THE RELATIONSHIP BETWEEN OIL, RENEWABLE ENERGY, INFLATION AND SUSTAINABLE DEVELOPMENT GOALS IN OPEC AND NON-OPEC COUNTRIES

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DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

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My last tribute is to those who know I am not perfect but still love me.

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SDG	Sustainable Development Goals
OP	Oil Production
OC	Oil Consumption
INF	Inflation Rate
REC	Renewable Energy Consumption
POLS	Pooled Ordinary Least Squares
FEM	Fixed Effect Model
REM	Random Effect Model

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PREFACE

Energy is the foundation that supports the development of modern societies, and the way in which it is produced and consumed has a direct impact on the achievement of sustainable development. Sustainable development aims to meet the needs of the present without compromising the ability of future generations to meet their own needs and involves three dimensions: economic, social and environmental. This study seeks to understand how oil production and consumption, as well as the adoption of renewable energy sources and inflation, affect the process of achieving the sustainable development goals (SDGs) in major oil-producing and oil-consuming countries around the world. A total of eight OPEC countries and eight non-OPEC countries participated in the study. The selected OPEC countries are Saudi Arabia, Iraq, Iran, Kuwait, Venezuela, Algeria, Indonesia, Qatar; the non-OPEC countries are United State, China, India, Brazil, Russia, Canada, Australia, South Africa. Despite the fact that many factors can affect sustainable development, the researchers of this study strongly believe that energy factors still play a crucial role in achieving the SDGs. In addition, there is limited research on the relationship between sustainable development and energy dynamics, and this study was successfully completed due to the curiosity and multiple motivations of the researchers.

ABSTRACT

The energy factor is critical to achieving the Sustainable Development Goals. Due to a lack of research comparing different energy perspectives with the SDGS, this paper examines the relationship between oil dynamics (including oil production and consumption), renewable energy, inflation, and the achievement of the Sustainable Development Goals (SDGS), focusing on OPEC and non-OPEC countries from 2000 to 2022. Through quantitative analysis, using fixed effects models and random effects models with panel data, the study examines how fluctuations in oil production and consumption, as well as renewable energy adoption and inflation, are linked to progress towards achieving the SDGS. The results show that renewable energy consumption and oil consumption have a positive impact on the overall achievement of the SDGS, but oil production has a negative impact on the overall achievement of the SDGS. In addition, the surprising result is that oil consumption contributes more to the achievement of the Sustainable Development Goals and only negatively impacts climate change (SDG13). This shows that the dynamics of the energy sector have complex implications for sustainable development. The study provides empirical evidence for the impact of oil and renewable energy on sustainable development and provides insights for decision-makers and stakeholders in energy planning and sustainable development strategies. The study highlights the urgent need for a balanced approach to energy management, emphasizing the transition to renewable energy to ensure long-term sustainability and achieve the Sustainable Development Goals.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

This study aims to examine the relationship between oil production and consumption, renewable energy, inflation, and the Sustainable Development Goals (SDGs) in OPEC (Saudi Arabia, Iraq, Iran, Kuwait, Venezuela, Algeria, Indonesia, and Qatar) and non-OPEC countries (United States, China, India, Brazil, Russia, Canada, Australia, and South Africa) from 2000 to 2022 Relationship between. This chapter will discuss the SDGs, oil production and consumption, renewable energy consumption, and inflation in OPEC and non-OPEC countries, followed by the problem statement, research questions, research objectives, hypotheses, and significance of the study.

1.1 Research Background

The Sustainable Development Goals (SDGs) that were implemented in 2015 by the United Nations have brought sustainability into the spotlight and has become a matter of immediate concern that must be resolved by every nation to prevent further destruction. By adhering to the three dimensions of sustainable development: economic, social and environmental, the 17 SDGs are put into practice. The Sustainable Development Goals (SDGs) is a group of objectives that aims at solving the most pressing problems by the year 2030 including such challenges as environmental pollution, poverty, inequality, and climate change along with justice and peace. More specifically, the 17 SDGs are eradicating poverty (SGD1), eradicating hunger (SGD2), establishing good health and well-being (SGD3), providing quality education (SGD4), strengthening gender equality

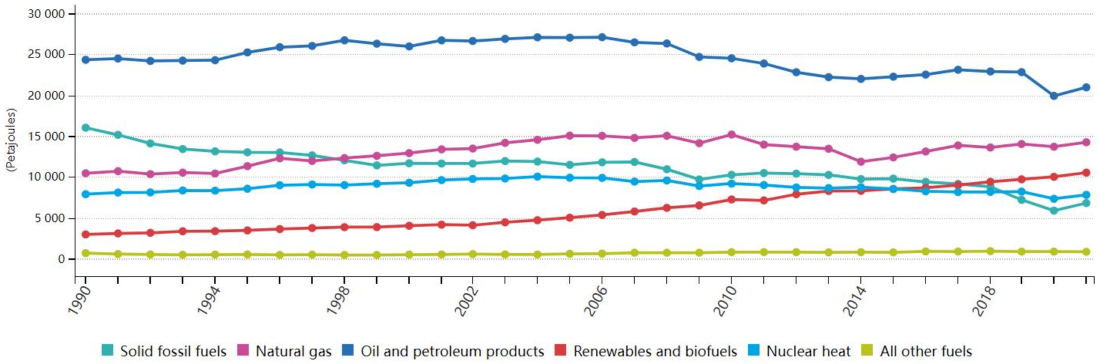
(SGD5), improving access to clean water and sanitation (SGD6), generating affordable and clean energy (SGD7), and creating decent jobs and economic growth (SGD8), promoting industry, innovation and infrastructure (SGD9), reducing inequality (SGD10), mobilizing sustainable cities and communities (SGD11), influencing responsible consumption and production (SGD12), organizing for climate action (SGD13), developing life underwater (SGD14), promoting life on land (SGD15), guaranteeing peace, justice (SGD16), strong institutions to build partnerships to achieve the Goals (SGD17). (The 17 Goals | Sustainable Development, n.d.)

Figure 1.1： 17 Sustainable Development Goals

Source: United Nations, Department of Economic and Social Affairs-Sustainable Development

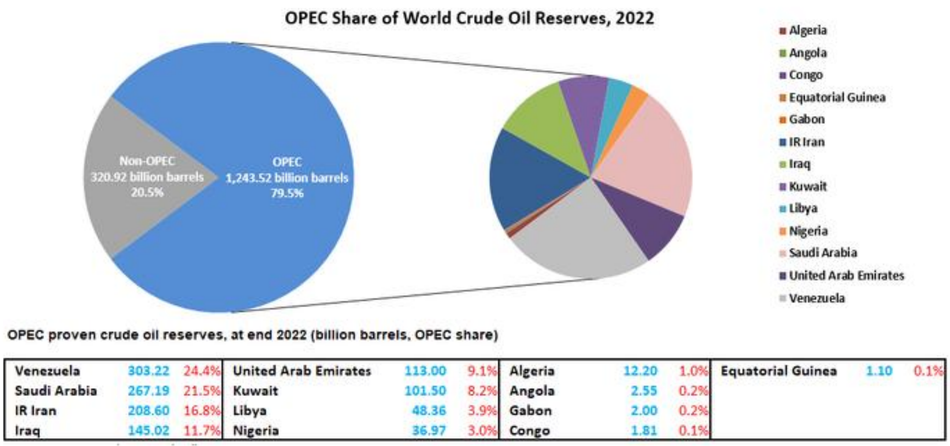
Since 1950, oil has become the most important strategic resource in the world economy, affecting all aspects of development and environmental sustainability. Oil consumption accounts for approximately 31% of global energy consumption, a proportion that exceeds the consumption of coal, natural gas, and renewable energy sources. In 2016, the oil industry produced an average of 96.3 million barrels of oil per day, which is equivalent to 2 liters of oil per person per day on the planet (Mapping the Oil and Gas Industry to the SDGs: An Atlas, n .d.). However, the over-consumption and production of oil resources not only raises concerns about resource depletion, but also has a huge negative impact on the environment and exacerbates the problem of climate change. Thus, hindering the progress of the Sustainable Development Goals (SDGs). Globally, the Organization of Petroleum Exporting Countries (OPEC), as the world's oil-producing countries, has about 79.5% of the world's oil reserves. Owing to the fact that the group may contribute large parts of the global supply and reserves of oil, members of OPEC set the oil price. A rise of that price consequently triggers an inflationary effect and creates conditions especially hard to oil importing countries. Volatility of crude oil prices plays a critical role in inflation, which, in turn, influences economic growth negatively and also has a negative impact on purchasing power. High inflation rate is one of the greatest impeders of economic growth and may also result in increasing poverty and inequality. Furthermore, high inflation rates make it harder for investments to be made into green development projects, among others. Accordingly, the reliance on resource wealth by OPEC nations on their economies is a long-standing problem which for the case under study makes their economy unsustainable. In contradiction, however, the growing importance of the non-OPEC players in bolstering the global oil supply through alternative resources and technologies has made the global energy market more complex. In addition, with the growing global consensus on reducing greenhouse gas emissions and achieving a low-carbon economy, the development and utilization of renewable energy resources is seen as one of the key ways to achieve sustainable development goals. Renewable energy is projected to be the fastest growing energy source, with its share of primary energy rising from 3% in 2015 to 10% by 2035 (Mapping the Oil and Gas Industry to the SDGs: An Atlas, n.d.). This shift is critical to mitigating climate change, reducing environmental degradation, and promoting economic and social sustainability. A country will not be considered sustainable if its income comes primarily from the consumption of non-renewable natural resources such as oil. Once resources are depleted, the country will not be able to sustain its economy. On the other hand, if a country is able to derive energy from renewable sources such as wind or solar energy, then it has the potential to continue generating income in the future. Then it can be considered to be on the path to sustainable development. (Responsible Consumption & Production | SDG 12: Responsible Consumption & Production, n.d.)

Figure 1.2: Gross available energy,1990-2021



Source: Eurostat (online data code: nrg_bal_s)

Figure 1.3: OPEC share of World Crude Oil Reserves,2022



Source: OPEC Annual Statistical Bulletin 2023

1.2 Problem Statement

Nations all over the world are working to advance and fulfill the Sustainable Development Goals of the United Nations in the twenty-first century. Oil is one of the key sources of energy for modern economies, driving industrialization and economic growth in many countries (FAQ 2: Oil and Gas, Poverty and Economic Development, 2020).

Numerous occupations are generated by the oil sector, ranging from production and transportation to marketing and exploration. The International Labor Organization (ILO) estimates that the oil industry directly employs roughly 6 million people worldwide. It is estimated that the industry's supply chain supports more than 60 million indirect jobs. The oil sector boosts income levels, lowers unemployment, and creates jobs (SDG8), all of which lower income poverty and enhance quality of life (SDG1). Furthermore, men make up over 75% of the workforce in the oil and gas sector. Women make up a smaller percentage of senior and executive roles than junior jobs (Rick et al., 2022). The percentage of women in national oil businesses is lower than that of multinational oil corporations (SDG5).

Oil consumption is the main source of energy in many countries, ensuring energy availability and accessibility (SDG7). Although oil is the traditional source of energy, pressures on oil consumption are also driving technological innovation and transformation in the energy sector (SDG9). The transportation and processing of oil requires advanced technologies and facilities, prompting related industries to continuously pursue technological innovations and improvements in order to increase production efficiency and reduce environmental impacts. In addition, the oil industry requires a large amount of infrastructure, such as pipelines, ports, refineries, etc., and the construction and operation of these infrastructures also provide support and impetus for economic development (SDG9).

However, as countries continue to develop, the finite nature of non-renewable conventional energy sources (e.g., oil) affects sustainable consumption and production patterns (SDG12). As well, oil consumption is closely linked to carbon emissions, as the combustion of oil releases greenhouse gases such as carbon dioxide, exacerbating concerns about climate change and global warming (SDG13). It also brings concerns about the environment, with oil production and consumption leading to pollution such as oil spills, air and water pollution, and jeopardizing marine life and biodiversity (SDG14, 15). In addition, some countries are highly dependent on oil exports, which can lead to sensitivity to foreign political and economic changes, affecting national stability and social development (SDG16).

Environmental impacts due to oil energy. Countries around the world are grappling with the urgent need to transition from conventional energy use of fossil fuels to renewable alternatives. The global energy landscape is undergoing a profound transformation. Countries need to make the transition to renewable energy by using renewable energy as an alternative to conventional energy. In this way, the impacts of environmental degradation and climate change will be mitigated. Environmentally, a transition to 100% renewable energy can reduce environmental impacts and promote sustainable development in industrialized countries (McGrath et al., 2023). Renewable energy consumption means that the transition to renewable energy reduces dependence on oil, which supports the goal of "ensuring access to affordable, reliable, sustainable and modern energy for all" (SDG7). In addition, IRENA estimates that by 2050, the transition to renewable energy will result in the loss of 8.2 million fossil fuel jobs (coal, oil and gas). However, these impacts will be offset by increased employment in the renewable energy sector, which employs more than 11 million people (SDG8).

However, while there is a global consensus on the need for renewable energy sources to replace conventional energy sources, this transition is fraught with challenges. Oil, as the main conventional energy source, plays an important role in the global economy. Disruptions in oil supply could have a knock-on effect on the global economy. In addition, the volatility of global oil prices could seriously affect the economic stability of oil-producing and oil-importing countries, in particular those that are members of the Organization of the Petroleum Exporting Countries and oil-importing countries. Inflationary pressures associated with oil price volatility further undermine economic growth (SDG 8) and exacerbate inequality (SDG 10), especially in countries that are heavily dependent on oil imports or those facing inflationary shocks as a result of exposure to external factors. It poses a threat to the economic stability and sustainable development aspirations of countries around the world. (Benhamed & Gassouma, 2023).

From this, it can be seen that the impact of oil production, oil consumption, inflation and renewable energy consumption on the SDGs varies from one SDG to another. With all the factors influencing the different SDGs, it is becoming increasingly important to address whether oil production, oil consumption, inflation, and renewable energy consumption affect each of the subdivided SDGs in order to achieve the SDGs.

1.3 Research Questions

1.3.1 General question

What is the relationship between oil production, oil consumption, renewable energy consumption and inflation and the achievement of sustainable development goals (SDGs) in OPEC and non-OPEC countries?

1.3.2 Specific questions

1. What is the impact of oil production on the achievement of SDGs in OPEC and non-OPEC countries?
2. What is the impact of oil consumption on the achievement of SDGs in OPEC and non-OPEC countries?
3. What is the impact of inflation in context of energy prices on the achievement of SDGs in OPEC and non-OPEC countries?
4. What is the impact of renewable energy consumption on the achievement of SDGs in OPEC and non-OPEC countries?

