

**ECONOMIC FREEDOM AND
ENVIRONMENTAL PERFORMANCE: THE
IMPACT OF GOVERNMENT SIZE, LEGAL
SYSTEM, AND MONETARY STABILITY ON
GREENHOUSE GAS EMISSIONS**

A Thesis

**Submitted to the Master's Study Program of Economics at the Faculty
of Economics and Business in partial fulfillment of the requirements
for the degree of**

Master of Arts (M.A.)



**Universitas
Islam Internasional
Indonesia**

by:

Neng Zulfa Azhar

03212210020

UNIVERSITAS ISLAM INTERNASIONAL INDONESIA

DEPOK

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ABSTRACT

Neng Zulfa Azhar

03212210020

zulfa.azhar@uiii.ac.id

Master in Economics

Universitas Islam Internasional Indonesia

This study aims to analyze the relationship between economic freedom and environmental performance specifically measured by per capita GHG emissions from 2010-2020 for OECD countries as well as non-OECD countries using fixed effects panel data regression. The results show that in OECD countries smaller government size has a significant and positive effect on GHG emissions, while in non-OECD countries, although there is a positive effect, it is not statistically significant. The legal system and property rights have a significant and negative effect in OECD countries, but in non-OECD countries, the impact is negative but lacks statistical significance. Additionally, the higher sound money in OECD countries is associated with a negative effect on GHG emissions, whereas in non-OECD countries, it has a positive effect and not significant. The EKC hypothesis is confirmed and significant in OECD countries indicating the existence of an inverted u-shaped link between GDP per capita and GHG emissions, while in non-OECD countries only the relationship is detected but not significant. Technological advancement is equally significant in increasing emissions in both OECD and non-OECD countries, as well as the influence of urbanization is equally influential in reducing emissions in both OECD and non-OECD countries. As for trade, while it has a positive effect in the non-OECD, it has a negative effect in the OECD. This research provides policy implications related to the role of government in mitigating the adverse impact of climate change and improving environmental performance through reducing emissions, one of which is through subsidy and tax regulations as well as strengthening the legal system and maintaining economic stability without sacrificing the environment in the observed countries.

Keywords: Economic Freedom, Climate Change, GHG Emission, Environment.

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ABBREVIATION DIRECTORY

IPCC	: <i>Intergovernmental Panel on Climate Change</i>
GHG	: <i>Greenhouse Gas</i>
OECD	: <i>Organization for Economic Co-operation and Development</i>
OEEC	: <i>Organization for European Economic Co-operation</i>
CO ₂	: <i>Carbon Dioxide</i>
CO ₂ -eq	: <i>Carbon Dioxide Equivalent</i>
NO ₂	: <i>Nitrogen Dioxide</i>
SO ₂	: <i>Sulfur Dioxide</i>
LULUCF	: <i>Land Use, Land Use Change and Forestry</i>
COP	: <i>Conference of the Parties</i>
IPAC	: <i>International Program of Action on Climate</i>
NDC	: <i>Nationally Determined Contributions</i>
GDP	: <i>Gross Domestic Product</i>
CCPI	: <i>Climate Change Performance Index</i>
NAFTA	: <i>North American Free Trade Agreement</i>
ASEAN	: <i>Association of Southeast Asian Nations</i>
IEA	: <i>International Energy Agency</i>
STIRPAT	: <i>Stochastic Impacts by Regression on Population, Affluence and Technology</i>
CEM	: <i>Common Effect Model</i>
FEM	: <i>Fixed Effect Model</i>
REM	: <i>Random Effect Model</i>

CHAPTER I

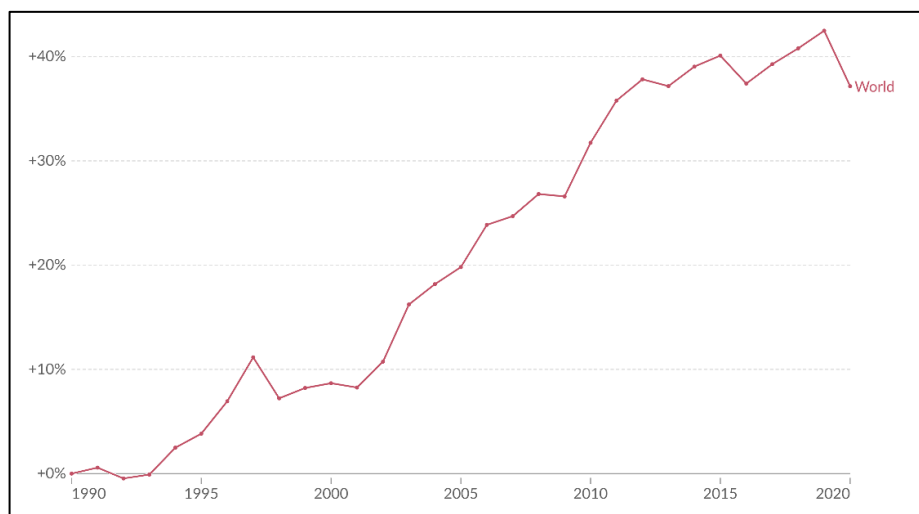
INTRODUCTION

1.1 Background

The activities that have been carried out by humans have influenced many changes in the climate that cause significant problems for human life and the environment. One of the impacts is diminished economic growth and widespread loss of biodiversity (Cai et al., 2020; Mamghaderi et al., 2023). The Intergovernmental Panel on Climate Change (IPCC) in 2021 has issued a report on climate change that causes permanent damage to all ecosystems, from marine, coastal, freshwater to land. Ecosystems have suffered significant degradation in structure, function, resilience and capacity to adapt, as well as changes in seasonal patterns, leading to adverse socio-economic consequences. Some species have experienced isolated extinctions due to increased temperature extremes, mass mortality events on land and in water, and loss of kelp forests (Eyring & Gillett, 2021).

Recent studies have emphasized the increasing release of GHG emissions due to the consumption of non-renewable energy resources such as coal, oil, natural gas, and nuclear energy. These resources are believed to have significant negative impacts on the environment, especially if they produce emissions such as carbon dioxide (CO₂), methane and other gases in the atmosphere (Majeed & Luni, 2019). Based on statistics from Our World in Data (2024), there was a significant increase of about 37% in overall greenhouse gas emissions, which include carbon dioxide, methane, and nitrous oxide, from all sources between 1990 and 2020.

Figure 1.1 Annual GHG Emission of the World (1990-2020)

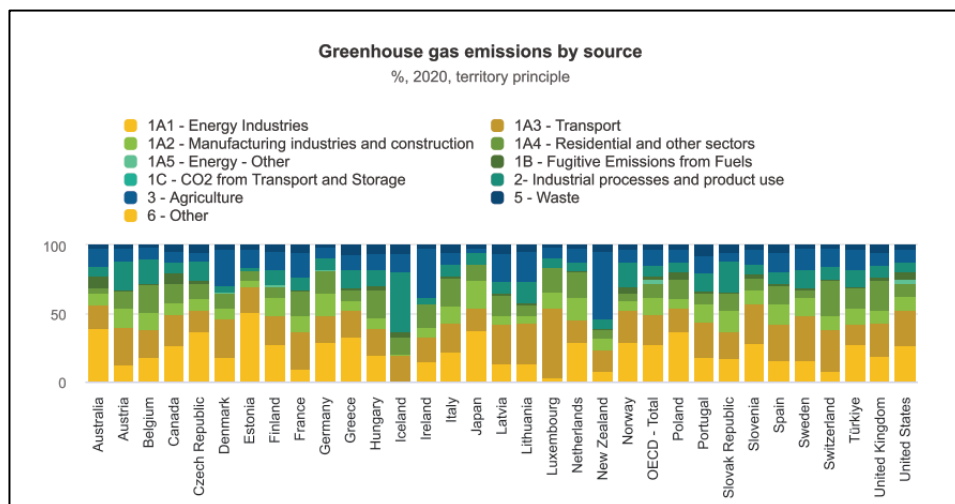


Source: (Jones et al., 2024)

There are many countries that still maintain fossil energy as the main energy, such as European Union member countries, which still depend on coal, gas, and oil for their energy sources. until 2020 it was reported that around 37% of the sources used for power generation came from fossil-derived energy. Thus, causing a significant spike in CO2 emissions. besides European Union member countries, the Climate Change Performance Index (CCPI) reported by Germanwatch states that OECD member countries are also among the largest contributors to global greenhouse gas emissions (Burck et al., 2020).

The OECD reports that GHG emissions in OECD countries come from different sectors. In 2020, energy from industry accounted for 28% of emissions, and is considered the largest contributor, while the transportation sector accounted for about 23%. The manufacturing sector accounted for 12% and agriculture contributed 10%. Meanwhile, waste and industrial processes account for 3% and 8%, respectively. The transportation sector in countries such as Luxembourg, Slovenia, Switzerland and Sweden accounts for more than 30% of greenhouse gas emissions. In Ireland and New Zealand, the sector accounts for more than 35% of GHG emissions. The level of mitigation efforts and progress in emissions regulation varies across OECD countries. Variations in economic growth, socio-demographics, consumption and production activities account for the variance.

Figure 1. 2 GHG Emissions of OECD by Source (2020)

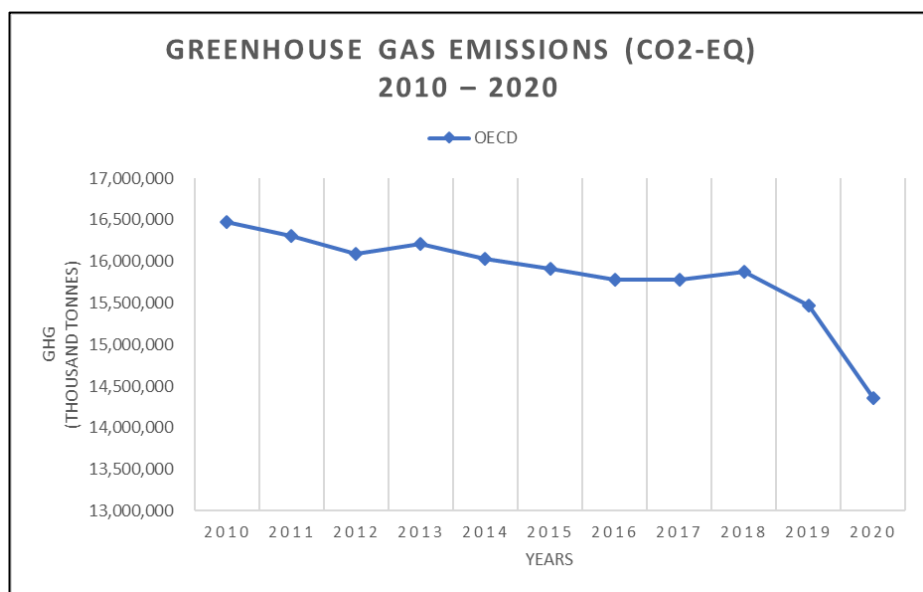


Source: (OECD, 2024a)

However, GHG emissions in most OECD countries have been reported to have decreased since 2010 due to the economic slowdown following the financial crisis in 2008. Other possibilities include the implementation of stricter climate legislation, as well as the transition towards more environmentally friendly energy sources and technologies. The

decline in emissions is said to have been gradual since 2017, with a reduction of about 4.5%. The OECD also reported a decrease in 2020 emissions by 7.15% from 2019 as a result of the COVID-19 pandemic and massive human activity restrictions (OECD, 2024b). This record aligns with the report by the Climate Change Performance Index in 2020 which said that many OECD countries managed to improve their climate performance compared to the previous years. The report revealed that there was a decrease in GHG emissions worldwide by 8.8% in the first half of 2020. In May 2020, the study showed a decrease in global emissions by approximately 4-7 percent (Burck & Nascimento, 2021).

Figure 1. 3 GHG Emissions of OECD Countries (2010-2020)



Source: OECD (2024)

Countries with high levels of GHG emissions such as China, India and The United States are required to control emissions as a consequence of climate change and growing global concerns over emissions (Alola, Adebayo, et al., 2022). Likewise, some European countries have swiftly taken steps to mitigate the increase in emissions. So that currently every country in the world has variations in the level of emissions released as well as variations in policies and standards pursued in protecting the environment and commitment to reduce greenhouse gas emissions (Z. Ahmed et al., 2019; G. Ali et al., 2019; Kasman & Duman, 2015; Khaliq & Mamkhezri, 2023; S. Sharma et al., 2021).

Various worldwide actions have been proposed since 1992 to address the issue of rising emissions, particularly after the establishment of the United Nations Framework Convention on Climate Change (UNFCCC), global accords have acknowledged the

significance of decreasing greenhouse gas (GHG) emissions to sustain steady economic growth and environmental advancement. Global efforts have been made up to the Kyoto Agreement implemented in 2005. Likewise, the global agreement established at the Conference of the Parties (COP21) in 2015 in Paris. This agreement discusses global agreements and commitments to combating climate change by limiting global temperature rise to a maximum of 2 degrees Celsius compared to pre-industrial levels (Buhari et al., 2020).

