500
1000
500
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Oil Electricity per Capita of Least Developed nations 1995-2021
70
60
50
40
30
20
10
0
1990
1995
2000
2005
2010
2015
2020
2025


Average Gas Elecricity per Capita of Least Developed Countries 1995-2021
20
18
16
14
12
10
8
6
4
2
0
1990
1995
2000
2005
2010
2015
2020
2025