1.4 Research Objectives

1.4.1 General Objective

To examine the relationship between oil production, oil consumption, renewable energy consumption, inflation and the achievement of sustainable development goals (SDGs) in OPEC and non-OPEC countries.

1.4.2 Specific Objectives

1. To examine the impact of oil production on the achievement of the SDGs in OPEC and non-OPEC countries.
2. To examine the impact of oil consumption on the achievement of the SDGs in OPEC and non-OPEC countries.
3. To examine the impact of inflation in the context of energy prices on progress towards the SDGs in OPEC and non-OPEC countries.
4. To examine the impact of renewable energy consumption to the achievement of the SDGs in OPEC and non-OPEC countries.

1.5 Significance of the Study

The key information of the study can be used by international organizations and government bodies including officials to take the decision-making process to a new level in energy and sustainable development. The research on the complex balance between oil dynamics, renewable-energy adoption, inflation rates, and the achievement of sustainable development goals took the stage, yet, it led the way to the economic growth, energy security and environmental sustainability through the strategic policies. When it comes to the development of effective plans, realizing these crucial ones facilitate the organization of actions intended to tackle the climate emergency as soon as possible.

Initially, it is very crucial to master the change of comprehending the oil dynamics because more and more countries are embracing alternative renewable energy sources as they go green and adopt sustainable sources of energy. These data could, for example, be used by engineers and officials to formulate action plans that would be consistent with the goal of phasing out fossil fuels and replacing them with renewable fuels. Because of this, the same level of stable and low energy prices can be maintained in spite of the fluctuations of oil prices.

For economic stability, exploring the connection of the oil prices and inflation is necessary. The article shows the fact that, every time when the crude oil prices influence inflation the insufficient renewable energy sources may serve as a restraint of inflation. Central banks, economic authorities and stabilization-minded authorities will be able to draw great benefits from such policies which they should take into account and use them during the process of making monetary policies.

Not only this, but it is also very significant to study this since it gives an insight on covalent relationship of oil dynamics and it is a step further for the nations that are developing this and they are on the path of acknowledging its capacity. The same data can provide officials (policy makers and planners) with important inputs as they base on them to realize appropriate solutions reducing the financial risks caused by the price variation of oil is the one of the aimed results.

It has the ability not only to conduct the international research of far reaching scope in a comparison of Non-OPEC and OPEC nations but also to develop levels of expertise in various fields. Avoiding the development of the policies by different countries that affect the oil-bearing regions of the globe, we made a complete analysis of the factors that determine the level of exploitation and the utilization of the extracted resources, especially the oil. In addition, we compared the possibility of the various countries to retain the equilibriums in the world oils as well as the renewable energy applications.

At last, it demonstrates the role of green energy as the complementing factor of the oil situation for the sake of ecological viability. Supplementing inflation and promoting sustainable development cause which by the greenness and resilience is meant is the broader goal will be more understood if we look into the way how renewable energy consumption influence these.

1.6 Chapter Arrangement

Chapter 1 briefly discusses the background of the study in terms of sustainable development goals, oil production and consumption, renewable energy consumption and inflation in OPEC and non-OPEC countries. In addition, it includes the significance of the study, research questions, objectives and problem statement.

Chapter 2 will review the literature for each variable. It includes the findings and results of previous studies and the relevant theoretical framework. In addition, this chapter presents the supply and demand theory, the resource curse theory, the sustainability theory and the conceptual framework of the study.

Chapter 3 will explain the methodology of this study. This chapter will discuss the empirical model, data sources, definitions of determinants and data analysis methods for this study.

Chapter 4 describes the data analysis using the methods outlined in the previous chapter, as well as the empirical findings, diagnostic tests and interpretations. Finally, the chapter summarizes and discusses the main findings.

Chapter 5 summarizes Chapters 1 to 4 and their policy implications. Their limitations are noted and recommendations for further research are made.

1.7 Conclusion

This chapter includes some background to the study, including comparing the sustainable development goals of OPEC and non-OPEC countries and details of the factors that affect sustainable development, including oil production, oil consumption, renewable energy, and inflation. Overall, the results of the study will be able to determine how these factors directly or indirectly affect sustainable development in OPEC and non-OPEC countries and will serve as a guide for policy decision makers as they will be aware of the relationship between energy, inflation, and sustainable development goals.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The previous chapter outlined the research background, problem statement, research questions, research objectives, and progress of the research on sustainable development in OPEC and non-OPEC countries for each determinant. Before turning to empirical analyses, there have been several studies that have examined the relationship between oil production and consumption, renewable energy, inflation and sustainable development in a variety of ways. In the studies, various factors were used. This chapter examines the correlation between independent determinants (oil production, oil sales, renewable energy sales, inflation) and dependent determinants (sustainable development index). In addition, theories used in previous studies will be discussed.

2.1 Empirical Evidence

2.1.1 Sustainable Development Goals

The intersection of oil, renewable energy, and inflation with the pursuit of the Sustainable Development Goals (SDGs) has been the focus of recent research. Vasiljeva et al. (2022) explore the complex relationship between these variables and the various ways in which countries have aligned their energy policies with the SDGs. The literature emphasizes the need for an integrated approach to balance economic growth, environmental management and overall sustainable social development. A study by Ecer et al. (2019) concludes that the United Arab Emirates is the most sustainable OPEC country with a performance score of 71.9 per cent, with Qatar, Kuwait and Iran in second place, with performance scores of 69.3%, 66.6% and 56.2%, respectively. Relatively and absolutely pricing coal in relation to oil and renewable energy encourages the switch, which improves both the sustainability of the economy and the environment (Bloch et al., 2015).

Alamsyah et al. (2023) argued that oil production is positively correlated with sustainable development, showing potential for poverty reduction (SDG1). However, Ite (2022) mentioned the negative impact of oil production on sustainable development. Moreover, oil consumption is inversely related to sustainable development. Increase in oil consumption will lead to environmental degradation and ecological damage (SDG15). Therefore, the increase in oil consumption will hinder the process of sustainable development (Penna, 2022). Bittencourt et al. (2015) mentioned that high inflation rate hinders sustainable economic development (SDG8), which is negatively related to sustainable development. Furthermore, renewable energy consumption has a significant positive impact on promoting clean energy adoption (SDG7), thus contributing to sustainable development ("Renewable Energy", 2023).

2.1.2 Oil Production

The dynamics of global oil have been extensively explored in the literature in recent years. Regarding the question of how oil production contributes to the accomplishment of the sustainable development goals (SDGs), the findings are conflicting. Vasiljeva et al. (2022) demonstrate that regardless of the degree of sustainable development, the effects of oil production and export intensity on environmental parameters are universal. This is due to the increase in pollutant emissions from oil production. While oil palm development in Indonesia shows potential for poverty reduction (SDG1) (Alamsyah et al., 2023), the oil and gas industry in Nigeria faces the challenge of aligning its operations with the SDGs due to its negative impact on communities and ecosystems (SDG15) (Ite, 2022). By the means of assuring a large part of energy needs worldwide the global oil and gas industry obtain a rather poor public image and environmental concerns caused to be reason of questions about its support for the United Nations Sustainable Development Goals (SDGs) (Naceur, 2019). Furthermore, oil production in Nigeria has been shown to directly affect the well being of smallholding farmers (SDG3) and negatively impact them economically, mainly through environmental problems or revenue decline (Ofuoku et al., 2014). Overall, oil producers contribute to the economic growth of countries' driving GDP up but are usually followed by heavy environmental and social costs to violate the sustainable development goals (SDGs) (Alnuaim, 2018).

2.1.3 Oil Consumption

Oil consumption is a vital element in economic growth and development for the recognition of Sustainable Development Goals (SDGs). A very primary step to achieving SDGs is oil phasing out, a move that saves on climate action (SDG13), producing cheap and clean (SDG7) energy and environmental sustainability (SDG15). Oil usage generates environmental degradation (Penna, 2022), causes ecological footprint to increase (SDG14,15) (Rachidi & Zeraibi, 2022), and becomes a problem for the achievement of the target on universal energy access (SDG12) (Adebayo et al., 2023). The sustainable development pathway that envisages lower oil consumption and increased reliance on renewable energy resources that can result in improved energy efficiency are also important pillars of this scenario (Naceur, 2019). To this end, annual oil dispute must be considered a top priority for reaching out to the SDGs and an in particular sustainable future for humanity. Khan (2023) research displays that an increase in oil consumption using several channels (for instance, it instigates the use of advanced technologies (SDG 9), it brings up the local business profits and it stimulates the work force employment

(SDG 8)) result in economic growth. Relatedly, the oil usage in countries like India can be linked to the economic progress which seems to have contributed significantly to a stimulation of the economic growth in the country (SDG8) (Fakher and Goldansaz, 2015). However, if we are serious about achieving the agendas of the Sustainable Development Goals (SDGs) and making the world free of greenhouse gases, then it is important for us to move away from fossil fuel including oil as a source of energy. To alter the dark scenario of climate change and make the world a better place, we should reach out to the renewable energy resources such as wind, hydro, solar, and nuclear power (Penna, 2022).

2.1.4 Inflation Rate

Research works by Bala and Lee (2018) and Bellouni et al. (2023) are the recent ones in which they discuss the behavior of inflation dynamics. Their major focus is to examine the dynamics of inflation, particularly in oil producing countries. OPEC faces this difficulty in fighting inflation which originates from oil price volatility and discusses efficient monetary policies in controlling inflation of oil-dependent economies. This evidence implies that at least a flexible without oversimplification macroeconomic approach is required in response to the oil price gyration. Based on the study by Bala and Chin (2018), reversing oil prices' movements (high to low or the opposite) determine a rise in the inflation rate. In contrast to the upward effect, the impact is more prominently seen when oil prices drop. Belloumi and other researchers state (2023) Saudi Arabia's short and long-term inflation has a symmetric effect on global crude oil prices (up and down), however, any changes in the crude oil prices affect short- and long-term inflation to a symmetric extent. A rise causes the increase in crude oil prices that in turn spurs inflation, whereas the fall in crude oil prices brings about diminution both in the short-run and the long-run inflation rates.

The sustainable development goals (SDG) can be affected by inflation in varying ways, for instance, it can impact the economic growth (SDG8), it can affect and reduce the standard of living of people (SDG1), it can influence the education (SDG4) and overall welfare (SDG3). Studies in this regard have indicated that inflation rates of more than moderate levels retard economic growth to a significant degree, in the long run, up to the point of a multiple-times decline in economic activity and stalled long-term sustainable growth target (Bittencourt et al, 2015). In the urban population of the city where inflation has been observed to slowly increase poverty levels, school drop out (especially among girls due to longer distance to school) and long periods of unemployment. The same phenomenon manifests itself among the disadvantaged households in the form of food insecurity and hunger. (Afulaga et al., 2022). In addition to this, the link between inflation, technology, taxation and the economic growth in Indonesia clearly exhibits the complex dynamics among the related aspects with inflation possibly hindering technical advancement but promoting economic growth as indicated in Puspaningtyas and Mukhlis (2022). The twenty-first century goals (SDGs) involve the global eradication of high inflation to accomplish economic stability, reduction of poverty and increase in standard of living.

2.1.5 Renewable Energy Consumption

The literature on renewables has grown to occupy a larger space over the past few years against the backdrop of a global trend world’s nations in particular towards green energy. The accelerating battle in production of renewable technologies, as well as governmental policies that entail embracing green energy sources and the effect of ongoing innovation in this sector are emphasized by the works of Lin and Moubarak (2014) and Sadorsky (2009). Experts have pointed out the fact that developing renewable energy should be in line with the aims of environment and economy. Those goals can be achieved only by having a supportive environment for the growth of renewable energy. The many SDGs include access to affordable, reliable, and sustainable sources of electricity. More than that, it is no tremendous advances reveal that renewable energy is one of the main instruments in achieving relevant SDGs such as Climate Action (SDG13) and Clean Energy (SDG7) (Payamfar et al., 2023) ("Renewable Energy," 2023) (He et al., 2023). As previously stated, studies have proven that renewable energy projects could be successfully developed by public investments thus serving both for climate causes and as a means for achieving the sustainable development goals (Tampubolon et al., 2022). Furthermore, renewable energy similarly results in less free radicals and carbon emissions (Amin et al., 2020). The meta-analysis underpinned that the use of renewable energy is a key to an emissions reduction and a sustainable development objectives accomplishment. Consequently, we see the importance of introducing renewable power more and more, for both developed and developing countries, to succeed in the course of accomplishing the SDGs and battling with the consequences of climate change.

2.1.6 Research Gap

Previous research has focused on a specific country or only on OPEC countries. They have also focused on the impacts of non-renewable energy sources (e.g., oil, gas) or renewable energy sources on sustainable development. Therefore, in order to address the shortcomings of previous studies and to fill the gaps of previous studies, this study will compare the impacts of the energy aspects of multiple OPEC and non-OPEC countries on the realization of sustainable development from a more comprehensive perspective, taking into account both non-renewable and renewable energy sources.

2.2 Examining Pertinent Theoretical Models

2.2.1 Theory of Demand and Supply

The demand supply theory explains that demand and supply are the two forces that act together. Demand regards the amount of product or service a consumer wants to be show while supply shows the quantity the seller is willing to provide. An example can be given by Sorokin et al. (2023) who studied the impediment of oil prices on energy demand. As the theory goes, high oil prices impose burden on both consumers and businesses thus they may opt for other energy sources to save money. This, in consequence, could cause to a change in use towards other lower cost and environment-friendly energy sources. Also, there is an upward trend interest and investment in renewable energies associated with high oil prices. This is the case when social factors play an important role (cost-effectiveness) and environmental factors (Selmi et al., 2023). From the economic theory, higher oil prices are the cause of cost-push inflation. Energy price increases finally rise to the level of the cost of production of goods and as a result the prices for these goods rise too. As demonstrated by the research of Talha (2021), the volatility of oil prices curbs the energy demand and supply dynamics which further impede achieving sustainability goals and the rate of inflation.