European states formed the European Green Deal in 2019 intending to achieve a sustainable economy by 2050. The U.S. Energy Information Administration reports that in addition to European countries, many non-European countries, including OECD members, have also demonstrated their commitment to combat climate change by aiming to decrease CO2 emissions by 80 to 95 percent by the year 2050 (Tutak et al., 2021).

Global attention has been directed on literature that analyze the correlation between climate change trends and the factors that influence the rise and fall in emission levels. Relevant research emphasizes that a country's economic freedom is a factor that can affect its emission levels, by reviewing the initiatives taken by the government and the private sector to preserve and maintain its environmental performance, such as the research conducted by Jain & Kaur (2022) who has discussed how economic freedom and CO2 emissions are interrelated. The findings indicate that one of the indicators that illustrate economic freedom is high government size index, which signifies a more liberal and market-driven economy, has a positive effect on the environment by reducing emissions. Adesina & Mwamba (2019) also supported the findings that a country with a more free economy will likely experience a decrease in CO2 emissions. However, in the study conducted by Grossman & Krueger (1991) in Sakariyahu et al. (2023) discovered that there is a non-linear connection between economic freedom and environmental quality. This means that during the initial phases of economic development and technological advancement, there is a positive impact on environmental quality. However, once a certain level is reached, economic freedom can lead to negative consequences for the environment.

Contrary to popular belief, relevant research also shows the negative influence produced by countries with high economic freedom on their environmental quality, such as Alola, Alola, et al. (2022) which reveals that economic freedom has a positive and significant correlation with the ecological footprint in the countries examined. The research provides an explanation that when the economy is increasingly free, it leads to heightened environmental performance pressure, increasing CO2 emissions. In the research of Sart et

al. (2022), it emphasized that in a free economy, there will be a consequential rise in both output and demand for commodities, such as industrial expansion, would indirectly lead to the exploitation of natural resources, which is believed to contribute to environmental degradation. In line with Khaliq & Mamkhezri (2023) who asserted that the increase in consumption and economic activity generated due to economic freedom is also concerning to encourage an increase in emissions and contribute to environmental damage. From the results of these varied studies, it is concluded that the effect of economic freedom on the emissions in each country may differ depending on other influencing factors. Therefore, it is crucial to analyze how economic freedom reacts to environmental quality to support sustainable development.

Fluctuations in emissions are also linked to socioeconomic variables that may influence a country's environmental performance, with some literature finding an influence of GDP per capita (Aguir Bargaoui et al., 2014; Z. Ahmed et al., 2019; Hamit-Hagggar, 2012; Setyadharma et al., 2021), technological advancement (Balsalobre et al., 2015; Crenshaw & Jenkins, 1996; Paramati et al., 2022), urbanization (Poumanyong & Kaneko, 2010; Shahnazi & Dehghan Shabani, 2021; S. S. Sharma, 2011), and trade (Afesorbor & Demena, 2022; Antweiler et al., 2001).

The effect of economic expansion indicated by an increase in GDP per capita on environmental damage has attracted the attention of researchers. This is because economic growth is often associated with an increase in energy consumption which in turn leads to an increase in carbon emissions and other pollutants within a country. Several studies have also found a non-linear relationship between GDP per capita and emission levels and validated the Environmental Kuznets Curve (EKC) theory which shows the phenomenon that in the early stages of economic growth is accompanied by environmental damage, but when a certain threshold is surpassed, environmental damage begins to decline (Awan & Azam, 2022; Khan et al., 2019; Lacheheb et al., 2020; Wang et al., 2022).

Urbanization is also acknowledged as a factor that affects a country's emission levels, some studies have found a positive relationship indicating that an increase in urbanization is associated with an increase in emissions (Poumanyong & Kaneko, 2010; Sadorsky, 2014). Conversely, others have found that the level of urbanization contributes in reducing environmental damage by lowering emission levels (Effiong, 2018; S. S. Sharma, 2011). The effect of technology has also been examined by several researchers, some of whom concluded that more advanced technology has a positive impact on environmental quality because it enables economic activity to utilize cleaner and

environmentally friendly technologies (A. Ahmed et al., 2016; Balsalobre et al., 2015; Doğan et al., 2022; Sakariyahu et al., 2023). At the same time, other study suggests that the rising advancement of technology correlates with a substantial rise in output and investment throughout businesses, leading to an ensuing spike in emissions and environmental harm (W. Ali et al., 2016; Allard et al., 2018; Jin et al., 2017).

Al-Mulali et al. (2015) in his research indicates that trade openness leads to a decrease in pollution, specifically a reduction in CO₂ emissions. His research states that initiatives and trade-related policies have effectively reduced environmental pollution caused by trade. The results align with Shahbaz et al. (2013) which asserted that the expansion of economic activity and increased consumption led to an increase in CO₂ emissions. However, studies that examining other countries had conflicting results, indicating that international trade requires the shipment of finished and semi-finished commodities, is associated with increased pollution levels as found by Kasman & Duman (2015) who concludes that an increase in trade is associated with a rise in per capita emissions. Similar findings were also found by Afesorbor & Demena (2022) and Wang et al. (2022).

1.2 Research Objective

This study was conducted to explore the impacts of economic freedom by utilizing three variables that represent economic freedom according to the Fraser Institute consisting of government size, legal system and property rights and sound money on environmental performance using per capita greenhouse gas (GHG) emissions in countries that are considered large emitters, especially in the Climate Change Performance Index (CCPI) categorized as OECD and non-OECD member countries. As a support for the research, this study also utilizes a series of control variables identified as factors that can affect a country's emission levels consisting of GDP per capita, urbanization, technology, and trade.

To the best of the author's knowledge, most research on economic freedom primarily rely on the overall economic freedom index. In turn, most studies may not provide particular insights into which measures of economic freedom directly impact a country's emissions. Utilizing economic freedom indicators may provide a more comprehensive examination of how each indicator contributes to environmental performance. Most studies tend to concentrate on a single group of countries, which limits the potential for comparison and analysis. By dividing countries into two groups, specifically OECD and non-OECD, we may evaluate how each economic freedom indicator impacts environmental

performance based on the distinct characteristics that define the economic freedom of each group. This study in particular offers one of its advantages.

Steinberger & Roberts (2010) found that industrialized countries consume and emit excess energy and CO₂ per capita in order to sustain their high quality of life. Hence, they contend that genuine social and environmental advancement can only be attained with substantial reductions in consumption and emissions by developed nations. Many OECD member countries have high incomes based on World Bank classifications. Therefore, this research is specifically centered on OECD members as the study's emphasis. For comparison purposes, the study also includes non-OECD countries that are recognized as large contributors to global emissions as published in the Climate Change Performance Index.

1.3 Research Question

1. How does economic freedom affect greenhouse gas (GHG) Emissions of OECD Countries?
2. How does economic freedom affect greenhouse gas (GHG) Emissions of non-OECD Countries?
3. Are there differences in the effect of economic freedom on greenhouse gas (GHG) emissions between OECD and non-OECD countries?
4. What is the role of control variables; GDP per capita, Urbanization, Technology, and Trade in influencing greenhouse gas (GHG) emissions in OECD countries?
5. What is the role of control variables; GDP per capita, Urbanization, Technology, and Trade in influencing greenhouse gas (GHG) emissions in non-OECD countries?

1.4 Research Hypothesis

H1: Government size significantly impacts GHG emissions

H2: Legal system and property rights significantly impact GHG emissions

H3: Sound money significantly impacts GHG emissions

1.5 Research Significance

Academic Contribution

This study examines the influence of economic freedom on greenhouse gas (GHG) emissions and analyzes the link between socio-economic factors and environmental performance. This research contributes to the academic literature by presenting novel and

pertinent data that enhance the understanding of the correlation between economic freedom and climate change. This project aims to establish a solid basis for future research endeavors that explore the intricate connections between economic and environmental problems. It is expected to provide a model that can be utilized by academics to investigate the interaction of the examined variables on various observations from diverse countries.

Policy and Practice Contribution

This research is expected to provide valuable insight for policymakers by presenting empirical evidence derived from this study that might be considered in formulating policies related to mitigating GHG emissions. By looking at the results of this data-based empirical study, it is anticipated that it can assist policymakers to maintain or modify existing policies related to effective and efficient strategies to mitigate the adverse effects of climate change.

1.6 Research Outline

The writing of this paper is based on a systematic arrangement consisting of several chapters as follows:

Chapter I: Introduction

The introduction contains the research background, research objective, research questions, research hypothesis, research significance and research outline.

Chapter II: Literature Review

The literature review provides an overview of the conceptual framework which includes the theoretical background that discusses each variable utilized in the study, in-depth reviews of relevant previous research.

Chapter III: Methodology

The methodology chapter provides an explanation of the research design, operational definitions of each variable, techniques in collecting data to observe and address research questions, and methods utilized for data analysis.

Chapter IV: Results and Discussion

The findings and their interpretation are presented in this chapter, how the influence of the variables used will be explained while answering the research questions and evaluating the research hypotheses.

Chapter V: Closing

This chapter is a closing that contains conclusions from the research findings, policy implications that may be offered and research limitations.

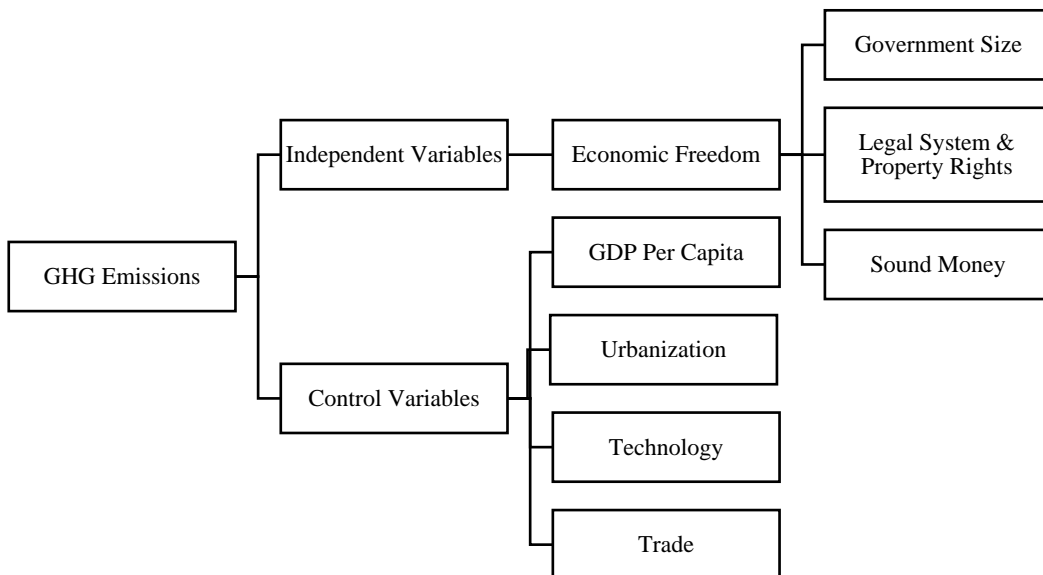
CHAPTER II

LITERATURE REVIEW

2.1 Conceptual Framework

This literature review contains a theoretical framework that examines each variable used and discusses relevant previous research that examines how economic freedom correlates with environmental performance. The factors examined in this study focus on GHG emissions per capita and economic freedom proxied by three core variables; government size, legal system and property rights, and sound money. To strengthen the result analysis, this study also utilizes supporting variables in the form of control variables consisting of GDP per capita and GDP squared to analyze the non-linear relationship between economic growth and emissions, urbanization, technology, and trade. presented in the following conceptual framework.

Figure 2. 1 Conceptual Framework



Source: Author's Compilation

2.2 Teoritical Background

2.2.1 Greenhouse Gas Emissions

Greenhouse gas emissions refer to a group of gases that collect in the Earth's atmosphere and are the cause of global warming and climate change. GHG emissions consist of several gases such as carbon dioxide, methane, nitrous oxide, and other smaller gases including hydrofluorocarbons and sulfur hexafluoride. Greenhouse gas emissions come from several sectors including the energy sector, manufacturing, transportation,

agriculture, waste, housing sector, industrial sector, and other sources. During many operations such as the burning of fossil fuels in the production of cement, steel, or plastics, as well as cultivating food, all of these processes emit gases and are subsequently released into the atmosphere. These gases become a layer that captures and maintains the sun's heat to regulate the earth's thermal temperature and keep it warm (Ritchie et al., 2023).