2.2.2 Theory of Resource Curse

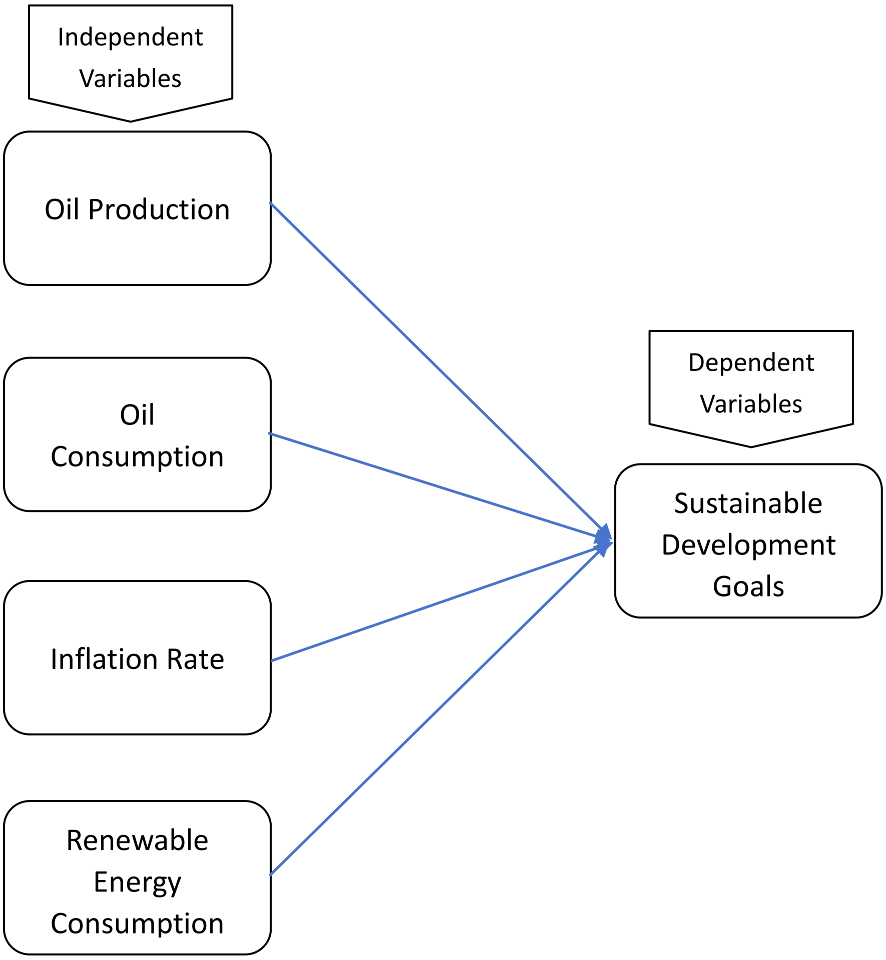
The resource curse theory would have it that countries with natural resources but of non-renewable type tend to score low in level of institutional performance and rank high on the corruption scale. This, however, can cause the misutilization of oil revenues and mineral rents which will in turn limit economic growth, decrease inequality, and with the effect of diminishing poverty (Zhao, 2019). This type of the evil of riches can derive from various reasons, however in the majority of cases it is related with a shift in a nation's economic priorities towards the development of a specific industry and an inattention to the general economic development. The abundant commodity disadvantage, especially, in the countries that depend on oil and gas, is a matter of concern. The research carried out by Vasiljeva et al. (2022) brings to light the way "resource curse" can present itself, which makes oil-exporting countries especially unattractive in investors' eyes. Falling and surging oil prices can ruin their stability and sustainable development similarly. Investors only opt to leave for greener pastures with the sector and the country being less attractive. Higher oil prices boost corporate profits and budgetary income, but they also have a negative impact on the sustainable development of OPEC member nations. The "resource curse" theory provides an explanation for the consequent detrimental effects. Frankel (2012) examines how macroeconomic imbalances, such as inflation, are impacted by national currencies appreciating in value as a result of resource riches in the context of the Dutch Disease. In view of the present economic difficulties, the consequences for accomplishing the objectives of sustainable development and economic stability are investigated. All things considered, the resource curse theory offers a crucial framework for comprehending the difficulties and possibilities brought about by reliance on oil. As a result, the oil sector must play a big part in solving a number of environmental, social, and health issues, particularly those relating to climate change, which may have a big effect on reducing poverty (SDG1).

2.2.3 Theory of Sustainable Development

An organizing concept known as "sustainable development" aims to meet human development objectives while preserving natural systems' ability to give humans the ecosystem services and natural resources they require. A civilization where resources and living conditions satisfy human needs without jeopardizing the stability and integrity of Earth's natural systems is the intended result. The goal of sustainable development is to strike a balance between social progress, environmental preservation, and economic growth (Mensah, 2019). "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" is how sustainable development was defined in the 1987 United Nations World Commission on Environment and Development report Our Common Future, also known as the Brundtland Report. The contemporary notion of sustainable development encompasses the advancement of the economy, social progress, and preservation of the environment for posterity (Wikipedia authors, 2024a). Economic, environmental, and social factors are all integrated. By using this theory, one can evaluate the effects of inflation, the adoption of renewable energy, and oil production and consumption on more general sustainable development objectives, such as social justice, economic efficiency, and environmental preservation. Maltsoglou (2009) demonstrated how the establishment of strict pollution criteria combined with renewable energy can lead to sustainable development in the oil sector and good long-term sustainability. To ensure long-term environmental and economic viability, however, the theory of sustainable development tackles the unsustainable use of non-renewable oil resources and highlights the necessity for renewable alternatives ("Sustainable Development," 2022). In a similar vein, Pérez et al. (2018) suggest that for sustainable energy development in communities, the theory of sustainable development should prioritize renewable energy sources above fossil fuels

2.3 Conceptual Framework

Figure 2.1: The SDGs' determinants



Sources: Developed from research

Three independent variables affecting sustainable development goals are described. Determinants include oil production, oil consumption, inflation and renewable energy consumption.

2.4 Hypotheses Development

H1: There is a significant relationship between sustainable development goals (SDGs) and oil production (OP) in OPEC and non-OPEC countries.

H2: There is a significant relationship between sustainable development goals (SDGs) and oil consumption (OC) in OPEC and non-OPEC countries.

H3: There is a significant relationship between sustainable development goals (SDGs) and inflation rate (INF) in OPEC and non-OPEC countries.

H4: There is a significant relationship between sustainable development goals (SDGs) and renewable energy consumption (REC) in OPEC and non-OPEC countries.

2.5 Conclusion

To conclude this chapter, the link between the SDGs and the determinants of OPEC and non-OPEC countries has been clarified using previous research literature, some researchers have come up with inconsistent results due to the fact that the studies were carried out in different countries or in a single country with different data, this chapter also covers the theoretical framework between the SDGs and the factors that influence them.

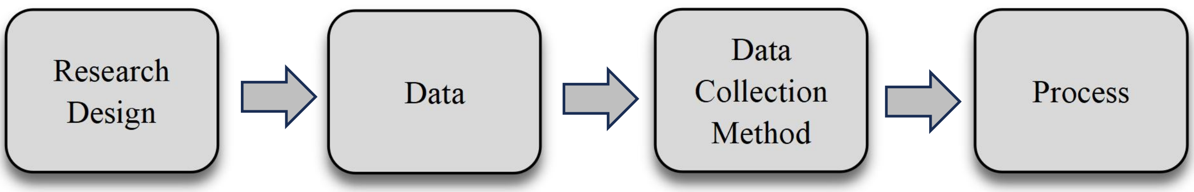
CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter will outline the research design, data collection methods, sampling design, and data analysis for this study. In the next chapter, the research model will be tested using each step. The four factors used in this study to determine the countries' Sustainable Development Goals (SDG) scores are crude oil production, oil consumption, inflation rate, and renewable energy consumption. The sample period for this study is from 2000 to 2022, with a total of 368 observations in the annual form for all data.

3.1 Design of Research

Figure 3.1: Research Flow



The purpose of this study is to explore the relationship between the overall SDG score (dependent determinant) and crude oil production, oil consumption, inflation rate and renewable energy consumption (independent determinants). The data in this study is quantitative because it is more appropriate to use numerical data for hypothesis testing. The research design of this study is quantitative; therefore, it is more appropriate to use numerical data to quantify the relationship between the variables and hypothesis testing.

3.2 Data Collection Methods

Data Collection Methods Data collection is the process of compiling structured and organized information on variables of interest. Primary and secondary data are the two main classifications used to organize the data. Secondary data was used in this study.

3.2.1 Secondary Data

Data collection is necessary in order to study the relationship between SDGs and crude oil production, oil consumption, inflation rate and renewable energy consumption. Each piece of information was obtained from secondary sources in annual form. Each dependent and independent determinant is numerical with 23 observations. The independent determinants are crude oil production, oil consumption, inflation rate, and renewable energy consumption, which are used to examine the relationship with OPEC countries (Saudi Arabia, Iraq, Iran, Kuwait, Venezuela, Algeria, Indonesia, Qatar) and non-OPEC countries (United State, China, India, Brazil, Russia, Canada, Australia, South Africa) are significantly correlated with the purpose of sustainable development. In addition, data were obtained from the Sustainable Development Report, OECD, Our World in Data, and World Bank databases from 2000 to 2022. Secondary data sources were chosen because they are more accessible, cost effective and time saving than primary data.

3.2.1.1 Sustainable Development Goals

The Sustainable Development Report database was used to gather information for the SDG ratings for the years 2000 through 2022. In this investigation, 23 observations were made. The entire progress towards accomplishing all 17 SDGs is gauged by the total SDG score. One way to interpret the score (0-100) is as the proportion of the SDGs that have been met. When all SDGs are scored at 100, they are considered accomplished.

3.2.1.2 Oil Production

Data on crude oil production are from the OECD database and cover the period 2000 to 2022. The study has a total of 23 observations, which are measured in kilotons of oil equivalent (toe). For some crude oil producing countries, increased crude oil production can improve energy security and contribute to the goal of affordable and clean energy (SDG 7). Countries that are highly dependent on crude oil revenues may face the so-called "resource curse," in which the economy is too concentrated in the crude oil industry, affecting long-term sustainable development.

3.2.1.3 Oil Consumption

Data on oil consumption were obtained from Our World in Data database for the period 2000 to 2022. There are 23 observations in this study and the unit of measurement is TWh.

3.2.1.4 Inflation Rate

Inflation rate data are from the World Bank's database. All information is annual for the years 2000 - 2022 and the unit of measurement is percentage (%). Moderate inflation is often considered a sign of economic growth and may contribute to the goals of increasing employment and reducing poverty (SDG1, SDG8). However, excessive inflation may lead to economic instability and weaken economic growth, thereby negatively affecting poverty reduction efforts.

3.2.1.5 Renewable Energy Consumption

Every year from 2000 to 2022, data on the usage of renewable energy is gathered from the World Bank database. The percentage of renewable energy in total final energy consumption, expressed in percentage terms, is known as renewable energy consumption. Increasing the use of renewable energy directly helps to achieve SDG 7's objective of providing everyone with access to modern, affordable, dependable, and sustainable energy. This is so because sustainable energy sources like solar, wind, and hydropower are renewable. This supports the development of alternative energy sources, lowers greenhouse gas emissions, and lessens reliance on fossil fuels.

3.3 Design of Sampling

3.3.1 Target Sample

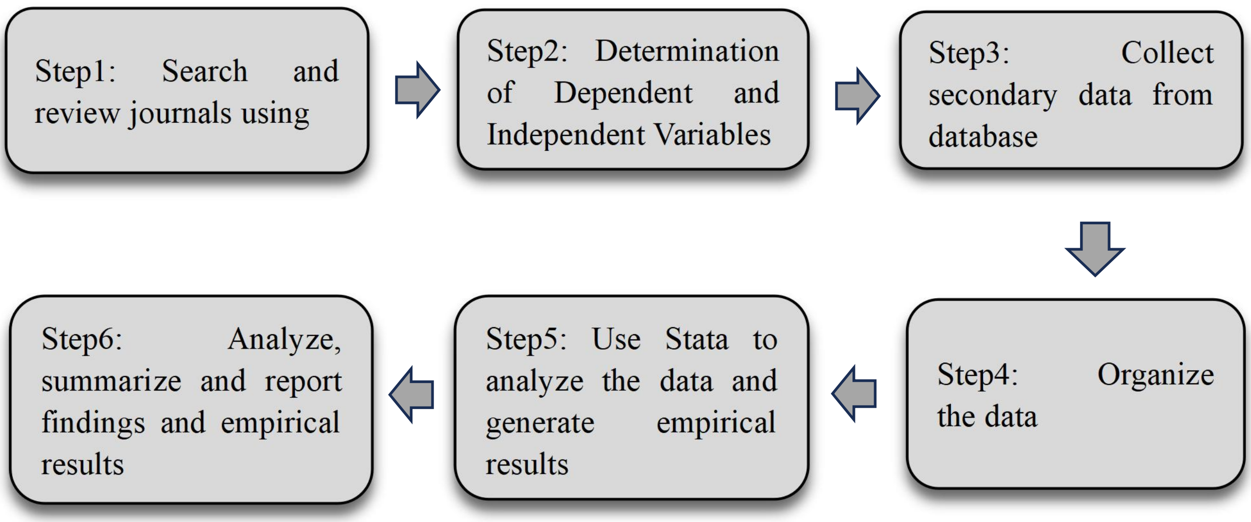
The target sample of this study consists of two different groups of countries: the OPEC (Organization of Petroleum Exporting Countries) and non-OPEC countries. These countries were selected on the basis of their significant role in the global oil market, with OPEC countries being the major producers and non-OPEC countries being the major consumers and leaders in energy adoption. This selection criterion ensured that the study covered a wide range of oil dependence and renewable energy integration, facilitating a comprehensive analysis of their impact on economic stability, growth and the process of achieving the sustainable development goals.

3.3.2 Sample Size

The study examines annual panel data for 16 countries (8 OPEC members + 8 non-OPEC members) from 2000 to 2022 from the datasets of the Sustainable Development Report, OECD, Our World in Data and. captures the dynamics of oil price volatility, renewable energy consumption trends and inflationary pressures over more than two decades. The study was conducted to understand the impact of oil energy and renewable energy on sustainable development in OPEC and non-OPEC countries. 16 sample countries, including 8 OPEC countries: Saudi Arabia, Iraq, Iran, Kuwait, Venezuela, Algeria, Indonesia, and Qatar; and 8 non-OPEC countries: the United States, China, India, Brazil, Russia, Canada, Australia, and South Africa.

3.4 Data Processing

Figure 3.2: Flow of Data Processing



Step 1: Search and review journals using.

Google Scholar, Science Direct, Scopus and other databases to find journals related to research on factors affecting sustainable development in several selected OPEC and non-OPEC countries. These journals are from different countries including Saudi Arabia, Iraq, Iran, Kuwait, Venezuela, Algeria, Indonesia, Qatar, United State, China, India, Brazil, Russia, Canada, Australia, South Africa to help select the appropriate independent variables for this study.