Carbon dioxide emissions are generated from a variety of fuels consisting of coal, oil, gas combustion, and cement manufacturing, due to the prevalence of solid fuels in energy production and industrialization. Coal-fired power plants were introduced in the 18th century in North America. Subsequently, in the late 19th century, there was a significant increase in the release of pollutants resulting from the extraction and utilization of oil and gas. Based on energy data, the origins of CO₂ emissions from fossil fuels may be traced back to 1751 in historical records. This reconstruction encompasses the production volumes of many fossil fuels, including coal, crude oil, lignite, and peat. These amounts may be utilized to prospectively examine the progression of CO₂ emissions across time. Carbon dioxide emissions are widely acknowledged as the primary catalyst for global climate change on a worldwide scale. Therefore, in order to mitigate the worst effects of climate change, it is imperative to take collective action at an international level to decrease emissions (Ritchie et al., 2020a).

Methane emissions originate from agricultural practices such as the cultivation of rice, which leads to soaked rice fields and subsequent methane emissions from the methanogenesis process. Furthermore, methane emissions arise from animal operations, including from cows, goats, and sheep, through enteric fermentation processes. Another instance arises in waste management, where the breakdown of organic waste in landfills may generate methane via a sequence of biological events. While methane gas does not contribute as significantly as carbon dioxide to the generation of greenhouse gas emissions, it possesses a higher warming potential than CO₂, making it a more potent greenhouse gas. When methane is compared to CO₂, it is shown that one ton of methane will cause 28 times greater heat than one ton of CO₂ over a span of 100 years (Huang et al., 2013).

A significant portion of nitrous oxide (N₂O) emissions originate from agricultural activities, particularly the application of nitrogen fertilizers to the soil. This leads to a significant abundance of nitrogen available for bacteria to convert into nitrous oxide. This form of emission is also generated during the same procedure when utilizing organic fertilizers derived from waste from animals. Nitrous oxide, similar to methane, is a greenhouse gas that has a greater effect on warming potential compared to CO₂. It is

estimated that one ton of nitrous oxide over a span of 100 years produces 265 times more warmth than one ton of carbon dioxide (Huang et al., 2013).

2.2.2 Economic Freedom

Economic freedom is defined as the ability of an entity, including individuals, corporations, or government agencies to take actions and decisions without restrictions, prohibitions, or force from other parties, such as from government agencies (Sakariyahu et al., 2023). Economic freedom is often associated with its influence on economic growth, this is due to the fact that when a country's economy is more free, it provides more prospects and opportunities for its citizens to engage in entrepreneurial endeavors, without strict interventions from the government (Brkić et al., 2020). Hence, countries with a high degree of economic freedom have a safer and steady economic expansion. The economy is freer when it gives capital and resources entirely to the market based on the demand and preferences that occur within it. Economic freedom is also linked with fiscal and monetary policies that are more flexible to changes and economic cycles within a country (Prados de la Escosura, 2016).

The fundamental principles related to economic freedom have been reviewed by several observers, such as the Fraser Institute which has presented a comprehensive framework related to economic freedom which includes protecting individuals and property from criminal activities, emphasizing personal choice, allowing entities to enter and compete in the market, and supporting and facilitating voluntary exchanges that have been regulated within the market. Economic freedom that is reflected for individuals can be seen from the protection of property rights legally without the interference of other parties to seize it through violence, fraud, or theft. Additionally, individuals are also free to utilize, exchange, or give away their property as long as this behavior does not harm and interfere with the rights of other parties. Economic freedom encompasses personal choice, including the freedom to collaborate, exchange ideas with others in a legal manner, and compete in the marketplace with creativity according to their preferences (Fraser Institute, 2023).

The Fraser Institute is an independent entity focused on research and education originating from Canada, this institute has published the World Economic Freedom Index which has been recognized and widely used by researchers around the world. The index is built on five main areas consisting of 1) Government size; 2) Legal system and property rights; 3) Sound money; 4) International trade freedom; and 5) Regulation. These five areas consist of various components and sub-components. The data used to construct each

component in each indicator is sourced from third-party organizations, including the International Country Risk Guide, the World Bank's Doing Business Project, and the Global Competitiveness Report. The range for each component is from 0 to 10. In the case of components with sub-components, the ratings of each sub-component are averaged to determine the rating of the main component. These component ratings are then averaged to calculate the score and rating for each of the five areas in this index. Finally, the ratings of these five areas are averaged to obtain a summarized rating for each country.

Out of these five areas, three areas (1, 2, and 3) are selected as indicators of economic freedom variables in the study. Instead of using the overall economic freedom index, these variables are used to represent economic freedom. This approach allows for a more in-depth exploration of the impact of each variable, which reflects economic freedom, on environmental performance, specifically GHG emissions per capita. The detailed explanation for each of the three variables is as follows:

2.2.2.1 Government Size

This field consists of five components which are:

- 1) Government consumption
- 2) Transfers and subsidies
- 3) Government enterprises and investments
- 4) Highest marginal tax rate
 - a) Highest marginal income tax rate
 - b) Highest marginal income and payroll tax rates
- 5) State ownership of assets

This metric shows the degree of a country's dependence on the political process in allocating resources for goods and services. When government consumption, transfers and subsidies account for a larger share, individual choice might be replaced by political choice. The highest marginal tax rate component, which consists of the highest marginal income tax rate and the highest marginal income and payroll tax rate. These two components are averaged to get the highest marginal tax rate. High marginal tax rates imposed on relatively low incomes represent a country's dependence on its government, so that individual freedom in allocating income is reduced and economic freedom is relatively low.

Components 3 and 5; State enterprises and investment and State ownership of assets describe the extent to which resources are allocated by private investment and enterprise compared to investment by government enterprises. State-owned companies

frequently have different rules by not relying on consumers and investors for profits and capital, but rather through protected market operations. If the proportion is larger, individual economic freedom is reduced as state-owned enterprises produce more output.

Thus, the assessment is derived from the degree to which individuals in a country have the freedom to exercise their choices, with a strong emphasis on the significance of market functioning in comparison to government involvement or political policies. The high index value of this indicator indicates a higher level of freedom in a nation, which is characterized by lower government expenditure, lower tax rates, and reduced government ownership of assets or investments.

2.2.2.2. Legal System and Property Rights

Within this area, there are multiple constituent elements that form its foundation, including:

- 1) Judicial independence
- 2) Impartial courts
- 3) Protection of property rights
- 4) Military interference in the rule of law and politics
- 5) Integrity of the legal system
- 6) Enforcement of contracts
- 7) Regulatory costs of selling real property
- 8) Reliability of the police
- 9) Business costs of crime
- 10) Gender Disparity Adjustment

One of the most important functions of government is to protect individuals and their property, which is part of their rights as citizens. The 10 components in this area therefore indicate the extent to which the effectiveness of the government's protection function has been carried out to support economic freedom for individuals. It is based on the security and protection of property rights that enables markets to operate more efficiently. When the strength of property rights and individual ownership diminishes, it would compromise individuals' capacity to engage in market transactions. Inadequate safeguarding of property rights and an ineffective legal system will diminish trust in contract enforcement and the protection of the results of productive efforts, consequently diminishing the motivation of market participants to engage in productive work.

The principle implied by the rule of law is the affirmation that every entity, whether it be an individual, institution, or government, is subject to the same legal framework. This would establish a robust legal guarantee for the realm of investment and business which may significantly bolster the confidence of investors and business professionals in making persistent investments and enhancing their operations (Asandului et al., 2015). The establishment of an independent and impartial legal system is crucial in a country to prevent preferential treatment by an entity for political or other interests that may harm other parties. This aspect assures the community that any violations that occur, including property rights violations, will be handled and prosecuted with applicable laws and regulations fairly regardless of socioeconomic standing.

2.2.2.3 Sound Money

This area consists of several components including:

- 1) Money growth
- 2) Standard deviation of inflation
- 3) Last year's inflation
- 4) Freedom to hold foreign currency bank accounts

This indicator emphasizes the importance of money and the maintenance of stable prices in the exchange of goods and services. A widely held belief is that a stable monetary environment is essential for maintaining profitability in trade. However, when there is an excessive amount of money in circulation compared to the available goods, it leads to inflation, which is a significant increase in prices. Stable money refers to currency that exhibits minimal fluctuations and maintains consistent purchasing power throughout time. Ensuring a stable currency will result in a decrease in transaction expenses, leading to improved efficiency in the exchange of goods and services. While high inflation rates can disrupt the relative prices of goods and make it challenging for individuals to effectively plan for future business and financial opportunities. Thus, the level of circulation and inflation significantly affects individuals' economic freedom as inflation can devalue monetary assets and property.

The highlight also placed on ensuring convenient availability of reliable currency for all individuals, along with the simplicity of utilizing alternative forms of money. The accessibility to trustworthy and credible currency will be enhanced by facilitating the ownership of foreign currencies through banking services such as savings and deposits. Consequently, this will indirectly contribute to an increase in individual economic freedom.

A country that implements effective measures to maintain low and steady inflation, while also avoiding excessively stringent regulations on the use of alternative currencies, would get a higher rating and performance in terms of economic freedom in this area. The purpose of evaluation in this domain is to appraise the degree of a nation's fiscal well-being and its stability. Hence, a stable currency plays a crucial role in strengthening a favorable economic environment and promoting economic freedom within a nation (Gwartney et al., 2021).

Economic methods focused on enhancing economic growth are frequently perceived as conflicting with the preservation of the environment and its connection to climate change. However, proponents argue that economic freedom may also bolster environmental sustainability by fostering innovation and encouraging investment in eco-friendly technology that optimizes the utilization of natural resources (Carlsson & Lundström, 2001).

According to Shahnazi & Dehghan Shabani (2021), there exists a theory that elucidates the correlation between economic freedom and environmental quality. This theory may be categorized into six distinct domains. The following concepts are: 1) Efficiency, 2) Stability, 3) Moderation, 4) Market failure, 5) Scale, and 6) Impact of trade restrictions.

- 1) From an efficiency standpoint, economic freedom is believed to generate greater energy efficiency, promote higher relative prices, foster improved environmental rules and regulations, and enhance the emphasis on reducing CO2 emissions as a worldwide public benefit. It may be inferred that nations with a high level of economic freedom demonstrate a higher degree of energy efficiency.
- 2) Stability impact, it is well acknowledged that a rise in economic freedom has tendency to enhance the stability of environmental investments due to two significant factors. Firstly, in nations characterized by a low degree of economic freedom, government policies tend to exhibit greater volatility in comparison to countries with a higher degree of economic freedom. Consequently, these policy fluctuations can lead to instability in financial markets as investors lack confidence in the newly implemented policy direction. Furthermore, countries with greater levels of economic freedom frequently have a corresponding high degree of political stability. Therefore, a stable political climate may offer assurance to investors and mitigate the risks linked to political volatility that could impact

environmental investments. Economic freedom not only fosters economic progress, but also enhances the durability of environmental investment.

- 3) Moderating effect, by promoting competition in the business sector, leading to a wider range of environmentally friendly products for consumers to choose from.
- 4) Market Failure Effect, suggests that market inefficiencies can arise from factors such as externalities or monopolies, resulting in market failures. It is commonly believed that while economic freedom and market development can stimulate economic growth, they can also lead to market failures. For instance, excessive deregulation can result in a lack of oversight and control over business practices, which ultimately harms consumers and the environment. Government involvement remains necessary to maintain equilibrium in market conditions through the implementation of regulations, fiscal policy, monetary policy, subsidies, and the provision of public goods and services.
- 5) Scale Effect and, 6) Effect of Trade Regulation, economic freedom promotes trade freedom and higher production levels, which might potentially lead to increased Co2 emissions in a nation (Datta-Chaudhuri, 1990).

2.2.3 Gross Domestic Product Per Capita

Scholars have shown significant interest in researching the correlation between per capita income and its influence on the environment. There are two distinct collections of literature that discuss the relationship between economic expansion and environmental damage. The first study on the relationship between income and the environment highlights the influence of social income on energy use. Economic growth that characterized by increasing levels of income, generally leads to greater energy consumption. The link between income and energy usage is complex and can have a mutually impactful effect on each other. The second literature explores the complex relationship between economic growth and environmental degradation commonly referred to as the Environmental Kuznets Curve (EKC) theory. This hypothesis developed as the extension of the Kuznets theory by Simon Kuznets in 1955 which examines the relationship between economic growth and inequality. His theory said that economic inequality will continue to increase alongside the increase in income per capita, However, it will start to decline after reaching a certain threshold as income increases.

2.2.4 Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve (EKC) hypothesis explains that the phenomenon of increasing environmental degradation is explained by an increase in

pollution along with economic growth until a particular threshold is reached. Subsequently, the level of pollution decreases due to certain factors such as increased awareness of the importance of protecting the environment, stricter enforcement of environmental regulations, and changes in consumption patterns along with an increase in income. Thus, the EKC hypothesis posits that problems arising in the environment caused by economic growth proxied by per capita income can be minimized in the future. The implications of the EKC hypothesis may provide different reactions and policies across countries in their efforts to promote a globally sustainable economy. Underdeveloped countries are often seen as a source of environmental damage. One of the underlying reasons is the relocation of industries that threaten environmental well-being from developed countries to developing countries because of the lack of strict regulations related to environmental maintenance in developing countries (Khan et al., 2019).

Carlsson & Lundström (2001) provide two perspectives on EKC theory. The first is the idea of how EKC analyzes structural transformations that occur in the economy. This assumption posits that during a country's era of economic expansion, there would be a shift from an agriculture-based economy to an industry-based economy. Consequently, there will be a rise in the exploitation of natural resources, leading to high emissions and environmental degradation. As a country progresses, its industrial sector tends to shift towards a service-based economy. This transition reduces the strain on the environment because a service-based economy relies less on natural resources and is more inclined to utilize environmentally friendly alternatives.

The second assumption posits that the EKC theory emphasizes the impact of income level on the environment, viewing the environment as a luxury product. When individuals have a low income, they often allocate their money towards meeting essential necessities for survival, such as clothes, housing, and food. As individuals see a gain in their money, their focus and inclinations shift towards prioritizing health and quality of life, which includes the upkeep of a hygienic and wholesome environment. Consequently, this will promote a shift in societal attention towards ecologically sustainable products, investments, and regulations.

2.2.5 Urbanization

Urbanization is a process of modernization that occurs in both the economic and social aspects of society. This phenomenon encompasses not only the migration of agricultural-based rural people to the industrial and service sectors in metropolitan regions but also a process of structural change from rural areas to urban areas. The process of global

urbanization has experienced significant and rapid growth in the past decade, with projections indicating that the urban population will reach 6.4 billion by 2050. During this era of transition, there will be a need for improved and advanced urban infrastructure, which will result in increased resource consumption and severe environmental consequences. The observation of this pattern has sparked extensive discussions on the correlation between urbanization and emissions (Poumanyong & Kaneko, 2010).

There are three theories that explain the effects of urbanization on the environment:

1) The Ecological modernization theory, 2) The urban environmental transition theory, and 3) The compact city theory (Burton, 2000) in (Shahnazi & Dehghan Shabani, 2021).

- 1) Ecological modernization theory, environmental problems are likely to arise as a society moves from a low level of development to a medium level of development, with a strong emphasis on economic expansion rather than environmental concerns. Nevertheless, this theory states that future modernization will lead to a decrease in environmental harm due to the growing societal awareness of environmental issues, technological advancements, and the shift towards a service-based economy that generates fewer emissions compared to the industrial sector.
- 2) Urban environmental transition theory, when cities experience economic growth and shift towards a manufacturing-based economy, there will be a corresponding increase in pollution levels inside urban areas. Over time, air pollution will decrease in more developed cities due to their adoption of cleaner technology, implementation of sustainability policies, improved environmental laws, and innovation in green technology. These changes may also involve structural adjustments in the economy.
- 3) The compact city idea highlights the beneficial effects of urbanization. When a city experiences a high rate of population growth, it necessitates the enhancement of public facilities, such as improving energy efficiency through the promotion of public transportation. This can lead to a decrease in per capita CO₂ emissions by reducing reliance on personal vehicles and increasing the utilization of public transportation.

2.2.6 Technological Development

Literature extensively explores the correlation between enhancing efficiency to decrease emission levels and the integration of technological advancements that align with environmentally sustainable practices. This includes innovations in renewable energy that can help reduce reliance on fossil fuels (Doğan et al., 2022). The advancement of

technology and its efficient progress typically comes from strong governmental assistance and the implementation of laws that promote research and development. This includes providing financial incentives to individuals and corporations who successfully embrace environmentally friendly technology. In addition, the government actively engages in international collaboration on global environmental agreements, including the widely adopted Paris Agreement. Likewise, the government promotes and facilitates investment in technology that promotes environmental sustainability.

Crenshaw & Jenkins (1996) in his study discusses about technology and the environment, criticism has been raised regarding greenhouse gas (GHG) emissions. It is said that GHG emissions often increase in nations with low population growth, suggesting that the level of emissions is not solely driven by the size of a country's population. Critics argue that rapid country growth leads to the development of a large-scale economic system and economic incentives due to production and investment shocks. This is referred to as a "production treadmill" and is believed to result in increased consumption. However, continuous technological advancements only have a limited effect in reducing environmental impacts. Despite the existence of superior technologies that decrease the environmental effect per unit of product, the overall emissions remain elevated as a result of heightened production and consumption (Buttel et al., 1994). The second objection emphasizes that the primary causes of rising greenhouse gas (GHG) emissions are industrial technology and the growing use of fossil fuels, rather than a country's population or capitalist growth.

2.2.7 International Trade

Discussion on the environmental effects of trade have continually provoked strong debates including economic and political considerations. Antweiler et al. (2001) propose a reliable approach that demonstrates how increased trade openness can improve environmental quality. They emphasize the positive effects of trade on income and argue that trade has a beneficial impact on the environment by stimulating demand for environmentally friendly products as income levels rise.

Environmentalists and economists contend that heightened business activity can exacerbate environmental harm by promoting the excessive manufacturing and consumption of things that are high in pollution. The correlation between how trade affects emissions was popularized by Grossman and Krueger in 1991. The study was conducted as an evaluation of the ecological consequences of the North American Free Trade Agreement (NAFTA). The results revealed that the relationship between the two variables

was complex. Three components were proposed as a general equilibrium model, consisting of: 1) scale effects; 2) technique effects; and 3) composition effects. Copeland et al. (2004) has utilized this model to examine the relationship between trade and the environment including both internal and external factors.

- 1) The scale effect is responsible for the rise in emissions due to higher economic production. This effect explains that when there is an increase in output resulting from heightened production levels, it implies an increase in the utilization of natural resources and energy, hence potentially causing harm to the environment by producing greater emissions. Countries involved in international trade frequently have massive production capacities to meet high global demand, if not balanced with effective environmental policies, this could adversely affect the environment by increasing the resulting emissions. As a common belief, countries with high levels of trade and tend to be less developed frequently have inadequate policies and regulations related to environmental maintenance. This is a result of the need to meet the demand for commodities in the market at competitive prices, minimize production costs, and fear of losing competitiveness in the global market when raising too stringent environmental policy standards. Thus, frequently sound environmental standards are disregarded.
- 2) The technical effect explains the positive influence of international trade on the environment. This idea presents that wider international trade might positively influence the environment by reducing emission levels. This phenomenon can occur in two scenarios as explained by Grossman and Krueger (1991). First, the increase in trade commodities is accompanied by environmentally friendly technology. Competitiveness in the global market can encourage companies to sell or produce ecologically sustainable goods, giving them an advantage over their competitors. This manufacturing method will result in the utilization of eco-friendly technology that is more effective in terms of resources and energy use which has a significant impact on reducing emissions. Second, more open international trade will provide wider access for consumers to non-domestic product offerings that may be produced with more stringent environmental standards that may not be found in their own country.
- 3) The composition effect refers to the fluctuations in the sectoral composition of a nation's economy, which can change over time. A nation may see accelerated and extensive growth of environmentally harmful sectors, resulting in a detrimental

impact on the ecosystem through the amplification of overall emissions. Reducing the size of these industries will result in a drop in emissions. If sectors that are more environmentally conscious and have embraced renewable energy sources or employ clean energy technologies had an accelerated growth, there will be a reduction in overall emissions. The effect is significantly impacted by how the compositions and alterations in a nation's economic structure affects levels of emissions.

2.3 Previous Research

2.3.1 Economic Freedom on Environmental Performance

In his research, J. Rapsikevicius et al. (2022) discovered that through various ways the economic freedom of a country may affect its environmental conditions. In a country with high international trade freedom, the government often incentivizes businesses to invest in environmentally friendly technologies, especially for companies that focus on energy innovation. This leads to widespread competition in the manufacturing of eco-friendly commodities and gradually lowers the cost of clean energy, ultimately enhancing long-term environmental standards. The government also has the authority to regulate market security through economic policies that encourage the use of green energy, including imposing high environmental tariffs on companies or industries that have a major role and impact on climate change.

Setyadharma et al. (2021) conducted a study that focused on the effect of economic freedom on the environment in 7 ASEAN member countries from 2011 to 2017 using panel data regression. The results show that countries with higher levels of economic freedom tend to have much better ecosystems and environment compared to countries with authoritarian regimes. Adesina & Mwamba (2019) have completed a study examining the effect of economic freedom on CO₂ emissions in African countries from 1995-2013. They utilized dynamic regression using several variables such as the business freedom index, fiscal freedom index, freedom of trade, and freedom from corruption index. The results showed an engaging relationship between economic freedom and emissions. Thus, countries with more economic freedom tend to have lower CO₂ emissions.

The contrary research findings were found by Alola, Alola, et al. (2022), uses several indicators of economic freedom published by the Fraser Institute, one of which is the protection of law and property rights in the G20 countries in 2000-2016. The findings show that the protection of law and property rights has the potential to harm the

environment by amplifying its positive effect on the ecological footprint of the economy. The conclusion highlights that the higher the protection of property rights and the better the legal system can disrupt the efficiency and environmental resilience in the countries examined.

Khaliq & Mamkhezri (2023) investigated the correlation between economic complexity and economic freedom on ecological quality in four South Asian countries from 1995-2019. The results of his research highlighted that both in the long and short term, high economic freedom has implications for high CO₂ emissions. The Authors demonstrated that higher economic levels encourage excessive resource utilization and higher productivity that damage the environment. This finding is supported by Carlsson & Lundström (2001) who said that a more free economy tends to increase CO₂ emissions. This conclusion was drawn from their investigation of the emissions patterns of both poor and high-income nations. Sakariyahu et al. (2023) analyzed data from the Fraser Institute and the World Bank Database for 31 African countries between 2000 and 2018. The results show a large adverse impact of technical innovation and economic freedom on environmental quality indicators. Their study shows that greater economic freedom can have a detrimental impact on environmental quality, particularly when it is not accompanied by effective governance.

2.3.2 GDP per capita and EKC on Environmental Performance

Awan & Azam (2022) have conducted a rigorous examination of the EKC theory's validity, specifically focusing on five G20 countries spanning the years 1993 to 2017. Their findings confirm and support the EKC hypothesis. The analysis encompasses the correlation between GDP per capita, CO₂ emissions, technological advancement, economic expansion, energy usage, and social globalization. The findings indicate that there is a direct correlation between economic growth, namely an initial rise in GDP per capita and the ongoing increase in CO₂ emissions. However, the reduction in CO₂ emissions occurs gradually until the GDP per capita hits a specific threshold. They attributed this to heightened health consciousness, advancements in clean technology, improved infrastructure, and their consequential effect on air quality.

An investigation undertaken by Kasman & Duman (2015) has provided further evidence supporting the Environmental Kuznets Curve (EKC) idea. The research demonstrates a correlation between economic growth and environmental harm that follows an inverse U-pattern. A separate research conducted an analysis on the influence of different forms of renewable energy on carbon dioxide emissions in European nations from

2000 to 2018. This analysis took into account several aspects, including GDP per capita and other control variables. The findings validated the presence of the Environmental Kuznets Curve (EKC) hypothesis (Wang et al., 2022). Additional research supports this discovery, including the studies conducted Khan et al. (2019) and Li & Xu (2021) which both indicated that greater income leads to an increase in environmental harm.

Research by Lacheheb et al. (2020) has demonstrated the relationship between income and CO₂ emissions in Algeria throughout the period from 1971 to 2009. This connection was generated from several sources, including the use of solid fuel, liquid fuels, and the generation of electricity and heat. The ARDL testing method was employed in this study. The findings indicated the absence of any evidence supporting the existence of the EKC hypothesis in the nation under observation. Indicating that there is no direct causation between GDP per capita and carbon dioxide emissions.

2.3.3 Urbanization on Environmental Performance

Multiple studies have demonstrated the influence of urbanization on the quality of the environment. The study done by Effiong (2018) examined the environmental effects of urbanization in African nations between 1990 and 2010, utilizing the STIRPAT framework. The findings of his study indicate that as urbanization increases, there will be a decrease in environmental deterioration by lowering the levels of environmental pollutants, including carbon emissions and particulate matter (PM₁₀) in the surrounding air. Sadorsky (2014) has also examined further study findings that demonstrate a positive correlation between urbanization and emissions.

The study carried out by Poumanyong & Kaneko (2010) investigated the influence of urbanization on the environment by analyzing energy consumption. The study utilized the STIRPAT model and evaluated data from 99 nations, categorizing them into several categories. The study covered the time period from 1975 to 2005. The results reflect variation, as urbanization might lead to a decrease in energy consumption in nations with low income levels, but it tends to increase energy consumption in countries with moderate and high income levels. Meanwhile, his study findings indicate that CO₂ emissions remain consistent across all income levels, meaning that urbanization might lead to an increase in CO₂ emissions.

Nevertheless, there are other research findings that demonstrate non-linear outcomes. Z. Ahmed et al. (2019) study examined the non-linear correlation between urbanization and Indonesia's CO₂ emissions from 1971 to 2014. The findings of this study

indicate a curvilinear relationship between urbanization and emissions, characterized by an initial increase in CO₂ emissions during the early stages of urbanization, followed by a subsequent decline in emissions after reaching a certain level of urban development. Additional study findings indicate a negative correlation between urbanization and emissions, as demonstrated by S. S. Sharma (2011).