Step 2: Determination of Dependent and Independent Variables.

After reviewing the summary of journals and data availability, the sustainability score profile was identified as the dependent variable. In addition, crude oil production, oil consumption, inflation rate and renewable energy consumption were selected as independent variables for this study since they have significant impact on previous studies. In addition, this study only used data collected annually.

Step 3: Collecting secondary data from databases.

Sustainable Development Report, OECD, Our World in Data and World Bank databases collect all dependent and independent variables information. The data collected were annual data with 368 observations.

Step 4: Organize the data.

Once the collection was completed, all the data was collated into excel. The data is double checked after downloading to ensure accuracy and correct order of the data. Incorrect data is then modified and fixed.

Step 5: Use Stata to analyze the data and generate empirical results.

In order to run OLS and obtain empirical results, Stata was used. r-squared is shown and adjusted r-squared is calculated by derivation of the formulae. t-test and f-test are derived from the observed results.

Step 6: Analyze, summarize and report findings and empirical results.

The results of each variable and the whole model are verified and then the results and the correlation between the independent and dependent variables are analyzed. In addition, the impact of crude oil production, oil consumption, inflation rate and renewable energy consumption on sustainable development in OPEC and non-OPEC countries. This study compares these findings with those of earlier researchers to see if they support the hypotheses in chapters one and two.

3.5 Data Analysis

3.5.1 Empirical Models

3.5.1.1 Multiple Regression Analysis

An expansion of the two-variable model, multiple regression analysis takes into account more than two factors to explain the relationship between the independent and dependent variables. There are four different independent factors explaining the determinants of dependence in this study. In order to investigate the nature of the link that exists between the regressions and the regressed quantities, a multiple regression model was used. The results of this investigation will produce a comprehensive and general model. The general model only considers the independent variables.

The equation of the model is as follows:

$$\boldsymbol{SDG = \beta_0 + \beta_1 REC + \beta_2 INF + \beta_3 lnOC + \beta_4 lnOP + \varepsilon}$$

Where

SDG=Sustainable Development Goals score

REC=Renewable Energy Consumption

INF=Inflation Rate

OC= Oil Consumption

OP=Crude Oil Production

i=Indexes countries

t=Indexes time(years)

β_0=Intercept

$\beta_1, \beta_2, \beta_3, \beta_4$=Coefficients of the independent variables

ε=Error term

3.5.1.2 Panel Data

Panel data is a type of data set that combines cross-sectional and time series dimensions, and is derived from time series observations. Panel data enable for more accurate inference of model parameters since they contain more sample variability and degrees of freedom than cross-sectional data. Panel data better represent the complexity of human behavior than single cross-sectional or time-series data because they test more sophisticated and complex behavioral hypotheses.

3.5.1.3 Pooled Ordinary Least Squares Model (POLS)

The use of the Pooled OLS model allows assumptions to be made about units and time frames. It examines panel data, which combines cross-sectional and time-series data (Baltagi, 2008). If there are differences in influencing factors between the units in the analysis (e.g., individuals, firms, or countries) or within the time period, a simple pooled OLS model may ignore these differences, leading to inaccurate coefficient estimates (Clark & Linzer, 2015). The validity of mixed OLS models depends heavily on the reasonableness of their assumptions. In particular, if the unit effects are correlated with the explanatory variables, then the model estimation may be biased. Podesta (2000) noted that regressions estimated using mixed OLS models may be subject to heteroskedasticity, whereby the error variance varies from country to country, which may undermine the validity of the model. In this study, the POLS model will explore the relationship between energy factors and the SDGs.

The equation of the model is as follows:

$$\boldsymbol{SDG_{it} = \beta_0 + \beta_1 REC_{it} + \beta_2 INF_{it} + \beta_3 lnOC_{it} + \beta_4 lnOP_{it} + \varepsilon_{it}}$$

Where

SDG=Sustainable Development Goals score

REC=Renewable Energy Consumption

INF=Inflation Rate

OC= Oil Consumption

OP=Crude Oil Production

i=Indexes countries

t=Indexes time(years)

β_0=Intercept

$\beta_1, \beta_2, \beta_3, \beta_4$=Coefficients of the independent variables

ε_{it}=Error term

3.5.1.4 Random Effect Model (REM)

Unlike the fixed-effects model, which accomplishes this by using dummy variables, the random-effects model expresses its ignorance of the actual model by means of disturbance terms. A compound error term and an intercept β0 representing the mean value shared by all independent variables form a random effects model (Gujarati & Porter, 2009).

The equation of the model is as follows:

$$\boldsymbol{SDG_{it} = \beta_0 + \beta_1 REC_{it} + \beta_2 INF_{it} + \beta_3 lnOC_{it} + \beta_4 lnOP_{it} + \mu_i + \varepsilon_{it}}$$

Where

SDG=Sustainable Development Goals score

REC=Renewable Energy Consumption

INF=Inflation Rate

OC= Oil Consumption

OP=Crude Oil Production

i=Indexes countries

t=Indexes time(years)

β_0=Intercept

$\beta_1, \beta_2, \beta_3, \beta_4$=Coefficients of the independent variables

μ_i= Individual or cross-section error component

ε_{it}= Combined time series and cross-section error components

There must be no link between the different error components, which is one of the several presumptions of the random effects model. Furthermore, there is no autocorrelation between the cross-section and time series unit and the error components. Within a given cross-section unit, there is a correlation between the error terms associated with two distinct reference time points. OLS estimate is not useful in this scenario. Consequently, it is advised to use generalized least squares (Gujarati and Porter, 2009).

3.5.1.5 Fixed Effect Model (FEM)

For each cross-sectional cell, dummy variables are added to the fixed effects regression model, similar to OLS regression. It is important to ensure that n is not too large. (n-1) dummies must be considered in the regression to take advantage of the fixed effects of using squares. A random error term and a particular time-invariant error term varying over time in individual observations are estimated through a fixed effects composition (Clark & Linzer, 2015).

The equation of the model is as follows:

$$\boldsymbol{SDG_{it} = \alpha_i + \beta_1 REC_{it} + \beta_2 INF_{it} + \beta_3 lnOC_{it} + \beta_4 lnOP_{it} + \varepsilon_{it}}$$

Where

SDG=Sustainable Development Goals score

REC=Renewable Energy Consumption

INF=Inflation Rate

OC= Oil Consumption

OP=Crude Oil Production

i=Indexes countries

t=Indexes time(years)

α_i=Intercept

$\beta_1, \beta_2, \beta_3, \beta_4$=Coefficients of the independent variables

ε_{it}= Error term

Baltagi (2008) asserts that FEM is a suitable model if there is a particular set of n observations. The objects we analyze must also be the same and all exhibit the same scale effects, as our inferences must be based only on these particular observations.

3.5.2 Descriptive Analysis

From 2000 to 2022, descriptive analysis will be used to calculate the mean, median, standard deviation, etc. for each variable. In order to test the descriptive statistics of the data in this study, there are a total of five variables, including dependent and independent variables.

3.5.3 Panel Data Analysis

3.5.3.1 Poolability Test

A Poolability Test is performed to determine which empirical model between Pooled OLS Model or Fixed Effect Model (FEM) is more appropriate for estimating the equations. This test is the first step in determining which model is better suited to estimate the dataset. The following null and alternative hypotheses are possible:

H0: There is a common intercept. (POLS is more appropriate)
H1: There is no common intercept. (Fixed effects model is more appropriate)

Decision rule: Reject the null hypothesis if the probability of the f-statistic is less than the 5% significance level; otherwise, do not reject the null hypothesis.

Results: Rejecting the null hypothesis indicates that the fixed effects model is due to the POLS model.

3.5.3.2 Breusch and Pagan Lagrange Multiplier Test

The Breusch-Pagan LM (BPLM) test selects a regression that includes random effects. The statistic of Lagrange Multiplier (LM) consists of one degree of freedom and follows chi-square distribution. In the case of rejecting the null hypothesis, the optimal solution is chosen to be Random Effect Model (REM). The following null and alternative hypotheses are possible:

H0: No random effects. (POLS model is more appropriate)

H1: There are random effects. (Random effects model is more appropriate)

Decision rule: Reject the null hypothesis if the p-value of the test statistic is less than the 5% level of significance; otherwise, do not reject the null hypothesis.

Results: Rejection of the null hypothesis indicates that the random effects model is superior to the pols model.

3.5.3.3 Hausman Test

Torres-Reyna (2007) states that the Hausman test can be used to determine whether the model in this study is more appropriate for a fixed effects model (FEM) or a random effects model (REM). This test focuses on the correlation between disturbances and other explanatory factors. Once the model was completed, all tests were conducted according to the appropriate model. The following null and alternative hypotheses are possible:

H0: There is no correlation between state individual effects and X_{it}. (Random effects model is more appropriate)

H1: There is a correlation between state individual effects and X_{it}. (Fixed effects model is more appropriate)

Decision rule: Reject the null hypothesis if the p-value of the test statistic is less than 5% significant level; otherwise, do not reject the null hypothesis.

Results: Rejection of the null hypothesis indicates that the fixed effects model is superior to the random effects model.

3.5.3.4 Multicollinearity Test

The link between two or more independent variables is called multicollinearity. When multicollinearity develops, the regression model description is problematic and it is not possible to determine which explanatory variables affect the dependent variable because they are strongly correlated and interdependent. Major multicollinearity can be detected if the correlation coefficient between two independent variables is greater than 0.8; if the coefficient of variance expansion is about 10, the likelihood of multicollinearity is high (Gujarati & Porter ,2009). The following null and alternative hypotheses are possible:

H0: No multicollinearity residuals.
H1: Multicollinearity residuals.

Decision rule: Reject the null hypothesis if the correlation coefficient between the variables is greater than 0.8 or the VIF statistic is greater than 10; otherwise, do not reject the null hypothesis.

Results: Rejection of the null hypothesis indicates the existence of multicollinearity in the residuals.

3.6 Conclusion

This chapter includes the discussion and research design in section 3.1 of this research proposal, data sources and data collection methods in section 3.2, sampling design in section 3.3, data processing in section 3.4 and finally data analysis in section 3.5. This chapter clearly explains the concept of each method of the study and the way it was segmented and examined in precise details. In order to carry out the research for this study, the method known as Ordinary Least Squares (OLS) is used. In addition to this, both hypothesis testing and diagnostic checking were used to assess the relevance of the variables and models found as well as to determine if there are any econometric problems. This study was conducted using the statistical analysis software Stata. The results and findings of the data analysis of each method by Stata software will be presented and explained in detail in the next chapter.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

This chapter concentrates on presenting and analysing the empirical results obtained through the hypothesis testing used in the methodology described in Chapter 3. The main highlight of this chapter is the results of panel regression analysis tests such as the Poolability test, the Breusch-Pagan LM test and the Hausman test. Stata is used to generate all the results. Further clarifications are discussed after each test result.

4.1 Descriptive Analyses

Table4.1: Descriptive Summary Statistic of All Variables from 2000 to 2022

Variable	Mean	Std. Dev.	Min	Max
rec	12.893	14.948	0	54.99
inf	9.184	13.736	-30.2	79.943
oc	1690.962	2585.463	21.227	11214.078
op	158236.06	152211.24	0	613230.38
sdg	65.395	6.305	51.66	78.5
sdg1	81.935	19.778	16.2	100
sdg2	60.253	9.18	33.7	83.4
sdg3	72.12	14.82	34	95.6
sdg4	82.73	10.706	53.7	99.5

sdg5	57.908	16.635	17.5	83.9
sdg6	67.522	13.249	43.2	93.9
sdg7	65.062	11.235	37.7	90.6
sdg8	72.66	7.645	57.5	86.7
sdg9	48.684	24.822	14.8	97.8
sdg10	53.045	29.083	0	97
sdg11	70.644	12.624	43	92.7
sdg12	74.274	16.46	44.5	95.9
sdg13	62.294	31.508	0	96.8
sdg14	62.723	9.047	38.8	81.3
sdg15	58.769	10.267	39.8	82.3
sdg16	63.43	14.432	27.9	87.6
sdg17	59.197	12.494	29.348	87.4

Source: Calculated by the author using STATA.

The results in Table 4.1 are based on 368 annual observations from 2000 to 2022. Results are provided for all variables associated with descriptive statistics, such as SDG score (SDG), crude oil production (OP), oil consumption (OC), inflation (INF), and renewable energy consumption (REC). Standard deviations of the 17 SDGs, the overall SDG, crude oil production, oil consumption, and inflation are evenly spaced apart from the mean. This suggests that most of the nations in our sample are at comparable stages of sustainable development and that changes in these 22 variables are elastic across the board. It also implies that combining these SDGs into a composite indicator makes sense from an empirical standpoint.

From the above table 4.1, the maximum value of SDG score is 78.5 and minimum value is 51.66. standard deviation is 6.304727 and mean of SDG score is 6.304727.

Renewable energy consumption has a maximum of 54.99 and a minimum of 0. The standard deviation of renewable energy consumption is 14.948 while the mean is 12.8934.

Inflation has a high of 79.94301 and a low of -30.19965. The standard deviation of inflation is 13.73571 while the mean is 9.183895.

Oil consumption ranged from a high of 11214.08 to a low of 21.22673. The standard deviation of oil consumption was 2585.463, while the mean was 1690.962.

Crude oil production has a maximum of 613230.4 and a minimum of 0. The standard deviation of crude oil production is 152211.2, while the mean is 65.3953.

The maximum value of SDG 1 score is 100 and the minimum value is 16.2. The standard deviation is 19.778 and the mean of SDG 1 score is 81.935.

The maximum value of SDG 2 score is 83.4 and the minimum value is 33.7. The standard deviation is 9.18 and the mean of SDG 2 score is 60.253.

The maximum value of SDG 3 score is 95.6 and the minimum value is 34. The standard deviation is 14.82 and the mean of SDG 3 score is 72.12.

The maximum value of SDG 4 score is 99.5 and the minimum value is 53.7. The standard deviation is 10.706 and the mean of SDG 4 score is 82.73.

The maximum value of SDG 5 score is 83.9 and the minimum value is 17.5. standard deviation is 16.635 and the mean of SDG 5 score is 57.908.

The maximum value of SDG 6 score is 93.9 and the minimum value is 43.2. The standard deviation is 13.249 and the mean of SDG 6 score is 67.522.

The maximum value of SDG 7 score is 90.6 and the minimum value is 37.7. The standard deviation is 11.235 and the mean of SDG 7 score is 65.062.

The maximum value of SDG 8 score is 86.7 and the minimum value is 57.5. standard deviation is 7.645 and the mean of SDG 8 score is 72.66.

The maximum value of SDG 9 score is 97.8 and the minimum value is 14.8. The standard deviation is 24.822 and the mean of SDG 9 score is 48.684.

The maximum value of SDG 10 score is 97 and the minimum value is 0. The standard deviation is 29.083 and the mean of SDG 10 score is 53.045.

The maximum value of SDG 11 score is 92.7 and the minimum value is 43. The standard deviation is 12.624 and the mean of SDG 11 score is 70.644.

The maximum value of SDG 12 score is 95.9 and the minimum value is 44.5. standard deviation is 16.46 and the mean of SDG 12 score is 74.274.

The maximum value of SDG 13 score is 96.8 and the minimum value is 0. The standard deviation is 31.508 and the mean of SDG 13 score is 62.294.

The maximum value of SDG 14 score is 78.5 and the minimum value is 38.8. The standard deviation is 9.047 and the mean of SDG 14 score is 62.723.

The maximum value of SDG 15 score is 78.5 and the minimum value is 39.8. standard deviation is 10.267 and the mean of SDG 15 score is 58.769.

The maximum value of SDG 16 score is 78.5 and the minimum value is 27.9. standard deviation is 14.432 and the mean of SDG 16 score is 63.43.

The maximum value of SDG 17 score is 78.5 and the minimum value is 29.384. The standard deviation is 12.494 and the mean of SDG 17 score is 59.197.

4.2 Correlation Analyses

Table4.2: Correlation Summary Statistic of All Variables from 2000 to 2022

|	rec	inf	oc	op	sdg	sdg1	sdg2	sdg3
rec	1							
inf	-0.0281	1						
oc	-0.0441	-0.2364	1					
op	-0.3949	-0.049	0.4361	1				
sdg	-0.0954	-0.166	0.3222	0.1847	1			
sdg1	-0.3801	-0.2351	0.2659	0.4939	0.7138	1		
sdg2	0.1327	-0.121	0.5476	0.2111	0.5647	0.3915	1	
sdg3	-0.1853	-0.1622	0.3477	0.3112	0.8542	0.8254	0.5385	1
sdg4	0.1591	-0.1724	0.5179	0.2025	0.6889	0.3355	0.6274	0.5195
sdg5	0.1706	-0.1215	0.2809	-0.0976	0.6223	0.0862	0.4784	0.3345
sdg6	0.1124	-0.0624	0.2197	0.0681	0.79	0.456	0.3921	0.6985
sdg7	0.0239	0.0539	0.1218	0.222	0.716	0.5664	0.4481	0.6991
sdg8	0.1155	-0.2173	0.4256	0.2319	0.7265	0.4995	0.4844	0.7378
sdg9	-0.0576	-0.27	0.474	0.207	0.795	0.5007	0.5385	0.6966
sdg10	-0.4007	-0.1673	-0.1019	0.1429	0.2824	0.401	-0.2391	0.3785
sdg11	-0.1669	-0.1681	0.2788	0.1716	0.8228	0.5816	0.4707	0.6212
sdg12	0.2483	0.2242	-0.2856	-0.2741	-0.5931	-0.582	-0.2114	-0.7308
sdg13	0.3463	0.2371	-0.161	-0.2718	-0.5055	-0.6035	-0.1422	-0.6925
sdg14	-0.3195	0.5131	-0.2843	-0.159	-0.077	-0.0794	-0.1771	-0.0178
sdg15	-0.1435	0.454	-0.1388	0.0223	0.4115	0.308	0.148	0.3128
sdg16	-0.1205	-0.5122	0.1247	-0.0958	0.4979	0.4661	0.1181	0.5817
sdg17	-0.1278	-0.1117	-0.1125	-0.0037	0.5807	0.3815	-0.1242	0.3278

(Continued)

	sdg4	sdg5	sdg6	sdg7	sdg8	sdg9	sdg10	sdg11
sdg4	1							
sdg5	0.7258	1						
sdg6	0.5248	0.7336	1					
sdg7	0.3089	0.3336	0.7096	1				
sdg8	0.6784	0.6481	0.7974	0.5662	1			
sdg9	0.6572	0.698	0.7173	0.5496	0.8307	1		

sdg10	-0.0174	-0.2565	0.049	0.0093	0.1127	0.0554	1	
sdg11	0.546	0.6952	0.7536	0.5698	0.6195	0.7436	0.0025	1
sdg12	-0.311	-0.392	-0.7058	-0.5003	-0.7652	-0.7121	-0.3297	-0.633
sdg13	-0.2312	-0.3076	-0.6098	-0.4011	-0.7117	-0.6556	-0.3803	-0.5374
sdg14	-0.3741	-0.1874	-0.0867	0.1346	-0.3842	-0.2401	-0.1253	-0.0149
sdg15	0.1625	0.2614	0.3966	0.4514	0.1821	0.1051	-0.1731	0.452
sdg16	0.2018	0.2045	0.3819	0.1869	0.4392	0.5229	0.5209	0.4333
sdg17	0.0608	0.2754	0.4956	0.5139	0.27	0.4049	0.2584	0.5752

(Continued)

	Sdg12	Sdg13	Sdg14	Sdg15	Sdg16	Sdg17
Sdg12	1					
Sdg13	0.9566	1				
Sdg14	0.0822	0.1129	1			
Sdg15	-0.099	-0.0654	0.4985	1		
Sdg16	-0.6997	-0.6789	-0.1722	-0.2591	1	
Sdg17	-0.3706	-0.285	0.0777	0.3234	0.3613	1

Source: Calculated by the author using STATA.

The problem of multicollinearity in regression analysis is identified in Table 4.2. The correlation coefficients of the variables are less than 0.8, thus indicating that there is no serious problem of multicollinearity (Gujarati & Porter, 2009). The Variance Inflation Factor (VIF) number, which is less than 10, supports this.

4.3 Panel Data Analyses

Table 4.3: Main Regression Results of Model

	FEM	FEM	FEM	REM	REM	REM
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	sdg1	sdg2	sdg3	sdg4	sdg5	sdg6
rec	-0.215**	0.384***	-0.0938	0.0600	-0.0456	-0.276***

	(0.103)	(0.0482)	(0.0576)	(0.0732)	(0.0662)	(0.0366)
inf	-0.0978***	-0.0153	0.0173	0.0260	0.0112	0.00904
	(0.0365)	(0.0154)	(0.0184)	(0.0264)	(0.0219)	(0.0119)
lnoc	25.53***	5.662***	11.84***	5.508***	8.867***	2.512***
	(1.842)	(0.630)	(0.754)	(0.950)	(0.865)	(0.479)
lnop	1.694***	0.419	-1.364***	-0.399	-0.739*	0.115
	(0.569)	(0.280)	(0.336)	(0.457)	(0.394)	(0.215)
Constant	-108.8***	13.17**	9.796	49.61***	7.789	53.03***
	(13.99)	(5.127)	(6.134)	(8.139)	(8.190)	(5.304)
Poolability test	100.150***	29.773***	80.493***	8.945***	31.943***	33.060***
BP LM test	2040.68***	2973.66***	2732.87***	2141.41***	3308.98***	3687.50***
Hausman test	30.413***	13.507***	13.459***	4.755	4.062	3.003
Observations	322	368	368	368	368	368
R-squared	0.569	0.255	0.481			
Number of code	14	16	16	16	16	16

(Continued)

	FEM	REM	FEM	FEM	REM	REM
	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	sdg7	sdg8	sdg9	sdg10	sdg11	sdg12
rec	-0.118**	0.0778**	0.805***	1.344***	-0.0329	0.140***

	(0.0461)	(0.0315)	(0.148)	(0.101)	(0.0591)	(0.0262)
inf	0.0389***	0.0216**	0.186***	0.0586	-0.0434**	-0.00719
	(0.0147)	(0.0105)	(0.0472)	(0.0358)	(0.0198)	(0.00842)
lnoc	7.680***	2.240***	34.15***	11.73***	2.614***	1.590***
	(0.603)	(0.412)	(1.933)	(1.807)	(0.771)	(0.343)
lnop	-1.018***	-0.439**	-2.760***	0.824	0.209	-0.0589
	(0.269)	(0.188)	(0.860)	(0.558)	(0.354)	(0.153)
Constant	26.62***	61.50***	-159.3***	-57.40***	51.78***	62.64***
	(4.909)	(3.880)	(15.73)	(13.73)	(7.080)	(5.012)
Poolability test	56.827***	8.636***	78.863***	48.963***	6.236***	9.310***
BP LM test	3119.48***	3206.28***	2079.59***	1343.54***	3173.53***	3522.28***
Hausman test	26.26***	1.342	69.712***	747.147***	0.917	1.21
Observations	368	368	368	322	368	368
R-squared	0.395		0.475	0.392		
Number of code	16	16	16	14	16	16

(Continued)

	REM	REM	REM	REM	REM	FEM
	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	sdg13	sdg14	sdg15	sdg16	sdg17	sdg
rec	0.346***	-0.0242	-0.0471	-0.0567	-0.0949	0.111***
	(0.0506)	(0.0459)	(0.0398)	(0.0394)	(0.0655)	(0.0287)

inf	0.0417**	0.0491***	-0.00771	-0.0414***	0.0227	0.0170*
	(0.0163)	(0.0157)	(0.0133)	(0.0130)	(0.0221)	(0.00917)
lnoc	-2.969***	2.219***	3.932***	-0.314	7.284***	7.027***
	(0.662)	(0.598)	(0.519)	(0.514)	(0.854)	(0.376)
lnop	-0.500*	-1.021***	-0.294	0.219	-0.878**	-0.301*
	(0.296)	(0.279)	(0.238)	(0.234)	(0.394)	(0.167)
Constant	82.74***	59.26***	36.63***	64.18***	21.66***	20.52***
	(9.202)	(5.305)	(4.812)	(4.943)	(7.759)	(3.057)
Poolability test	33.409***	9.615***	22.649***	3.622***	24.302***	90.419***
BP LM test	3483.47***	2587.82***	2532.69***	2361.53***	3058.56***	3013.88***
Hausman test	2.999	5.507	7.937	2.122	4.099	23.366***
Observations	368	368	368	368	368	368
R-squared						0.510
Number of code	16	16	16	16	16	16

*Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*

Source: Calculated by the author using STATA.

4.3.1 Poolability Test

To choose between the fixed effects model and the pooled OLS model for the regression model, this test is used in conjunction with the poolability test. The probability values for each model are displayed in the table at a significance level of less than five percent. Consequently, the null hypothesis, which states that the panel data fits the pooled OLS model, is disproved. Consequently, selecting the fixed effect model (FEM) over the pooled OLS model is more appropriate.

4.3.2 Breusch-Pagan Lagrange Multiplier Test

The Pooled OLS Model or Random Effects Model (REM) was chosen based on the results of a Breusch-Pagan LM (BPLM) test (Gujarati & Porter, 2009). All of the models' p-values were below the 5% significance level, according to the table's "panel" results. We rejected the Pooled OLS model. Because the null hypothesis that supported the Random Effects Model (REM) was likewise rejected, it is therefore preferable to the Pooled OLS model.

4.3.3 Hausman Test

Since the Breusch-Pagan LM Test, a prior poolability test, rejected the pooled OLS model, the Hausman test is used to evaluate which model is preferable: the fixed effects model (FEM) or the random effects model (REM). In contrast to the null hypothesis, the alternative hypothesis contends that the panel data do not fit into a random effects model. The table's findings show that the original hypothesis should be disproved because models 1, 2, 3, 7, 9, 10, and 18 have probability values that are lower than the 5% significance level. Fixed effect model (FEM) is therefore the best option. On the other hand, models 4, 5, 6, 8, 11, 12, 13, 14, 15, 16, and 17 do not reject the original hypothesis and have probability larger than 5% at the significance level. Therefore, random effect model (REM) is the most appropriate.

4.4 Conclusion

This chapter includes descriptive analyses, panel data analyses, and inferential analyses. All results were run by Stata. Based on the panel data analysis for 16 countries from 2000 to 2022, the most appropriate model is FEM. The results show that oil consumption and renewable energy consumption have a significant effect on the SDGs. On the other hand, inflation rate and oil production were found to have insignificant effect on SDGs. The findings, conclusions, limitations, recommendations and other information of this study are further discussed in the next chapter (Chapter 5).

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

This chapter includes a summary of the independent variables and hypothesis testing from the previous chapter. This chapter will further discuss and summary the main findings, impacts and recommendations of the study. Therefore, the study will be evaluated as a conclusion of the research.

5.1 Synopsis of Statistical Analyses

Table 5.1: Synopsis of Regression Results for each model

	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6
REC	-(**)	+(***)	-	+	-	-(***)
INF	-(***)	-	+	+	+	+
lnOC	+(***)	+(***)	+(***)	+(***)	+(***)	+(***)
lnOP	+(***)	+	-(***)	-	-(*)	+

(Continued)

	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12
REC	-(**)	+(**)	+(***)	+(***)	-	+(***)
INF	+(***)	+(**)	+(***)	+	-(***)	+(**)
lnOC	+(***)	+(***)	+(***)	+(***)	+(***)	+(***)

lnOP	-(***)	-(**)	-(***)	+	+	-

(Continued)

	SDG13	SDG14	SDG15	SDG16	SDG17	SDG overall
REC	+(***)	-	-	-	-	+(***)
INF	+(***)	+(***)	-	-(***)	+	+(*)
lnOC	-(***)	+(***)	+(***)	-	+(***)	+(***)
lnOP	-(*)	-(***)	-	+	-(**)	-(*)

*Note: "+" represent POSITIVE; "-" represent NEGATIVE; *** p<0.01, ** p<0.05, * p<0.1.*

Source: Resulting from research

The main results of the baseline analyses for SDGs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 and the overall SDGs in Stata are shown in Table 4.3.The Poolability test, the Breusch Bagan Langragian multiplicity test, and the Hausman test supported random effect model (REM) as the optimal model in Models 4, 5, 6, 8, 11, 12, 13, 14, 15, 16 and 17, while fixed effect model (FEM) was the optimal model in Models 1, 2, 3, 7, 9, 10 and 18. The results of the study were interpreted only from the best model.

5.2 Summary of Major Findings

5.2.1 Oil Production

According to table 5.1, oil production has a significant positive correlation with SDG1; a significant negative correlation with SDGs 3, 5, 7, 8, 9, 13, 14, 17 and the overall SDG; and no correlation with SDGs 2, 4, 6, 10, 11, 12, 15, 16.