2.3.4 Technological Development on Environmental Performance

Sakariyahu et al. (2023) in his study examines the impact of technical innovation on the ecological footprint. The results show that technological innovation has a positive impact on environmental quality by mitigating harm to the environment. Consistent with the results of A. Ahmed et al. (2016) which examined technological innovation in 24 European countries for the period 1980-2010. The results show that the increasing number of patents representing technological innovation affects the decrease in CO₂ emissions. In other words, this factor contributes positively to environmental performance in the countries examined.

The findings of a study by Balsalobre et al. (2015) on the correlation between per capita greenhouse gas emissions and technological progress have been confirmed in OECD countries. The findings show that investment in research and development has the potential to reduce a country's GHG emissions. Another study has been conducted by W. Ali et al. (2016) using ARDL which examines technical progress and its effect on emissions in Malaysia from 1985 to 2012. The findings confirm that technological progress has an adverse impact on air pollution.

The opposite results were found in the research of Allard et al. (2018), they found that in the 74 countries analyzed, technological improvements had a bad impact on environmental quality as evidenced by the higher number of CO₂ emissions generated due to more advanced technology. This finding was also confirmed by Yao et al. (2020) who examined human capital with technological advancement as a control variable, the results showed that technological progress has the potential to damage the human environment by exacerbating the amount of carbon dioxide emissions. Similar findings were also revealed by Awan & Azam (2022) in G-20 countries which said that there was a positive relationship between technological progress and carbon dioxide emissions.

2.3.5 International Trade on Environmental Performance

Van Bergeijk (1991) as quoted in Afesorgbor & Demena (2022), elucidated the impact of a nation's participation in global commerce on its environment, particularly in

relation to its emission patterns. Al-Mulali et al. (2015), Managi et al. (2009), Shahbaz et al. (2013) have also discovered empirical evidence. Varied outcomes in observations have been discovered, leading to a lack of conclusive and uniform conclusions in this matter. Nevertheless, the observations validate that the deterioration of the environment, particularly shown by carbon dioxide, may be attributed to the expansion of commercial activities and represents a significant worldwide concern.

A meta-analysis of 88 empirical papers has been conducted by Afesorgbor & Demena (2022). The study was conducted to examine the negative impact of trade which is environmental damage by increasing environmental emissions. The results of the study varied showing the uncertainty of the effect of trade on environmental emissions due to the varied literature. After reviewing more deeply and considering heterogeneity, the results show that the effect of trade on CO₂ emissions is higher and significant than on sulfur dioxide (SO₂). Trade emissions are said to be more in industrialized developed countries compared to developing countries. Wang et al. (2022) also verifies that free trade has a robust and significant relationship in increasing CO₂ emissions. According to this research, the European Union's status as a free trade zone favors the unrestricted movement of products and services, increasing the possibility of this happening.

Other empirical evidence is provided by Kasman & Duman (2015) who studied the relationship between trade freedom and carbon emissions in 1992-2010 in European Union member countries. The research resulted in a short-term and one-way relationship between trade freedom, urbanization, and energy use on carbon emissions. The opposite result was found by Shahbaz et al. (2013) which revealed that in the case study of Indonesia in 1975-2011, the more open trade resulted in a decrease in CO₂ emissions. In line with Al-Mulali et al. (2015) research which said that the wider and more open trade has the potential to improve the environmental ecosystem, one of which is through reducing CO₂ emissions.

CHAPTER III

METHODOLOGY

3.1 Research Design

This research has been conducted using a quantitative approach to examine the influence exerted by economic freedom as measured by three variables including government size, legal system and property rights and sound money on per capita GHG emissions. The study incorporates various control variables to ensure the reliability and validity of the findings. A series of control variables are employed in this study to further investigate the factors that influence GHG emissions. These variables include GDP per capita, urbanization, technology, and trade. The study observed countries recognized as having high global emissions based on the Climate Change Performance Index, taking into account the availability of data, the number of countries used was 36 countries classified into OECD and non-OECD countries, while the research period spanned 11 years from 2010-2020.

Table 3. 1 Country Classification

OECD		Non-OECD
Australia	Korea, Rep.	Argentina
Austria	Luxembourg	Brazil
Belgium	Netherlands	Bulgaria
Canada	Norway	China
Czechia	Portugal	Croatia
Denmark	Poland	India
Estonia	Slovak Republic	Indonesia
Finland	Spain	Iran
France	Sweden	Malaysia
Germany	Switzerland	Morocco
Greece	Turkiye	
Italy	United States	
Japan	United Kingdom	

Author's Compilation

3.2 Data Collection Method

This study incorporates secondary data, which refers to the data that has been collected by third parties and comes from various sources. Utilizing secondary data might provide advantages for researchers due to the systematic collection and validation by several qualified institutions with extensive resources. These sources may originate from government agencies, research organizations, think tanks, scientific journals, or reputable online repositories. This study employs relevant and credible data sources in

comprehensive data collection to ensure the accuracy, completeness and reliability of the information that has been obtained.

The secondary data collected for this study comprises literature citations, relevant journals, official websites from reputable world organizations such as the Organization for Economic Co-operation and Development (OECD), World Bank, International Energy Agency (IEA), Climate Change Performance Index (CCPI), Fraser Institute, etc.

Table 3. 2 Data and Corresponding Sources

Variables	Measurement	Sources
Dependent Variable		
GHG Emissions	Per Capita GHG Emissions (tonnes of carbon dioxide-equivalents)	Our World in Data
Independent Variables		
Economic Freedom Index:		
Government Size Index	0-10 (0 = Low) (10 = High)	Fraser Institute
Legal System & Property Rights Index	0-10 (0 = Low) (10 = High)	Fraser Institute
Sound Money Index	0-10 (0 = Low) (10 = High)	Fraser Institute
Control Variables		
GDP Per Capita	GDP per capita (constant 2015 US\$)	World Development Indicators
Urbanization	Urban population (% of total population)	World Development Indicators
Technology	Total Patent Applications (R&D)	World Development Indicators
Trade	Trade (% of GDP)	World Development Indicators
Author's Compilation		

This study utilizes GHG Emission Per capita as the dependent variable, measured in carbon dioxide equivalents. Carbon dioxide equivalents are a metric unit utilized to quantify emissions of greenhouse gases. Carbon dioxide equivalent (CO₂eq) is a comprehensive metric that quantifies the total emissions of all greenhouse gases responsible for global warming. The meter utilized by the United Nations Framework Convention on Climate Change (UNFCCC) and employed in official greenhouse gas reporting and target establishment by

governments and organizations is the most extensively adopted metric in the scientific literature (Lynch, 2019).

The research focuses on economic freedom as the independent variable, by following Alola, Alola, et al. (2022) as published by the Fraser Institute. The decision to select the economic freedom index published by the Fraser Institute is justified by the institute's esteemed reputation. The Fraser Institute, a Canadian think tank, is renowned globally for publishing the World Economic Freedom Index, establishing its esteemed reputation. The University of Pennsylvania's *Global Go to Think Tank Index* states that the Fraser Institute is ranked 14th out of 11,000 think tanks of the world and is recognized as a *Center of Excellence*. Additionally, the Fraser Institute's Economic Freedom Index is considered the most influential report at the 5th level among 6,618 think tanks of the world. Economic freedom index is further separated into three variables: government size index, legal system and property rights index, and sound money index.

The selection of control variables in this study was also influenced by the existing literature. Gross Domestic Product (GDP) per capita is a measure that tracks the average economic output per person in a given country or region following (Carlsson & Lundström, 2001; Sakariyahu et al., 2023). Urbanization refers to the proportion of a country's population residing in urban regions relative to the overall population, as utilized by (Z. Ahmed et al., 2019). Technology refers to the aggregate number of patent applications, encompassing both those submitted by residents and non-residents of a certain country. The total quantity of patents is utilized to assess the influence of a nation's technological advances on the environment. We adhere to the guidance of (A. Ahmed et al., 2016; Allard et al., 2018). The International trade variable in this research represents trade statistics as a percentage of GDP following (Wang et al., 2022), indicating the ratio of a country's total international commerce (exports and imports) to its total Gross Domestic Product (GDP).

3.3 Data Analysis

This study utilizes panel data, which is a blend of time-series and cross-sectional data, encompassing observations of several units across various time intervals. The data consists of information from 26 OECD and 10 non-OECD countries from 2010 to 2020, spanning 11 years of research. Gujarati (2004) defines panel data as information collected from people, businesses, states, countries, etc., over a period of time. Panel data has the benefit of providing more informative, diverse, less correlated, and efficient data by integrating time series of cross-sectional observations, resulting in more degrees of freedom. Panel data is considered better in discovering and quantifying impacts that are not discernible in

either cross-sectional or time series data alone. The study utilized a balanced panel dataset, where each cross-sectoral unit includes an equal amount of time series observations (Brooks, 2019).

3.3.1 Panel Data Regression

This study utilized panel data regression for data analysis. Panel data regression is a statistical method that merges cross-sectional and time-series data, resulting in a larger number of observations than using cross-sectional or time-series data separately (Gujarati, 2004). The panel data regression general model is represented by the equation provided by (Baltagi, 2005):

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \dots + \beta_n X_{nit} + \epsilon_{it} \quad (3.1)$$

- Y_{it} = Dependent variable
- β_0 = Intercept coefficient
- $\beta_1, \beta_2, \beta_n$ = Coefficients assigned to each independent variable.
- ϵ_{it} = error term in prediction.

The mathematical model used to analyze the impact of government size, legal system and property rights, sound money, GDP per capita, GDP², urbanization, technology, and trade on greenhouse gas (GHG) emission is as follows:

$$\ln ghg_{it} = \beta_0 + \beta_1 Govtsize_{it} + \beta_2 Legal_{it} + \beta_3 Smoney_{it} + \beta_4 \ln gdp_{it} + \beta_5 gdpsq_{it} + \beta_6 urban_{it} + \beta_7 Intech_{it} + \beta_8 trade_{it} + \epsilon_{it} \quad (3.2)$$

Where i and t denote the nation and time (year) respectively. The error term is represented by ϵ , while the parameter or coefficient to be estimated is denoted by β_i ($\beta_1 - \beta_9$). Further details on the specs are provided below. $\ln ghg$ represents the logarithm of GHG per capita emission, the variables $govtsize$, $legal$, and $Smoney$ serve as indicators of economic freedom. The variable $\ln gdp$ represents the logarithm of GDP per capita, while $gdpsq$ represents the squared form of the logarithm of GDP per capita. The variable $urban$ measures urbanization, $Intech$ represents the logarithm of technology, and $trade$ represents trade as a percentage.

Panel data regression models may be estimated using several methodologies such as the common effect model, fixed effect model, and random effect model.

3.3.1.1 Common Effect Model

This model utilizes pooled least squares estimation method to merge cross-sectional and time series data into a single entity. The model's parameters are calculated using the least squares approach or ordinary least squares (OLS). The common effect model is the most basic estimate method compared to other panel data regression model estimation strategies. The common effect model ignores variations in individual and temporal dimensions. In the common effect model, it is believed that the data behavior of each individual remains consistent throughout different time periods. Parameter estimation in the common effect model involves merging cross-sectional and time-series data as a unified entity, disregarding variations in time and individual characteristics (Widarjono, 2007).