There is a significant positive correlation between oil production and poverty reduction (SD1). This finding supports the findings of Alamsyah et al. (2023) who showed that increasing oil production has the potential to reduce poverty in Indonesia. This is because Indonesia as one of the OPEC member countries, the oil industry is usually an important pillar of the economy of OPEC countries, which earns financial revenue through oil extraction and export. Thus, it improves the living standard of citizens and reduces the poverty rate. As well as, oil production has a negative impact on the ecosystem, agricultural sustainability. This finding supports the findings of Ite (2022), Naceur (2019), Ofuoku et al. (2014). The process of oil extraction and refining leads to environmental pollution, ecological damage (SDG15), as well as social conflicts and inequalities. In addition, carbon emissions released from the combustion of oil can exacerbate climate change (SDG13) and affect biodiversity and marine ecosystems (SDG14).

5.2.2 Oil Consumption

According to table 5.1, oil consumption has a significant positive correlation with SDGs 11, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 17 and the overall goal of sustainable development; a significant negative correlation with SDG 13; and no correlation with SDG 16.

Oil consumption has a positive impact on sustainable consumption patterns, conservation of marine resources and ecosystems. This contradicts the findings of Penna (2022), Adebayo et al. (2023) and Naceur (2019). They found that oil consumption exacerbates ecological impacts (SDG15). One possible explanation for the positive impact of oil on sustainable consumption patterns and ecology is that the widespread use of oil has fostered many technological innovations, including energy efficient technologies, renewable energy technologies and clean energy technologies. The development of these technologies has helped to promote sustainable consumption patterns (SDG12), such as the development of more energy-efficient modes of transport, buildings, and manufacturing, thereby reducing energy consumption and ecological impacts. Furthermore, in line with Khan (2023), Fakher & Goldansaz (2015), oil consumption has a positive impact on economic development. For example, it stimulates the application of advanced technology (SDG9), increases labour force employment (SDG8), and so on. This is because oil consumption stimulates economic expansion, especially in oil producing countries.

5.2.3 Inflation Rate

According to table 5.1, inflation is significantly and positively correlated with SDGs 7, 8, 9, 12, 13, 14 and the overall goal of sustainable development; significantly and negatively correlated with SDGs 1, 11, 16; and not correlated with SDGs 2, 3, 4, 5, 6, 10, 15, 17.

Inflation and the promotion of sustainable economic growth (SDG8). This finding contradicts Girdzijauskas et al. (2022), Etang et al. (2022), Bittencourt et al. (2015) who demonstrated that high inflation can have a negative impact on economic growth. In theory, inflation is usually seen as unfavourable to the economy as it may lead to currency depreciation and decrease in purchasing power. However, this may not be the case in practice, and moderate inflation may stimulate consumption and investment. Inflation causes the value of money to fall over time, which may encourage people to be more willing to consume and invest rather than keep money in non-value-added cash or savings. This increase in consumption and investment can contribute to economic growth, boosting employment and output expansion (SDG8) (Moderate Inflation: Benefits, Types & Causes, n.d.). Poverty rates rise as a result of inflation (SDG1). This result is in line with the findings of Atigala et al. (2022). Money's real purchasing power decreases as a result of inflation, therefore the same amount of money can now only purchase a lower number of goods and services. Inflation has a greater impact on the purchasing power of money, particularly for those with lower incomes, whose earnings may not be able to keep up with price rises. This leads to increasing living expenses and makes it more difficult to maintain a minimal quality of living. However, inconsistent with the findings of Atigala et al. (2022), the results of the present study show that inflation is not relevant for hunger eradication (SDG3) and equitable access to education (SDG4). The possible reason for this is that inflation affects food prices, but hunger is more affected by food production, distribution and social support systems. Eradicating hunger requires integrated agricultural development, social protection measures and poverty reduction policies; similarly, inflation affects the cost of education and the price of educational resources, but it is factors such as a society's educational policies, family background, and level of regional development that really affect the equity of educational opportunities. Eliminating inequality of opportunity in education requires investment in educational infrastructure, the provision of equitable educational resources and policy support, and inflation is not the primary means of directly addressing these issues. Thus, the impact of inflation on eradicating hunger and providing equitable educational opportunities is minimal.

5.2.4 Renewable Energy Consumption

According to table 5.1, renewable energy consumption is significantly and positively correlated with SDGs 2, 8, 9, 10, 12 and 13 and the overall SDGs; significantly and negatively correlated with SDGs 1, 6 and 7; and not correlated with SDGs 3, 4, 5, 11, 14, 15, 16 and 17.

Renewable energy consumption is positively correlated with achieving climate action (SDG13). This finding supports Payamfar et al. (2023), He et al.(2023), Amin et al. (2022). Their findings suggest that renewable energy use can positively affect the quality of the environment by reducing carbon emissions. However, the results of the present study contradict their view by showing that renewable energy consumption is negatively correlated with ensuring a sustainable energy supply (SDG7). Theoretically, renewable energy sources such as solar, wind, electricity, etc. as affordable, sustainable and modern energy sources will contribute to the development of clean energy. However, there is a possible reason for this result: the utilisation of renewable energy sources such as solar, wind, etc. is limited by geographical location. For example, some regions may lack adequate sunlight or wind resources, making it difficult to adopt these energy sources on a large scale. Furthermore, renewable energy development and maintenance entail the incurrence of great financial and technological commitment and abilities. In a number of country or regions, seminal spending and (or) technical assistance is a factor deterring a reliance on renewable energy sources. Today, current storage technologies are not able to produce a steady supply of energy, and they do not have the strength needed to ensure consistent supply during periods of demand, especially during the days when intermittent energy resources, such as solar and wind, are hit by unpredictable weather.

5.3 Implications of the Study

5.3.1 Policy implications

The focus of this study is on the need to have strong government policies that are strongly based on the use of energy sources that are renewable, especially in countries that are heavily dependent on energy in order for the SDGs to be realized. Decision makers in OPEC as well as non-OPEC countries should consider the benefits of renewable energy use for sustainable development and provide tax exemptions, subsidies and investment for renewable energy.

5.3.2 Economic implications

Scarcity of oil production and a weakened role for inflation in SDGs indicate that there should be a review of how the economy can be run without depending on oil as the major driver. Significant diversification, mostly in Organisation of Petroleum Exporting Countries (OPEC) countries, is crucial to the reduction of susceptibility to oil price fluctuation. Overall wellbeing is achieved if diversification is strengthened further.

5.3.3 Environmental implications

One of the greatest advantages of using renewable energy instead of fossil fuels has been shown by the way environmental sustainability is improved in the global agenda known as Sustainable Development Goals. It is recommended for countries invest in various renewable energy technologies as looking for the combating of climate change and the protection of environmental sustainability.

5.4 Limitations of the Study

Despite the contributions, this study also has its limitations such as: Firstly, the availability or even compatibility of data or equivalency of data collected were the research limitations and the main preliminary obstacle found. This is because the exercise is set on a sample of OPEC and non-OPEC countries, which hampers the information derived from the results to other parts of the world. Moreover, it is not feasible using the selected countries in this study to represent all the countries the world over. The example for this study covers 20 years of data for a specific time period, from 2000 through 2022. The comprehensive evaluation of long-term trends and dynamic aspects of the energy market and environmental policy require more time than a research period which covers only two years. Though the global economy and energy policy scenarios undergo on-the-spot changes, our findings may need to be updated by regular researches continually. Yet again, there is a factor of energy that modulates the rising of SDG scores with regard to global sustainable development. Additionally, the emergence of new technologies and an increase in geopolitical tensions have the potential to affect the SDG score profile as well. It could have been noted that the analysis of SDGs in this study may have not been complete enough therefore it is advised that upcoming research compare sustainable development with energy factors or any other important factors to give reliable data.

5.5 Recommendations for Further Studies

It is proposed that future studies could have more diverse and independent variables – e.g., technological sophistication, level of governance, and global trade dynamics – to capture a wider spectrum of factors of the SDGs. These factors were outside the scope of this investigation. Adding more independent variables and enhancing flexibility could improve the model's accuracy, but this approach should also be supported by a theoretical framework to circumvent the problem of using an overfitting model. Furthermore, involve more countries in the study and consider enlarging the volume of research so as to be up to date. So, it would help them in doing deeper review and assessment of the SDGs and then they can put accurate SDG figure for these countries. It is essential to determine the role of the resulting policies and international treaties in achieving such transition. In addition, it is recommended that future researchers employ advanced statistical techniques to control for potential autocorrelation and multicollinearity in the data could also enhance the robustness of the findings.

5.6 Conclusion

This study examines the factors that influence sustainable development in 16 OPEC and non-OPEC countries, mainly energy factors. In addition, this study uses fixed effects models and random effects models, using data from 2000 to 2022 to arrive at results. The empirical results show that oil production, on the one hand, has a positive impact on poverty reduction (SDG1) through economic growth, and on the other hand, has a negative impact on ecosystems and social equality. Simultaneously ensuring the progression of the economy and technological innovation while oil consumption also causes the challenges of environment sustainability as well as climate action (SDG 13), we ought to be the people balance the consumption patterns. We often view inflation as a fuel that ignites the spurt of economic growth (SDG 8), but it, indeed, intensifies poverty degree (SDG 1), because the inflation rate causes people's money purchasing power to decline (SDG 1). Furthermore, it is less evident that inflation is any drive behind hunger eradication (SDG 3) and equitable education (SDG 4). The consumption of renewable energy is capable of forming the basis of climate action (SDG 13), yet there are some unpredicted difficulties that prevent the creation of energy sources with desirable characteristics (SDG 7). The fact that some areas feature no infrastructure or their geographical features stand in the way, makes it a big problem. These observations, unequivocally show that sustainable development is not just about meeting economic considerations while safeguarding the environment and promoting social justice simultaneously. Presently, oil consumption is actively involved in sustainable development becoming one of factors for the countries examined, and therefore environmental and sustainability issues associated with fossil fuels call for the need to turn to more eco-friendly and sound energy sources. It creates rules for the policy makers and stakeholders who are involved in the process of evolving step by step from short-term power needs to the long-term environmental objectives, where renewable energy is an important component of a sustainable development strategy. As the world moves towards the 2030 Agenda for Sustainable Development, this study lays the foundation for future research and policy formulation to align energy consumption with environmental sustainability and economic development goals. Finally, some limitations and recommendations are presented for future researchers to follow in order to prevent problems and enhance future research on related topics.

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APPENDICES

Appendix 1: Descriptive Statistic

Variable	Obs	Mean	Std. dev.	Min	Max
rec	368	12.8934	14.948	0	54.99
inf	368	9.183895	13.73571	-30.19965	79.94301
oc	368	1690.962	2585.463	21.22673	11214.08
op	368	158236.1	152211.2	0	613230.4
lnoc	368	6.638301	1.25748	3.055261	9.324925
lnop	368	11.17275	2.015208	0	13.3265
sdg	368	65.3953	6.304726	51.66	78.5
sdg1	322	81.93497	19.77755	16.2	100
sdg2	368	60.25281	9.180269	33.7	83.4
sdg3	368	72.12021	14.81959	34	95.6
sdg4	368	82.72987	10.70615	53.7	99.5
sdg5	368	57.90845	16.63532	17.5	83.9
sdg6	368	67.52169	13.24907	43.2	93.9
sdg7	368	65.06192	11.23546	37.7	90.6
sdg8	368	72.66038	7.645164	57.5	86.7
sdg9	368	48.68444	24.82202	14.8	97.8
sdg10	322	53.04478	29.08252	0	97
sdg11	368	70.64385	12.62387	43	92.7
sdg12	368	74.27357	16.45986	44.5	95.9
sdg13	368	62.29429	31.50784	0	96.8
sdg14	368	62.72257	9.047118	38.8	81.3
sdg15	368	58.76888	10.26652	39.8	82.3
sdg16	368	63.42956	14.43154	27.9	87.6
sdg17	368	59.19744	12.49367	29.34833	87.4

Appendix 2: Correlation Statistic

	rec	inf	oc	op	sdg	sdg1	sdg2	sdg3	sdg4	sdg5	sdg6
rec	1.0000										
inf	-0.0281	1.0000									
oc	-0.0441	-0.2364	1.0000								
op	-0.3949	-0.0490	0.4361	1.0000							
sdg	-0.0954	-0.1660	0.3222	0.1847	1.0000						
sdg1	-0.3802	-0.2352	0.2659	0.4939	0.7138	1.0000					
sdg2	0.1327	-0.1210	0.5476	0.2111	0.5647	0.3915	1.0000				
sdg3	-0.1853	-0.1622	0.3477	0.3112	0.8542	0.8254	0.5385	1.0000			
sdg4	0.1591	-0.1724	0.5179	0.2025	0.6889	0.3355	0.6274	0.5195	1.0000		
sdg5	0.1706	-0.1215	0.2809	-0.0976	0.6223	0.0862	0.4784	0.3345	0.7258	1.0000	
sdg6	0.1124	-0.0624	0.2197	0.0681	0.7900	0.4560	0.3921	0.6985	0.5248	0.7336	1.0000
sdg7	0.0239	0.0539	0.1218	0.2220	0.7160	0.5664	0.4481	0.6991	0.3089	0.3336	0.7096
sdg8	0.1155	-0.2173	0.4256	0.2319	0.7265	0.4995	0.4844	0.7378	0.6784	0.6481	0.7974
sdg9	-0.0576	-0.2700	0.4740	0.2070	0.7950	0.5007	0.5385	0.6966	0.6572	0.6980	0.7173
sdg10	-0.4007	-0.1673	-0.1019	0.1429	0.2824	0.4011	-0.2391	0.3785	-0.0174	-0.2565	0.0490
sdg11	-0.1669	-0.1681	0.2788	0.1716	0.8228	0.5816	0.4707	0.6212	0.5460	0.6952	0.7536
sdg12	0.2483	0.2242	-0.2856	-0.2741	-0.5931	-0.5820	-0.2114	-0.7308	-0.3110	-0.3920	-0.7058
sdg13	0.3463	0.2371	-0.1610	-0.2718	-0.5055	-0.6035	-0.1422	-0.6925	-0.2312	-0.3076	-0.6098
sdg14	-0.3195	0.5131	-0.2843	-0.1590	-0.0770	-0.0794	-0.1771	-0.0178	-0.3741	-0.1874	-0.0867
sdg15	-0.1435	0.4540	-0.1388	0.0223	0.4115	0.3080	0.1480	0.3128	0.1625	0.2614	0.3966
sdg16	-0.1205	-0.5122	0.1247	-0.0958	0.4979	0.4661	0.1181	0.5817	0.2018	0.2045	0.3819
sdg17	-0.1278	-0.1117	-0.1125	-0.0037	0.5807	0.3815	-0.1242	0.3278	0.0608	0.2754	0.4956

	sdg7	sdg8	sdg9	sdg10	sdg11	sdg12	sdg13	sdg14	sdg15	sdg16	sdg17
sdg7	1.0000										
sdg8	0.5662	1.0000									
sdg9	0.5496	0.8307	1.0000								
sdg10	0.0093	0.1127	0.0554	1.0000							
sdg11	0.5698	0.6195	0.7436	0.0025	1.0000						
sdg12	-0.5003	-0.7652	-0.7121	-0.3297	-0.6330	1.0000					
sdg13	-0.4011	-0.7117	-0.6556	-0.3803	-0.5374	0.9566	1.0000				
sdg14	0.1346	-0.3842	-0.2401	-0.1253	-0.0149	0.0822	0.1129	1.0000			
sdg15	0.4514	0.1821	0.1051	-0.1731	0.4520	-0.0990	-0.0654	0.4985	1.0000		
sdg16	0.1869	0.4392	0.5229	0.5209	0.4333	-0.6997	-0.6789	-0.1722	-0.2591	1.0000	
sdg17	0.5139	0.2700	0.4049	0.2584	0.5752	-0.3706	-0.2850	0.0777	0.3234	0.3613	1.0000