The equation for the Common Effect Model is as follows:

$$\text{Inghg}_{it} = \beta_0 + \beta_1 \text{Govtsize}_{it} + \beta_2 \text{Legal}_{it} + \beta_3 \text{Smoney}_{it} + \beta_4 \text{Ingdp}_{it} + \beta_5 \text{gdpsq}_{it} + \beta_6 \text{urban}_{it} + \beta_7 \text{Intech}_{it} + \beta_8 \text{trade}_{it} + \epsilon_{it} \quad (3.3)$$

Where:

Inghg_{it}	= dependent variable for unit i at time t,
β_0	= The intercept
$\beta_1 - \beta_9$	= The regression coefficient of the independent variable.
Govtsize_{it}	= Government size
Legal_{it}	= Legal system and property rights
Smoney_{it}	= Sound money
Ingdp_{it}	= Logarithm of GDP per capita
gdpsq_{it}	= The squared form of Ingdp_{it}
urban_{it}	= Urbanization (%)
Intech_{it}	= Logarithm of technology
trade_{it}	= Trade (%)
i	= The individual i-th,
t	= The time t-th.
ϵ_{it}	= The error term

3.3.1.2 Fixed Effect Model

The Fixed Effect Model is a statistical technique used in panel data analysis to account for individual-specific differences, including changes in intercepts across different units and helping to control for unobserved variability. It allows for the

management of distinct qualities that remain constant throughout time but may vary among different units or entities. The model uses fixed effects to examine changes inside each unit over time and determine the relationship between independent and dependent variables within each unit, while considering unit-specific characteristics that remain constant over time. To address these disparities, one can utilize methods like dummy variables or Least Square Dummy Variables (LSDV) to accommodate. The Fixed Effect Model equation is as follows:

$$\ln gh_{it} = \alpha_i + \beta_1 Govtsize_{it} + \beta_2 Legal_{it} + \beta_3 Smoney_{it} + \beta_4 \ln gdp_{it} + \beta_5 gdpsq_{it} + \beta_6 urban_{it} + \beta_7 \ln tech_{it} + \beta_8 trade_{it} + \epsilon_{it} \quad (3.4)$$

Where:

$\ln gh_{it}$	= dependent variable for unit i at time t,
α_i	= The intercept for each cross-section unit.
$\beta_1 - \beta_9$	= The regression coefficient of the independent variable.
$Govtsize_{it}$	= Government size
$Legal_{it}$	= Legal system and property rights
$Smoney_{it}$	= Sound money
$\ln gdp_{it}$	= Logarithm of GDP per capita
$gdpsq_{it}$	= The squared form of $\ln gdp_{it}$
$urban_{it}$	= Urbanization (%)
$\ln tech_{it}$	= Logarithm of technology
$trade_{it}$	= Trade (%)
i	= The individual i-th,
t	= The time t-th.
ϵ_{it}	= The error term

3.3.1.3 Random Effect Model

The random effect model is a statistical method that incorporates error factors to account for disturbances that may occur in the interaction between time and individuals. In the random effect model, it is assumed that there are variations in intercepts among individuals. There are two residual components: general residual and individual residual. The total residual comprises both time-series and cross-sectional data, whereas the individual residual pertains to the residual of each cross-sectional unit.

The panel data regression model utilizing the random effect model technique is expressed as follows (Gujarati, 2004):

$$\ln gh_{it} = \beta_0 + \beta_1 Govtsize_{it} + \beta_2 Legal_{it} + \beta_3 Smoney_{it} + \beta_4 \ln gdp_{it} + \beta_5 gdpsq_{it} + \beta_6 urban_{it} + \beta_7 \ln tech_{it} + \beta_8 trade_{it} + u_i + \epsilon_{it} \quad (3.5)$$

Where:

$\ln gh_{it}$	= dependent variable for unit i at time t ,
β_0	= The intercept for each cross-section unit.
$\beta_1 - \beta_9$	= The regression coefficient of the independent variable.
$Govtsize_{it}$	= Government size
$Legal_{it}$	= Legal system and property rights
$Smoney_{it}$	= Sound money
$\ln gdp_{it}$	= Logarithm of GDP per capita
$gdpsq_{it}$	= The squared form of $\ln gdp$
$urban_{it}$	= Urbanization (%)
$\ln tech_{it}$	= Logarithm of technology
$trade_{it}$	= Trade (%)
i	= The individual i -th
t	= The time t -th.
u_i	= Random component that differs for each unit
ϵ_{it}	= The error term

The random effect model is often referred to as the error component model. The random effect method suggests different intercept terms for each entity that remain constant across time. It assumes that the link between explanatory and explained factors is consistent both cross-sectionally and temporally. In the random effect model, the intercept terms for each cross-sectional unit are assumed to come from a common 'global' intercept α , which is consistent across all units and time periods, along with a random variable ϵ_i that varies between cross-sectional units but remains constant over time. ϵ_i quantifies the stochastic variation from the intercept term of each entity to the overall intercept term α (Brooks, 2019).

The random effect model is suitable when entities in the sample are randomly picked from the population, whereas the fixed effect model is more suited when the sample entities properly reflect the complete population. In the Random Effect Model, individual random effects (α_i) are assumed to adhere to a normal distribution. The random effects are calculated in conjunction with other model parameters. By including random effects, unobserved unique unit features that might impact the dependent variable can be accounted for.

The Random Effect Model is appropriate when there is considered random and uncorrelated unobserved heterogeneity among units with the independent variables. It offers estimates of the average impact of the independent factors on the dependent variable, considering the heterogeneity among various units. This model does not enable the calculation of unit-specific effects or the analysis of change within units over time.

3.3.2 Selecting the Appropriate Panel Data Regression Model

From the three methods of panel data regression model; common effect model, fixed effect model, and random effect model. The next stage is to identify the most suitable method for a specific situation among the three options. Widarjono (2007) identifies three particular tests for selecting the optimal panel data regression model: The Chow test, the Hausman test, and the Lagrange Multiplier test.

3.3.2.1 Chow Test

The Chow test is a statistical method used to assess the equality of coefficients in two distinct regression models. It is commonly used in econometrics to determine if there are significant changes in the structure of the data, especially in time series or panel data analysis. The Chow test evaluates the difference in the sum of squared residuals between a regression using combined data and another utilizing subsets of the data. The test statistic is compared to a critical value obtained from the F-distribution. The Chow test is utilized to choose the optimal panel data regression model between models derived from the common effect model method and models derived from the fixed effect model approach, based on specific assumptions (Baltagi, 2005).

The formulation presents two competing hypotheses: H_0 : *Common Effect Model*, while H_1 : *Fixed Effect Model*. When the p-value is greater than 0.05, the null hypothesis (H_0) is accepted, suggesting that the chosen model is the Common effect model. If the p-value is less than 5% significance (0.05) then the null hypothesis is rejected and indicates that the most appropriate model to use is the fixed effect model.

3.3.2.2 Hausman Test

The hausman test is utilized when choosing the best model to use between the fixed effect model and the random effect model. The specification test in the hausman test follows the chi-square distribution based on the Wald criterion. The two estimated models operate under different assumptions regarding the relationship between the independent variables and the specific impact on unobserved individuals.

The hypotheses used in the Hausman test are H_0 : *Random Effect Model*, and H_1 : *Fixed Effect Model*. If the test results show a P-value lower than the 5% significance level (P-value <0.05) the decision is to reject the null hypothesis and indicate that the fixed effect model is the most appropriate model to use. if the p-

value >0.05 indicates the acceptance of the null hypothesis which means that the random effect model is the most appropriate model to use.

3.3.2.3 Lagrange Multiplier Test

The Lagrangian multiplier test is a statistical test used to evaluate the feasibility of a regression model that assesses whether a set of restrictions on the model variables is in line with the data. This test analyzes the compatibility between the model and the restrictions on the parameters by estimating them independently. The LM test is used in choosing between two models, namely the Common Effect Model or the Random Effect Model.

The two hypotheses in the formulation are presented as follows, H_0 : *Common Effect Model*, while H_1 : *Random Effect Model*, with the criterion that if the P-value is smaller than the significance level (P-value <0.05), the decision is to reject the null hypothesis and the model used is random effect model, otherwise if the p-value >0.05 , the decision is to accept the null hypothesis and common effect model is the most appropriate model to use.

CHAPTER IV

RESULT AND DISCUSSION

4.1 Overview of The Study Subject

The Organization for Economic Co-operation and Development (OECD) is an international organization that was established as an extension of the Organization for European Economic Co-operation (OEEC). The OEEC was created in 1948 to oversee the distribution of aid from the United States and Canada as part of the Marshall Plan, which aimed to rebuild Europe after World War II. The OECD was officially formed on December 14, 1960, when 18 European countries, The United States, and Canada signed a convention. However, this convention only became effective on September 30, 1961. The current member countries of the OECD are those that collectively produce approximately two-thirds of the world's goods and services. These countries include Australia, Austria, Denmark, France, Belgium, Canada, Chile, Ireland, Czech Republic, Finland, Germany, Greece, Hungary, Iceland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, Netherlands, Slovakia, Slovenia, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States (Tikkanen, 2024).

The objectives of the OECD are defined in chapter 1 of the convention establishing the organization. These objectives include promoting member countries to adopt policies that foster robust economic growth and facilitate the creation of sustainable employment opportunities, thereby enhancing the living standards of member countries. Additionally, these policies should also contribute to maintaining financial stability, benefiting not only the economic growth of OECD members but also global economic growth. An instance of initiatives undertaken by the OECD is the facilitation of international commerce and capital mobility across nations, with the objective of assisting the economies of developing countries. The OECD is a consultative assembly that holds significant influence as a recognized advisory organization and information hub, offering extensive economic statistics. The OECD implements its approach by employing moral suasion, conducting seminars, workshops, conferences, and publishing various materials.

4.1.1 The Role of OECD in Mitigating the Impact of Climate Change

The OECD has implemented several activities and efforts to support its member nations in enacting policies through data analysis and international collaboration to reduce the negative impacts of climate change. Several initiatives undertaken by the OECD are:

- 1) The Net Zero+ Project: Climate and Economic Resilience. This project aims to facilitate the shift towards achieving net zero emissions. The issue also explores solutions that can promote the shift towards achieving net zero emissions while being able to withstand economic shocks, as well as negative effects from macroeconomic, social, and environmental variables (OECD, 2023b).
- 2) The International Program of Action on Climate (IPAC) is a monitoring and evaluation initiative that supports OECD member nations in their efforts to attain net zero greenhouse gas emissions and enhance climate resilience. IPAC offers member nations statistics and assessments of their enacted policies to assist them in enhancing and harmonizing their climate change efforts (OECD, 2021a).
- 3) The OECD created the Climate Action Monitor as a component of IPAC. This report is released on a yearly basis by IPAC. This resource offers insights into climate action and assesses the policies taken by OECD member nations in their pursuit of net-zero objectives. The Monitor can assist policy makers and practitioners by examining the climate action patterns, greenhouse gas emission patterns, and climate mitigation initiatives of various nations.
- 4) A project centered around Climate Change Loss and Damage, aims to comprehensively analyze the hazards, consequences, and prospective detriments associated with climate change, both in the immediate and distant future. The initiative aims to mitigate the effects of climate change and encourage action by policy makers, financial stakeholders, and technology managers at different levels (OECD, 2021b).
- 5) Climate change workshops and events: The OECD promotes climate change education by arranging workshops that encourage the sharing of knowledge and collaboration among member economies. These workshops focus on climate-related topics such as adapting to climate change, economic modeling of climate impacts, and strategies for achieving resilient net-zero transitions such as the Tipping Points Project focuses on investigating critical points or significant thresholds at which the Earth might undergo substantial changes. Critical elements refer to certain components of the Earth that are susceptible to these changes. Instances include the thawing of ice sheets and the disturbance of ocean circulation patterns (OECD, 2022).

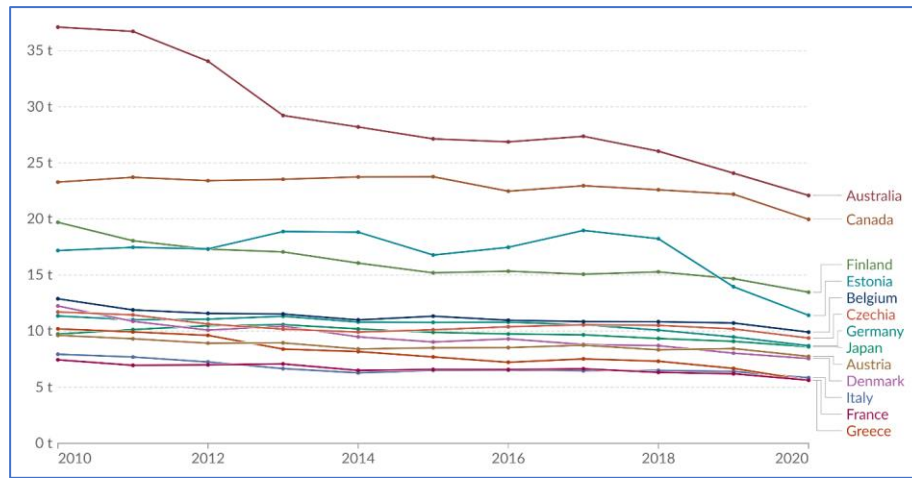
The Kyoto Agreement, established in 1992, marked the initial commitment of countries, particularly industrialized ones within the OECD, to reduce greenhouse gas

(GHG) emissions. This commitment was reinforced by the Kyoto Protocol in 1997, which set more stringent emission targets. The ambitions and targets were then updated in the 2012 Doha amendment to reflect a more evolved situation and more ambitious goals. In 2015, the Paris Agreement was established and received a lot of attention and support from various countries in the world, including OECD member countries. The international agreement intends to address climate change through the establishment of goals and strategies in limiting global temperature rise not to exceed 2 degrees Celsius, and preferably only 1.5 degrees Celsius compared to pre-industrial levels. The Paris Agreement provides for countries to formulate Nationally Determined Contributions (NDCs), to outline each country's specific goals and strategies for greenhouse gas (GHG) emissions mitigation. The role of the OECD is to provide support and monitoring to its member countries in achieving their goals as outlined in their respective NDCs (UN Climate Change, 2023).