Appendix 3: Breusch-Pagan LM Test

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                     sdg |   39.74958       6.304726
                       e |   2.918733        1.70843
                       u |   41.40369        6.43457

        Test: Var(u) = 0
                             chibar2(01) =  3013.88
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg1[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg1 |   391.1515       19.77755
                       e |   32.85992       5.732357
                       u |   254.5003       15.95306

        Test: Var(u) = 0
                             chibar2(01) =  2040.68
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg2[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg2 |   84.27734       9.180269
                       e |   8.208268       2.865007
                       u |   89.44913       9.457755

        Test: Var(u) = 0
                             chibar2(01) =  2973.66
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg3[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                        |       Var     SD = sqrt(Var)
                --------+-----------------------------
                   sdg3 |   219.6204       14.81959
                      e |   11.74953       3.427759
                      u |   176.8811       13.29966

        Test: Var(u) = 0
                             chibar2(01) =  2732.87
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg4[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                        |       Var     SD = sqrt(Var)
                --------+-----------------------------
                   sdg4 |   114.6217       10.70615
                      e |   24.61406       4.961256
                      u |   102.5592       10.12715

        Test: Var(u) = 0
                             chibar2(01) =  2141.41
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg5[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                        |       Var     SD = sqrt(Var)
                --------+-----------------------------
                   sdg5 |    276.734       16.63532
                      e |   16.76241       4.094192
                      u |   279.7959        16.7271

        Test: Var(u) = 0
                             chibar2(01) =  3308.98
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg6[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg6 |   175.5379       13.24907
                       e |   4.909688       2.215782
                       u |   207.5363       14.40612

        Test: Var(u) = 0
                             chibar2(01) =   3687.50
                          Prob > chibar2 =    0.0000
```


```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg6[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg6 |   175.5379       13.24907
                       e |   4.909688       2.215782
                       u |   207.5363       14.40612

        Test: Var(u) = 0
                             chibar2(01) =   3687.50
                          Prob > chibar2 =    0.0000
```


```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg8[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg8 |   58.44854       7.645164
                       e |   3.829842       1.956998
                       u |   61.28016       7.828165

        Test: Var(u) = 0
                             chibar2(01) =   3206.28
                          Prob > chibar2 =    0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg9[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                    sdg9 |   616.1327       24.82202
                       e |   77.24656       8.789002
                       u |   453.6111       21.29815

        Test: Var(u) = 0
                             chibar2(01) =  2079.59
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg10[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg10 |   845.7929       29.08252
                       e |   31.61824        5.62301
                       u |   245.3263        15.6629

        Test: Var(u) = 0
                             chibar2(01) =  1343.54
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg11[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg11 |    159.362       12.62387
                       e |   13.79366       3.713981
                       u |   171.6828       13.10278

        Test: Var(u) = 0
                             chibar2(01) =  3173.52
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg12[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg12 |   270.9269       16.45986
                       e |   2.462071       1.569099
                       u |   277.8195       16.66792

        Test: Var(u) = 0
                             chibar2(01) =  3522.28
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg13[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg13 |   992.7442       31.50784
                       e |   9.161662       3.026824
                       u |    887.188        29.7857

        Test: Var(u) = 0
                             chibar2(01) =  3483.47
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg14[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg14 |   81.85035       9.047118
                       e |   8.532378       2.921024
                       u |   69.54452       8.339336

        Test: Var(u) = 0
                             chibar2(01) =  2587.82
                          Prob > chibar2 =   0.0000
```

```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg15[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg15 |   105.4014       10.26652
                       e |   5.914545       2.431984
                       u |   81.78188       9.043334

        Test: Var(u) = 0
                             chibar2(01) =  2532.69
                          Prob > chibar2 =   0.0000
```


```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg15[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg15 |   105.4014       10.26652
                       e |   5.914545       2.431984
                       u |   81.78188       9.043334

        Test: Var(u) = 0
                             chibar2(01) =  2532.69
                          Prob > chibar2 =   0.0000
```


```
Breusch and Pagan Lagrangian multiplier test for random effects

        sdg17[code,t] = Xb + u[code] + e[code,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                   sdg17 |   156.0919       12.49367
                       e |   16.99779       4.122837
                       u |   188.2126       13.71906