4.1.2 Trends in Greenhouse Gas (GHG) Emissions in OECD Countries

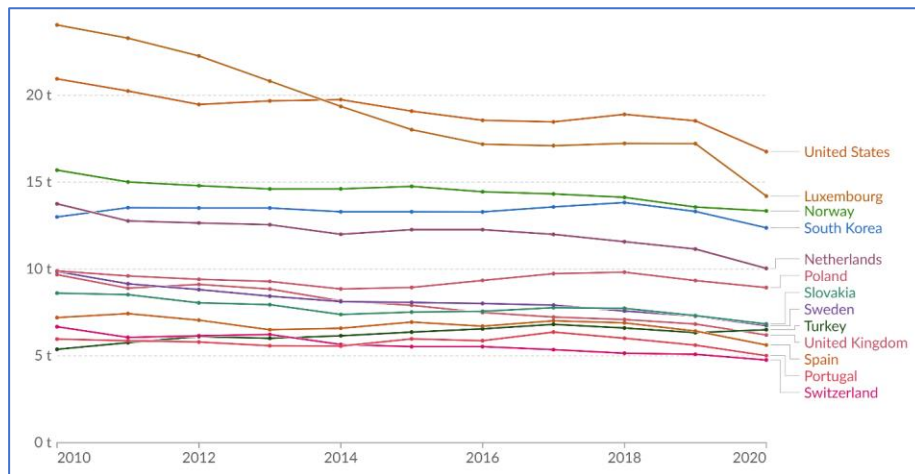
Greenhouse gas (GHG) emissions refer to the collective amount of gases that directly influence climate change and are widely recognized as a significant driver of global warming and climate change. The greenhouse gas emissions encompass carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄) (OECD, 2024a). The primary factor driving the elevated levels of greenhouse gas (GHG) emissions in OECD nations is the substantial amount of carbon dioxide (CO₂) emissions. The OECD study on "Climate change" in the Environment at a Glance Indicators states that OECD member nations have significantly greater levels of greenhouse gas (GHG) emissions per capita compared to other countries worldwide. In 2019, the average carbon dioxide emissions per person in OECD nations amounted to around 8.3 tons, but in other areas, the average was just 4.4 tons. Nevertheless, the endeavors and tactics employed by OECD nations to decrease emissions exhibit considerable disparities, whether assessed in terms of absolute figures, per person, or per unit of GDP (OECD, 2023a).

Figure 4. 1 Per Capita GHG Emissions of 26 OECD (metric tonnes CO2-eq)



Source: (Ritchie et al., 2020b)

Figure 4. 2 Per Capita GHG Emissions of 26 OECD (metric tonnes CO2-eq)



Source: (Ritchie et al., 2020b)

The figures labeled 4.1 and 4.2 represent the total greenhouse gas (GHG) emissions per person in metric tons of carbon dioxide equivalent (CO₂-eq) for the years 2010 to 2020. Based on the provided data, it is evident that the most of OECD nations witnessed a decline in greenhouse gas (GHG) emissions in 2020, with the exception of Turkey. According to the International Energy Agency (2021), Turkey has had a 99% rise in energy-related carbon dioxide (CO₂) emissions from the year 2000. In 2020, Turkey's climate performance was reported to have a poor rank in terms of its efforts to reduce greenhouse gas emissions. Turkey is considered a country that lacks a specific strategy to shift toward low emissions by 2050, the Turkish government is also criticized for its continued support of coal-fired power plants which are believed as the main source of high greenhouse gases

and harmful sources of the environment. Turkey according to Burck et al. (2020) is also said to be an OECD country that has not ratified the Paris Agreement.

In 2018, per capita greenhouse gas emissions in Estonia were recorded at 18,235 tons. This figure had a significant decline in 2019, dropping to 13,959 tons per capita. In 2020, the emissions were further reduced to 11,418 tons per capita. The significant decline in GHG emissions between 2018-2020 is estimated at 37.39%. The IEA (2021) highlights that Estonia has an impressive environmental performance. This achievement is partly due to a significant reduction in the use of oil shale, an energy-intensive rock for power generation. Estonia also has a strong ambition to achieve 100% renewable energy for electricity by 2030. Thus far, renewable energy in Estonia has shown significant growth, especially in the generation of wind and solar electricity.

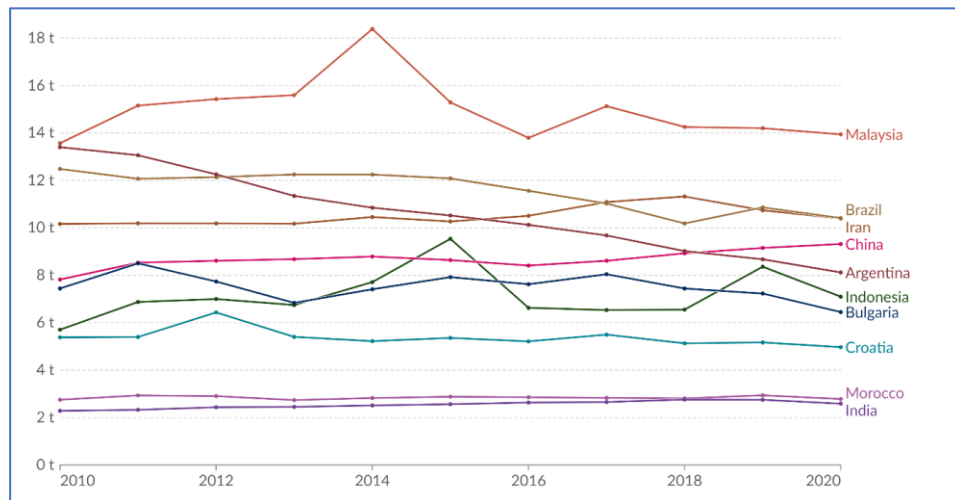
Based on the data provided, it is evident that Australia has the highest GHG per capita level among other OECD countries since 2010. However, GHG emissions are consistently decreasing and continue to decline until 2020. Trewin et al. (2021) reported that the decline was driven by the land use and forestry (LULUCF) within the country's. Based on the available statistics, this sector has consistently been a major contributor to emissions since 1990, however there was a decrease in emissions in 2000. As of 2015, this sector has transformed into an energy sink with negative implications. Renewable energy sources in Australia including wind and solar power were recorded to contribute around 20.9% to electricity generation in 2019. This is a significant increase in the renewable electricity sector compared to its proportion in 2000-2010 which was mainly from hydroelectric power with a proportion of 7-10%. By 2020, emissions in Australia are reported to decrease by 7%. Although seeing a decrease, Australia is recognized as one of the nations exhibiting the highest per capita emission rates globally.

The United States, as an OECD member, exhibits a high level of greenhouse gas (GHG) emissions per capita compared to other nations. In 2010, the country's GHG emissions per capita stood at 20.9 tons, which reduced to 16.8 tons in 2020, marking a 20% reduction. Nevertheless, the United States continues to maintain a comparatively high level of GHG emissions. According to the CCPI evaluation, the U.S is classified as a country with a climate performance that is categorized as extremely low in 2020. In 2020, the transportation infrastructure of the United States is widely regarded as inadequate, while its agriculture and forestry policies are highly criticized for their unsustainable practices and detrimental impact. The performance worsened significantly after United States president Donald Trump withdrew the United States from the Paris agreement in 2020.

Meanwhile, among the OECD nations that are also members of the European Union, greenhouse gas (GHG) emissions have shown a consistent pattern of stability from 2010, followed by a drop until 2020. European OECD nations have demonstrated commendable success in decreasing greenhouse gas emissions, embracing renewable energy sources, and enacting policies that align with the Paris Agreement. This has resulted in their effective reduction of GHG emissions. These endeavors encompass substantial funding in clean energy technology, incentives to promote the utilization of renewable energy, and stringent laws aimed at diminishing carbon emission.

Aside from the member nations of the OECD, there are also numerous non-member countries that are acknowledged as having significant amounts of emissions. The CCPI also assesses the climate performance of these countries on a regular basis. The nations that are among the greatest emitters and possess comprehensive data sources for study include Malaysia, Brazil, Iran, China, Argentina, Indonesia, Bulgaria, Croatia, Morocco, and India.

Figure 4. 3 Per Capita GHG Emissions of 10 Non-OECD (metric tonnes CO₂-eq)



Source: (Ritchie et al., 2020b)

Based on the provided data, it is evident that Morocco has had the least progress in development among the 10 non-OECD nations since 2010. Morocco's GHG emission per capita is relatively low compared to other countries, and its emissions have only increased by 1% from 2010 to 2020. Regarding China, the data indicates that there was a rise in greenhouse gas (GHG) emissions between 2017 and 2020, with a proportional increase of 8%. Specifically, the emissions increased from 8.6 tons in 2017 to 9.3 tons in 2020. This is in contrast to most other nations, which observed a decline in GHG emissions in 2020.

China's performance in handling GHG emissions in 2020 is inadequate, mostly because of its heavy reliance on coal. Despite this, China has reportedly implemented several measures to decrease its reliance on fossil fuels and achieve its greenhouse gas (GHG) reduction target by 2030. However, the country's GHG performance has been negatively affected by economic and trade uncertainty, resulting in a poor ranking on the CCPI 2020.

In the case of Indonesia, there were significant changes in greenhouse gas (GHG) emissions between 2010 and 2020. In 2019, greenhouse gas (GHG) emissions rose following a period of reduction and stabilization. The 2019 Climate Change Performance Index (CCPI) report highlighted Indonesia's alarming deforestation rate, mostly driven by the operations of the pulp and palm oil industries. This deforestation is one of the contributing factors to the increase in GHG emissions. Indonesia's renewable energy performance has been criticized for its lack of aggressive assistance, particularly in the electrical sector. The country's NDC objectives in carbon reduction efforts, energy consumption, and renewable energy are not included into the government's national policy, which has been subject to criticism. Consequently, the execution is deemed unsuitable.

Malaysia experienced a distinctive pattern in greenhouse gas (GHG) emissions between 2010 and 2020. During this period, GHG emissions consistently rose, reaching their highest point in 2014. The increase amounted to 36%, with emissions per capita rising from 13.6 tons to 18.4 tons. This trend aligns with the significant amount of CO₂ emissions recorded in Malaysia in 2014, which greatly contributed to the overall high GHG figure for that year. Subsequently, there was a gradual decline of 9% from 2015 to 2020. In the case of India, the per capita emission levels and energy consumption are reported to be consistently below 3 tons per capita. India has set ambitious objectives for 2030, aiming to align with the goal of limiting global temperature rise to below 2°C. To achieve this, India is implementing robust policies to promote the growth of renewable energy usage. In 2010, Argentina's greenhouse gas (GHG) emissions per capita were 13.4 tons. By 2020, this figure had decreased to 8.1 tons per capita. This represents a significant and relatively large decrease of 5.3 tons, equivalent to a relative change of -39%.

4.1.3 Economic Freedom in OECD and non-OECD Countries

Economic freedom can be contrasted with the idea of self-ownership, which grants each individual the right to autonomously determine how to utilize their time, opportunities, talents, and resources to fulfill their own needs and aspirations. As a consequence of this freedom, individuals do not have the right to force others to spend their time or utilize their skill in a specific manner. The fundamental principle of economic freedom is that

individuals lack the authority and power to take over other's property rights or force them into providing goods or services. The basic concept of economic freedom is the freedom of private property, voluntary transactions, unregulated markets and robust ownership. In the field of economics, each individual has the freedom to choose the products and services they want to consume or produce without harming others, This freedom is designed to be unrestricted, meaning it is not limited by other individuals or the political system (Gwartney et al., 2020).

The Economic Freedom of the World Index published by the Fraser institute aims to assess the extent to which a country's institutions and policies align with economic freedom. A high economic freedom index reflects a country that supports the necessary framework for voluntary transactions, protecting individual's property through legal laws against aggression from those who commit fraud, coercion and use violence to unlawfully seize property that does not belong to them. The indicators adopted are derived from the metric utilized by the Fraser institute in creating the global economic freedom index. These indicators encompass; 1) Government size, which refers to the extent of government spending and taxes that can impede the economic freedom of the country's citizens, 2) Legal system and property rights, referring to the level of legal protection a country applies to individuals and their property ownership, 3) Sound money which refers to maintaining price stability and keeping inflation rates low, and ensuring relatively stable purchasing power over time. The following data presents the level of economic freedom for 26 OECD nations in the year 2020:

Table 4. 1 Economic Freedom of 26 OECD Countries (2020)

Country	Government Size	Legal system	Sound Money	Country	Government size	Legal system	Sound Money
Australia	6.03	8.59	9.52	Korea	6.22	6.83	9.66
Austria	4.93	8.58	9.17	Luxembourg	4.87	8.65	9.06
Belgium	4.32	7.69	9.20	Netherlands	4.87	8.60	9.07
Canada	5.82	8.20	9.46	Norway	4.72	8.99	9.30
Czechia	6.17	7.32	9.44	Poland	5.72	6.45	8.24
Denmark	5.11	9.07	9.68	Portugal	6.03	7.36	9.22
Estonia	6.35	7.92	9.07	Slovakia	6.17	6.73	9.10
Finland	4.72	8.89	9.17	Spain	5.84	7.43	9.19
France	4.64	7.48	9.12	Sweden	4.45	8.42	9.56
Germany	5.65	8.16	9.19	Switzerland	6.17	6.73	9.10
Greece	4.85	6.06	9.11	Turkey	6.52	4.80	8.12
Italy	5.32	6.50	9.16	United State	6.78	7.81	9.60
Japan	5.62	7.94	9.80	United Kingdom	5.89	8.00	9.57

Source: Fraser Institute (2020)

Table 4.1 displays the degree of economic freedom among member nations of the OECD, classified into three distinct indicators. Compared to other OECD countries, The United States has a higher government size index in 2020, which is 6.78 out of 10. This shows that the U.S has a freer economy, in terms of government spending such as tax rates, and asset ownership of the government is considered to have a small proportion. While Belgium has the lowest government size index among other countries, which is 4.32 out of 10. This demonstrates that in Belgium, the size of government tends to be active, with a high proportion of government spending, tax rates and substantial number of government-owned assets.