        Test: Var(u) = 0
                             chibar2(01) =  3058.56
                          Prob > chibar2 =   0.0000
```

Appendix 4: Hausman Test

Hausman (1978) specification test

	Coef.
Chi-square test value	23.366

P-value	0

Hausman (1978) specification test

	Coef.
Chi-square test value	30.413
P-value	0

Hausman (1978) specification test

	Coef.
Chi-square test value	13.507
P-value	.009

Hausman (1978) specification test

	Coef.
Chi-square test value	13.459
P-value	.009

Hausman (1978) specification test

	Coef.
Chi-square test value	4.755
P-value	.313

Hausman (1978) specification test

	Coef.
Chi-square test value	4.062
P-value	.398

Hausman (1978) specification test

	Coef.
Chi-square test value	3.003
P-value	.557

Hausman (1978) specification test

	Coef.
Chi-square test value	26.26
P-value	0

Hausman (1978) specification test

	Coef.
Chi-square test value	1.342
P-value	.854

Hausman (1978) specification test

	Coef.
Chi-square test value	69.712
P-value	0

Hausman (1978) specification test

	Coef.
Chi-square test value	747.147
P-value	0

Hausman (1978) specification test

	Coef.
Chi-square test value	.917
P-value	.922

Hausman (1978) specification test

	Coef.
Chi-square test value	1.21
P-value	.876

Hausman (1978) specification test

	Coef.
Chi-square test value	2.999
P-value	.558

Hausman (1978) specification test

	Coef.
Chi-square test value	5.507
P-value	.239

Hausman (1978) specification test

	Coef.
Chi-square test value	7.937
P-value	.094

Hausman (1978) specification test

	Coef.
Chi-square test value	2.122
P-value	.713

Hausman (1978) specification test

	Coef.
Chi-square test value	4.099
P-value	.393

Appendix 5: The Fixed Effect Model

Regression results

sdg	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.111	.029	3.87	0	.055	.168	***
inf	.017	.009	1.85	.065	-.001	.035	*
lnoc	7.027	.376	18.70	0	6.288	7.766	***
lnop	-.301	.167	-1.80	.072	-.63	.028	*
Constant	20.525	3.057	6.71	0	14.512	26.538	***

Mean dependent var	65.395	SD dependent var	6.305
R-squared	0.510	Number of obs	368
F-test	90.419	Prob > F	0.000
Akaike crit. (AIC)	1427.958	Bayesian crit. (BIC)	1447.498

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg1	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.215	.103	-2.08	.038	-.418	-.012	**
inf	-.098	.037	-2.68	.008	-.17	-.026	***
lnoc	25.523	1.842	13.85	0	21.897	29.148	***
lnop	1.694	.569	2.98	.003	.574	2.813	***
Constant	-108.788	13.993	-7.77	0	-136.323	-81.254	***

Mean dependent var	81.935	SD dependent var	19.778
R-squared	0.569	Number of obs	322
F-test	100.150	Prob > F	0.000
Akaike crit. (AIC)	2029.779	Bayesian crit. (BIC)	2048.652

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg2	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.384	.048	7.98	0	.289	.479	***

inf	-.015	.015	-1.00	.32	-.046	.015	
lnoc	5.662	.63	8.98	0	4.423	6.902	***
lnop	.419	.28	1.49	.136	-.133	.971	
Constant	13.171	5.127	2.57	.011	3.088	23.255	**

Mean dependent var	60.253	SD dependent var	9.180
R-squared	0.255	Number of obs	368
F-test	29.773	Prob > F	0.000
Akaike crit. (AIC)	1808.467	Bayesian crit. (BIC)	1828.007

*** p<.01, ** p<.05, * p<.1

Regression results

sdg3	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.094	.058	-1.63	.104	-.207	.02	
inf	.017	.018	0.94	.348	-.019	.054	
lnoc	11.842	.754	15.71	0	10.359	13.325	***
lnop	-1.364	.336	-4.06	0	-2.024	-.704	***
Constant	9.796	6.134	1.60	.111	-2.269	21.86	

Mean dependent var	72.120	SD dependent var	14.820
R-squared	0.481	Number of obs	368
F-test	80.493	Prob > F	0.000
Akaike crit. (AIC)	1940.458	Bayesian crit. (BIC)	1959.999

*** p<.01, ** p<.05, * p<.1

Regression results

sdg4	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.117	.083	1.40	.163	-.047	.281	
inf	.029	.027	1.09	.276	-.023	.081	
lnoc	6.471	1.091	5.93	0	4.324	8.617	***
lnop	-.454	.486	-0.93	.351	-1.409	.502	
Constant	43.072	8.878	4.85	0	25.61	60.534	***

Mean dependent var	82.730	SD dependent var	10.706
R-squared	0.093	Number of obs	368
F-test	8.945	Prob > F	0.000
Akaike crit. (AIC)	2212.596	Bayesian crit. (BIC)	2232.136

*** p<.01, ** p<.05, * p<.1

Regression results

sdg5	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.042	.069	-0.61	.544	-.177	.094	
inf	.013	.022	0.61	.542	-.03	.057	
lnoc	9.155	.901	10.16	0	7.384	10.926	***
lnop	-.624	.401	-1.56	.121	-1.412	.165	
Constant	4.52	7.327	0.62	.538	-9.89	18.929	

Mean dependent var	57.908	SD dependent var	16.635
R-squared	0.269	Number of obs	368
F-test	31.943	Prob > F	0.000
Akaike crit. (AIC)	2071.218	Bayesian crit. (BIC)	2090.758

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg6	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.288	.037	-7.72	0	-.361	-.214	***
inf	.009	.012	0.78	.439	-.014	.033	
lnoc	2.403	.487	4.93	0	1.444	3.362	***
lnop	.127	.217	0.59	.559	-.3	.554	
Constant	53.774	3.965	13.56	0	45.975	61.572	***

Mean dependent var	67.522	SD dependent var	13.249
R-squared	0.275	Number of obs	368
F-test	33.060	Prob > F	0.000
Akaike crit. (AIC)	1619.340	Bayesian crit. (BIC)	1638.881

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg7	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.118	.046	-2.56	.011	-.209	-.027	**
inf	.039	.015	2.64	.009	.01	.068	***
lnoc	7.68	.603	12.73	0	6.493	8.867	***
lnop	-1.018	.269	-3.79	0	-1.546	-.49	***

Constant	26.62	4.909	5.42	0	16.965	36.275	***

Mean dependent var	65.062	SD dependent var	11.235
R-squared	0.395	Number of obs	368
F-test	56.827	Prob > F	0.000
Akaike crit. (AIC)	1776.482	Bayesian crit. (BIC)	1796.022

*** p<.01, ** p<.05, * p<.1

Regression results

sdg8	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.084	.033	2.56	.011	.019	.149	**
inf	.022	.011	2.06	.04	.001	.042	**
lnoc	2.28	.43	5.30	0	1.433	3.126	***
lnop	-.468	.192	-2.44	.015	-.845	-.092	**
Constant	61.477	3.502	17.55	0	54.589	68.364	***

Mean dependent var	72.660	SD dependent var	7.645
R-squared	0.090	Number of obs	368
F-test	8.636	Prob > F	0.000
Akaike crit. (AIC)	1527.934	Bayesian crit. (BIC)	1547.474

*** p<.01, ** p<.05, * p<.1

Regression results

sdg9	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.805	.148	5.45	0	.514	1.095	***
inf	.186	.047	3.94	0	.093	.279	***
lnoc	34.155	1.933	17.67	0	30.352	37.957	***
lnop	-2.76	.86	-3.21	.001	-4.452	-1.067	***
Constant	-159.296	15.728	-10.13	0	-190.23	-128.363	***

Mean dependent var	48.684	SD dependent var	24.822
R-squared	0.475	Number of obs	368
F-test	78.863	Prob > F	0.000
Akaike crit. (AIC)	2633.472	Bayesian crit. (BIC)	2653.012

*** p<.01, ** p<.05, * p<.1

Regression results

sdg10	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	1.344	.101	13.27	0	1.144	1.543	***
inf	.059	.036	1.64	.103	-.012	.129	
lnoc	11.735	1.807	6.49	0	8.178	15.291	***
lnop	.824	.558	1.48	.141	-.274	1.922	
Constant	-57.403	13.726	-4.18	0	-84.413	-30.394	***

Mean dependent var	53.045	SD dependent var	29.083
R-squared	0.392	Number of obs	322
F-test	48.963	Prob > F	0.000
Akaike crit. (AIC)	2017.376	Bayesian crit. (BIC)	2036.249

*** p<.01, ** p<.05, * p<.1*

Regression results

sdg11	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.027	.062	-0.43	.668	-.15	.096	
inf	-.043	.02	-2.17	.03	-.083	-.004	**
lnoc	2.612	.817	3.20	.002	1.005	4.219	***
lnop	.257	.364	0.71	.479	-.458	.973	
Constant	51.17	6.646	7.70	0	38.098	64.242	***

Mean dependent var	70.644	SD dependent var	12.624
R-squared	0.067	Number of obs	368
F-test	6.236	Prob > F	0.000
Akaike crit. (AIC)	1999.484	Bayesian crit. (BIC)	2019.024

*** p<.01, ** p<.05, * p<.1*

Regression results

sdg12	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.138	.026	5.24	0	.086	.19	***
inf	-.007	.008	-0.86	.391	-.024	.009	
lnoc	1.594	.345	4.62	0	.915	2.273	***
lnop	-.052	.154	-0.34	.735	-.354	.25	
Constant	62.557	2.808	22.28	0	57.034	68.079	***

Mean dependent var	74.274	SD dependent var	16.460

R-squared	0.097	Number of obs	368
F-test	9.310	Prob > F	0.000
Akaike crit. (AIC)	1365.344	Bayesian crit. (BIC)	1384.884

*** p<.01, ** p<.05, * p<.1

Regression results

sdg13	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.337	.051	6.61	0	.236	.437	***
inf	.041	.016	2.54	.012	.009	.073	**
lnoc	-3.093	.666	-4.65	0	-4.403	-1.784	***
lnop	-.493	.296	-1.66	.097	-1.076	.09	*
Constant	83.615	5.416	15.44	0	72.962	94.268	***

Mean dependent var	62.294	SD dependent var	31.508
R-squared	0.277	Number of obs	368
F-test	33.409	Prob > F	0.000
Akaike crit. (AIC)	1848.905	Bayesian crit. (BIC)	1868.445

*** p<.01, ** p<.05, * p<.1

Regression results

sdg14	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.009	.049	0.18	.86	-.088	.105	
inf	.048	.016	3.06	.002	.017	.079	***
lnoc	2.794	.643	4.35	0	1.531	4.058	***
lnop	-1.049	.286	-3.67	0	-1.611	-.486	***
Constant	55.335	5.227	10.59	0	45.054	65.616	***

Mean dependent var	62.723	SD dependent var	9.047
R-squared	0.100	Number of obs	368
F-test	9.615	Prob > F	0.000
Akaike crit. (AIC)	1822.718	Bayesian crit. (BIC)	1842.259

*** p<.01, ** p<.05, * p<.1

Regression results

sdg15	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig

rec	-.024	.041	-0.58	.561	-.104	.057	
inf	-.008	.013	-0.65	.517	-.034	.017	
lnoc	4.422	.535	8.27	0	3.37	5.474	***
lnop	-.303	.238	-1.27	.204	-.771	.165	
Constant	33.183	4.352	7.62	0	24.624	41.743	***

Mean dependent var	58.769	SD dependent var	10.267
R-squared	0.207	Number of obs	368
F-test	22.649	Prob > F	0.000
Akaike crit. (AIC)	1687.863	Bayesian crit. (BIC)	1707.404

*** p<.01, ** p<.05, * p<.1*

Regression results

sdg16	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.046	.04	-1.15	.251	-.125	.033	
inf	-.039	.013	-3.07	.002	-.064	-.014	***
lnoc	-.155	.524	-0.30	.767	-1.186	.875	
lnop	.223	.233	0.96	.339	-.235	.682	
Constant	62.921	4.262	14.76	0	54.538	71.304	***

Mean dependent var	63.430	SD dependent var	14.432
R-squared	0.040	Number of obs	368
F-test	3.622	Prob > F	0.000
Akaike crit. (AIC)	1672.490	Bayesian crit. (BIC)	1692.030

*** p<.01, ** p<.05, * p<.1*

Regression results

sdg17	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.077	.069	-1.11	.266	-.214	.059	
inf	.025	.022	1.11	.268	-.019	.068	
lnoc	7.824	.907	8.63	0	6.041	9.608	***
lnop	-.826	.404	-2.05	.041	-1.62	-.032	**
Constant	17.259	7.378	2.34	.02	2.748	31.77	**

Mean dependent var	59.197	SD dependent var	12.494
R-squared	0.218	Number of obs	368
F-test	24.302	Prob > F	0.000
Akaike crit. (AIC)	2076.349	Bayesian crit. (BIC)	2095.890

**** p<. 01, ** p<. 05, * p<. 1*

Appendix 6: The Random Effect Model

Regression results

sdg	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.083	.028	2.96	.003	.028	.138	***
inf	.016	.009	1.75	.08	-.002	.035	*
lnoc	6.548	.365	17.93	0	5.832	7.264	***
lnop	-.292	.167	-1.75	.081	-.62	.036	*
Constant	23.974	3.397	7.06	0	17.316	30.632	***

Mean dependent var	65.395	SD dependent var	6.305
Overall r-squared	0.125	Number of obs	368
Chi-square	332.631	Prob > chi2	0.000
R-squared within	0.509	R-squared between	0.111

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg1	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.361	.098	-3.69	0	-.553	-.169	***
inf	-.112	.038	-2.97	.003	-.185	-.038	***
lnoc	21.421	1.709	12.53	0	18.072	24.771	***
lnop	1.739	.57	3.05	.002	.622	2.855	***
Constant	-78.735	13.689	-5.75	0	-105.564	-51.905	***

Mean dependent var	81.935	SD dependent var	19.778
Overall r-squared	0.211	Number of obs	322
Chi-square	356.599	Prob > chi2	0.000
R-squared within	0.563	R-squared between	0.192

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg2	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.333	.046	7.24	0	.243	.423	***
inf	-.015	.015	-0.99	.32	-.046	.015	
lnoc	5.035	.599	8.41	0	3.861	6.209	***

lnop	.447	.276	1.62	.106	-.095	.989	
Constant	17.681	5.434	3.25	.001	7.032	28.331	***

Mean dependent var	60.253	SD dependent var	9.180
Overall r-squared	0.078	Number of obs	368
Chi-square	107.671	Prob > chi2	0.000
R-squared within	0.255	R-squared between	0.074

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg3	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.139	.056	-2.46	.014	-.249	-.028	**
inf	.017	.019	0.88	.377	-.02	.053	
lnoc	11.079	.735	15.08	0	9.638	12.519	***
lnop	-1.243	.336	-3.70	0	-1.901	-.584	***
Constant	14.097	6.878	2.05	.04	.616	27.579	**

Mean dependent var	72.120	SD dependent var	14.820
Overall r-squared	0.022	Number of obs	368
Chi-square	298.769	Prob > chi2	0.000
R-squared within	0.479	R-squared between	0.011

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg4	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.06	.073	0.82	.412	-.083	.203	
inf	.026	.026	0.98	.325	-.026	.078	
lnoc	5.508	.95	5.80	0	3.647	7.369	***
lnop	-.399	.457	-0.87	.384	-1.295	.498	
Constant	49.606	8.139	6.09	0	33.654	65.558	***

Mean dependent var	82.730	SD dependent var	10.706
Overall r-squared	0.091	Number of obs	368
Chi-square	33.938	Prob > chi2	0.000
R-squared within	0.092	R-squared between	0.101

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg5	Coef.	St.Err.	[95% Conf	Interval]	Sig

			t-value	p-value			
rec	-.046	.066	-0.69	.491	-.175	.084	
inf	.011	.022	0.51	.61	-.032	.054	
lnoc	8.867	.865	10.26	0	7.173	10.562	***
lnop	-.739	.394	-1.87	.061	-1.512	.034	*
Constant	7.789	8.19	0.95	.342	-8.262	23.84	

Mean dependent var	57.908	SD dependent var	16.635
Overall r-squared	0.098	Number of obs	368
Chi-square	127.211	Prob > chi2	0.000
R-squared within	0.268	R-squared between	0.090

*** *p<.01, *** *** *p<.05, *** * *p<.1*

Regression results

sdg6	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.276	.037	-7.53	0	-.348	-.204	***
inf	.009	.012	0.76	.447	-.014	.032	
lnoc	2.512	.479	5.25	0	1.573	3.45	***
lnop	.115	.215	0.54	.592	-.307	.537	
Constant	53.034	5.304	10.00	0	42.638	63.431	***

Mean dependent var	67.522	SD dependent var	13.249
Overall r-squared	0.003	Number of obs	368
Chi-square	131.186	Prob > chi2	0.000
R-squared within	0.275	R-squared between	0.001

*** *p<.01, *** *** *p<.05, *** * *p<.1*

Regression results

sdg7	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.13	.045	-2.90	.004	-.218	-.042	***
inf	.039	.015	2.61	.009	.01	.068	***
lnoc	7.349	.586	12.55	0	6.201	8.496	***
lnop	-.976	.266	-3.67	0	-1.498	-.454	***
Constant	28.508	5.654	5.04	0	17.427	39.59	***

Mean dependent var	65.062	SD dependent var	11.235
Overall r-squared	0.006	Number of obs	368
Chi-square	218.440	Prob > chi2	0.000
R-squared within	0.395	R-squared between	0.001

*** *p<.01, *** *** *p<.05, *** * *p<.1*

Regression results

sdg8	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.078	.032	2.46	.014	.016	.14	**
inf	.022	.01	2.07	.039	.001	.042	**
lnoc	2.24	.412	5.44	0	1.433	3.046	***
lnop	-.439	.188	-2.34	.02	-.807	-.071	**
Constant	61.497	3.88	15.85	0	53.892	69.101	***

Mean dependent var	72.660	SD dependent var	7.645
Overall r-squared	0.076	Number of obs	368
Chi-square	35.407	Prob > chi2	0.000
R-squared within	0.090	R-squared between	0.076

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg9	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.466	.141	3.30	.001	.19	.743	***
inf	.174	.049	3.53	0	.078	.271	***
lnoc	28.815	1.834	15.71	0	25.221	32.41	***
lnop	-2.837	.867	-3.27	.001	-4.537	-1.137	***
Constant	-118.515	15.962	-7.42	0	-149.799	-87.231	***

Mean dependent var	48.684	SD dependent var	24.822
Overall r-squared	0.112	Number of obs	368
Chi-square	249.671	Prob > chi2	0.000
R-squared within	0.470	R-squared between	0.100

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg10	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	1.008	.105	9.64	0	.803	1.213	***
inf	.052	.04	1.30	.195	-.027	.131	
lnoc	6.277	1.827	3.44	.001	2.697	9.857	***
lnop	1.433	.609	2.35	.019	.24	2.627	**
Constant	-21.6	14.632	-1.48	.14	-50.279	7.078	

Mean dependent var	53.045	SD dependent var	29.083

Overall r-squared	0.118	Number of obs	322
Chi-square	111.354	Prob > chi2	0.000
R-squared within	0.378	R-squared between	0.152

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg11	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.033	.059	-0.56	.578	-.149	.083	
inf	-.043	.02	-2.19	.028	-.082	-.005	**
lnoc	2.614	.771	3.39	.001	1.102	4.126	***
lnop	.209	.354	0.59	.555	-.486	.904	
Constant	51.777	7.08	7.31	0	37.901	65.653	***

Mean dependent var	70.644	SD dependent var	12.624
Overall r-squared	0.092	Number of obs	368
Chi-square	26.372	Prob > chi2	0.000
R-squared within	0.067	R-squared between	0.094

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg12	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.14	.026	5.33	0	.088	.191	***
inf	-.007	.008	-0.85	.393	-.024	.009	
lnoc	1.59	.343	4.64	0	.918	2.262	***
lnop	-.059	.153	-0.38	.701	-.359	.241	
Constant	62.64	5.012	12.50	0	52.817	72.462	***

Mean dependent var	74.274	SD dependent var	16.460
Overall r-squared	0.062	Number of obs	368
Chi-square	38.199	Prob > chi2	0.000
R-squared within	0.097	R-squared between	0.062

*** *p<.01,* ** *p<.05,* * *p<.1*

Regression results

sdg13	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	.346	.051	6.83	0	.246	.445	***
inf	.042	.016	2.56	.01	.01	.074	**
lnoc	-2.969	.662	-4.48	0	-4.266	-1.671	***

lnop	-.5	.296	-1.69	.091	-1.08	.08	*
Constant	82.744	9.202	8.99	0	64.708	100.781	***

Mean dependent var	62.294	SD dependent var	31.508
Overall r-squared	0.090	Number of obs	368
Chi-square	134.402	Prob > chi2	0.000
R-squared within	0.277	R-squared between	0.089

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg14	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.024	.046	-0.53	.597	-.114	.066	
inf	.049	.016	3.13	.002	.018	.08	***
lnoc	2.219	.598	3.71	0	1.047	3.391	***
lnop	-1.021	.279	-3.66	0	-1.568	-.475	***
Constant	59.262	5.305	11.17	0	48.865	69.659	***

Mean dependent var	62.723	SD dependent var	9.047
Overall r-squared	0.005	Number of obs	368
Chi-square	34.600	Prob > chi2	0.000
R-squared within	0.097	R-squared between	0.014

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg15	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.047	.04	-1.19	.236	-.125	.031	
inf	-.008	.013	-0.58	.561	-.034	.018	
lnoc	3.932	.519	7.58	0	2.915	4.948	***
lnop	-.294	.238	-1.23	.217	-.759	.172	
Constant	36.627	4.812	7.61	0	27.196	46.059	***

Mean dependent var	58.769	SD dependent var	10.267
Overall r-squared	0.045	Number of obs	368
Chi-square	78.502	Prob > chi2	0.000
R-squared within	0.205	R-squared between	0.066

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg16	Coef.	St.Err.	[95% Conf	Interval]	Sig

			t-value	p-value			
rec	-.057	.039	-1.44	.15	-.134	.021	
inf	-.041	.013	-3.19	.001	-.067	-.016	***
lnoc	-.314	.514	-0.61	.541	-1.322	.694	
lnop	.219	.234	0.93	.35	-.24	.677	
Constant	64.184	4.943	12.98	0	54.495	73.872	***

Mean dependent var	63.430	SD dependent var	14.432
Overall r-squared	0.198	Number of obs	368
Chi-square	15.796	Prob > chi2	0.003
R-squared within	0.040	R-squared between	0.232

**** p<.01, ** p<.05, * p<.1*

Regression results

sdg17	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
rec	-.095	.066	-1.45	.148	-.223	.034	
inf	.023	.022	1.03	.303	-.02	.066	
lnoc	7.284	.854	8.53	0	5.61	8.959	***
lnop	-.878	.394	-2.23	.026	-1.65	-.105	**
Constant	21.663	7.759	2.79	.005	6.455	36.87	***

Mean dependent var	59.197	SD dependent var	12.494
Overall r-squared	0.026	Number of obs	368
Chi-square	93.546	Prob > chi2	0.000
R-squared within	0.218	R-squared between	0.018

**** p<.01, ** p<.05, * p<.1*