In the category of legal system and property rights, Denmark has the highest index score of 9.7 out of 10. This shows that the higher level of economic freedom in Denmark is reflected in a higher level of property and legal protection. On the other hand, Turkey has the lowest index in this area with a score of 4.80 out of 10. This suggests that the degree of property safeguarding and legal system in Turkey is somewhat worse than in other OECD countries.

In the category of sound money, Japan has the highest index score among other OECD countries, this indicates that in Japan, price stability and purchasing power tend to be stable and the government can effectively control the inflation rate at a low level. As a result, individual economic freedom within the country is increased. The country that has the lowest sound money index is Turkey, indicating that the Turkish government has not effectively maintained price stability. As a result, inflation fluctuates, which negatively impacts the economic freedom within this country.

Table 4. 2 Economic Freedom of 10 Non-OECD Countries (2020)

Country	Government Size	Legal System	Sound Money
Argentina	6.09	4.98	4.12
Brazil	6.28	5.22	9.22
Bulgaria	7.06	5.75	9.45
China	4.96	4.87	8.42
Croatia	4.89	5.99	9.60
India	7.57	5.30	8.08
Indonesia	7.88	4.66	9.53
Iran	6.66	3.27	5.99
Malaysia	7.12	5.81	8.34
Morocco	6.62	5.27	7.34

Source: Fraser Institute (2020)

Table 4.2 shows the economic freedom index presented in three categories for 10 non-OECD countries. Based on the government size category, Indonesia has the highest score in this index with a score of 7.88 out of 10. This indicates that the level of economic freedom in Indonesia in terms of government size is greater than other countries, with a fairly low level of government spending and government-owned assets. While Croatia has the lowest index of 4.89. This suggests that in Croatia, the government plays a more prominent role in terms of government expenditure, imposing high taxes, and owning more government assets.

In the realm of legal system and property rights, Croatia has a commendable score of 5.99 out of 10. This indicates that the Croatian government, despite its dominance in terms of assets and government expenditure, actively upholds the safeguarding of property and individual rights through legal means. Iran, in this area, has the lowest score of 3.27 out of 10, indicating that the government does not enforce legal protection of property and individual property rights extremely strictly in Iran.

Croatia is considered to have the highest score of 9.60 out of 10 in terms of sound money, indicating that the Croatian government performs at maintaining the stability of the currency's value and keeping inflation low. Argentina has the lowest score of 4.12, indicating that the Argentine government struggles with preserving monetary stability and controlling volatile inflation in the nation.

4.2 Country Classification and Regression Model Framework

This study utilizes a sample of 36 countries from various regions around the world. These countries are classified into two groups: OECD member countries and non-OECD member countries. To provide a more comprehensive analysis, separate regression models are conducted for each country group, resulting in a total of three models. Model 1 presents the regression results for a total 36 countries. The model aims to examine the overall results. Model 2 presents the regression results for a dataset that includes 26 countries, all of which are the members of the OECD, while model 3 presents the regression results for non-OECD countries, encompassing a total of 10 countries.

4.3 Descriptive Statistics

This study aims to investigate the impact of economic freedom on environmental performance, specifically measured by per capita greenhouse gas (GHG) emissions in countries identified as major contributors to greenhouse gas emissions based on the climate change performance index.

Table 4. 3 Descriptive Statistics of Model 1

Variable	Obs	Mean	Std. dev.	Min	Max
Greenhouse gas emissions per capita	396	10.67295	5.616721	2.283076	37.09964
Government size	396	6.10346	0.897207	4.29	8.51
Legal system	396	6.942702	1.510786	3.26	9.19
Sound Money	396	9.067929	0.952842	4.12	9.9
GDP per capita	396	31408.08	24282.52	1238.015	108351.5
GDP2	396	83.24133	43.95988	9.565	134.401
Urbanization	396	73.21901	15.26419	30.93	98.08
Technology	396	68561.1	209794.3	23	1542002
Trade	396	88.35887	57.88703	22.48623	382.35

Author's compilation

Table 4.3 presents the statistical summary for model 1, encompassing all observations from different countries. The highest value of greenhouse gas (GHG) emissions per capita is 37.099, while the lowest value is 2.283. On average, the value is 10.672. The average score for government size in terms of economic freedom is 6.103, ranging from a minimum of 4.29 to a maximum of 8.51. The average score for the legal system is 6.942702, with a minimum value of 3.26 and a maximum of 9.19. As for sound money, the average score is 9.06792, with a minimum value of 4.12 and a maximum of 9.9. Table 4.3 also includes descriptive statistics for other factors such as GDP per capita, GDP2, Urbanization, technology, and trade.

Table 4. 4 Descriptive Statistics of Model 2

Variable	Obs	Mean	Std. dev.	Min	Max
Greenhouse gas emissions per capita	286	11.6319	5.897058	4.757318	37.09964
Government size	286	5.91993	0.804745	4.29	7.9
Legal system	286	7.676329	1.017436	4.7	9.19
Sound money	286	9.425559	0.411951	7.03	9.9
GDP per capita	286	40687.73	22369.25	8396.924	108351.5
GDP2	286	109.7237	11.95829	81.642	134.401
Urbanization	286	78.13416	10.6737	53.73	98.08
Technology	286	50242.28	126973.7	23	621453
Trade	286	97.22161	61.80351	23.38	382.35

Author's compilation

Table 4.4 presents the descriptive statistics for model 2, specifically the data for all OECD nations. The maximum recorded number for greenhouse gas (GHG) emissions per capita is 37.099, while the lowest recorded value is 4.757. On average, the value is at

11.682. The average score for government size in terms of economic freedom is 5.919, ranging from a minimum of 4.29 to a maximum of 7.9. The average score for the legal system is 7.676, with a minimum value of 4.7 and a maximum of 9.19. Lastly, the average score for sound money is 9.425, with a minimum value of 7.03 and a maximum of 9.9. Table 4.4 also includes descriptive statistics for other factors such as GDP per capita, GDP2, urbanization, technology, and trade.

Table 4. 5 Descriptive Statistics of Model 3

Variable	Obs	Mean	Std. dev.	Min	Max
Greenhouse gas emissions per capita	110	8.179683	3.835515	2.283076	18.38398
Government size	110	6.580636	0.951663	4.58	8.51
Legal system	110	5.035273	0.693438	3.26	5.99
Sound money	110	8.138091	1.279956	4.12	9.81
GDP per capita	110	7280.999	3876.651	1238.015	14321.33
GDP2	110	14.38707	2.1284	9.565	17.272
Urbanization	110	60.43961	17.83974	30.93	92.111
Technology	110	116190	337897.2	129	1542002
Trade	110	65.31576	37.60353	22.48623	157.9448

Author's compilation

Table 4.5 displays the statistical summary for model 3, particularly the data pertaining to non-OECD nations. The maximum value for GHG emissions per capita is 18.38398, while the minimum is 2.283076, with an average value of 8.179683. The average score for government size in terms of economic freedom is 6.580636, ranging from a minimum score of 4.58 to a maximum score of 8.51. The average score for the legal system is 8.138091, with a minimum score of 4.12 and a maximum score of 9.81. Similarly, the average score for sound money is 8.138091, with a standard deviation of 1.279956. The minimum score for sound money is 4.12, while the maximum score is 9.81. Descriptive statistics for other variables such as GDP per capita, urbanization, technology, trade and education are also shown in table 4.5.

4.4 Classical Assumption Test

The classical assumption test in the regression model is employed to validate the effectiveness of the linear regression model and determine the reliability of the outcomes. The classical assumption test in this study comprises of multicollinearity test, heteroscedasticity test, and autocorrelation test.

1) Multicollinearity Test

Multicollinearity test in research is employed to see the high correlation between independent variables. According to Kennedy (2008), the variance inflation factor (VIF) value is commonly utilized as a general measure to investigate multicollinearity symptoms with an acceptable threshold of 10. When the VIF value exceeds 10, it indicates the presence of multicollinearity or high correlation between predictor variables in the study.

The results of the multicollinearity test for the three models in this study are presented in appendices 1, 2, and 3. The results confirm the presence of multicollinearity in each model for the GDP and GDP2 variables, as indicated by VIF values over 10. The reasons behind this strong correlation between these two variables can be attributed to a robust mathematical relationship between GDP and GDP2, where GDP2 is a non-linear function of the logarithm of GDP per capita.

Kalnins (2022) asserts that the presence of multicollinearity in a model does not introduce bias in the estimated coefficients. However, it does lead to an increase in the variance of the estimates, resulting in larger standard errors and consequently reducing the statistical significance (p-value) of the model. According to the literature, if a variable with collinearity is a control variable and is not collinear with the variable of interest, then it does not pose an issue (Allison, 2012). Previous scholars, such as Awan & Azam (2022) and Jin et al. (2017) have utilized the variables GDP and GDP2 to provide evidence for the EKC theory.

2) Heteroscedasticity Test

Heteroscedasticity is the presence of different amounts of residual variability in a regression model, where this variability varies across different data sets. The examination of heteroscedasticity in these three research models indicates the presence of signs of heteroscedasticity, as shown in appendices 4, 5, and 6. This is corroborated by the results of the heteroscedasticity test with $p\text{-value} < 0.05$ indicates the rejection of the null hypothesis and the presence of heteroskedasticity.

3) Autocorrelation Test

An autocorrelation test, also known as a serial correlation test, examines the connection between errors or residuals from a regression model at different time intervals or data points. This phenomenon occurs when errors in a time series or panel data display a consistent pattern of correlation. Autocorrelation challenges the concept of independence in classic linear regression, which posits that errors are uncorrelated. When there is autocorrelation, the calculated coefficients may

remain unbiased, but the standard errors and hypothesis tests may become inaccurate (Kennedy, 2008).

This study used the Wooldridge’s test, described by Drukker (2003), to examine autocorrelation test. The null hypothesis being tested is the absence of serial correlation. The results of the Wooldridge’s test for the three models in this study indicate a P-value of less than 0.05. Please refer to appendix 7, 8, and 9 for further details. Based on these results, it rejects the null hypothesis (H0) and conclude that there is a presence of serial correlation in this study.

The classical assumption test findings for the models in this study indicated the presence of heteroscedasticity and autocorrelation. Additionally, after testing for cross-sectional dependency, this study also revealed the existence of dependency across groups (please refer to appendix 10,11, and 12). In order to address these flaws, it is necessary to rectify the standard error. This ensures that the regression estimate findings stay both valid and dependable. One effective approach is to employ the Driscoll Kraay standard error. Hoechle (2007) has devised the Driscoll and Kraay technique in stata and has performed simulations to assess the efficacy of this method compared to others that do not account for cross-sectional dependency. The results demonstrate that the Driscoll and Kraay technique effectively generates precise standard errors, particularly in cases where there is interdependence among groups. The Driscoll Kraay approach is known for its robustness against violations of heteroskedasticity and autocorrelation assumptions. Therefore, this study employs the Driscoll Kraay standard error in estimation.

4.5 Choosing the Best Regression Model

When selecting the most suitable regression model for analyzing panel data, it is necessary to perform three testing steps: 1) Chow Test; 2) Hausman Test; and 3) Lagrange Multiplier Test. These three tests are utilized to ascertain the most suitable model to employ among the three models, specifically the common effect model, fixed effects model, or the random effects model.

Table 4. 6 Model Specification Test Results for Model 1

Chow Test (Prob > F)	Hausman Test (Prob > chi2)	Lagrangian Multiplier Test (Prob > chibar2)	Best Model
0.0000	0.000	0.0000	Fixed Effect Model

Data processed by author

Table 4.6 presents the most appropriate selection for model 1, The Chow test is employed to ascertain if the fixed effect model outperforms the common effect model, based on the test results. Model 1 has a probability of $0.000 < 0.05$. This indicates that the fixed effect model technique is more appropriate than common effect model. The Hausman test is employed to select between the fixed effect model and random effect model. The Hausman test probability in model 1 is $0.000 < 0.05$, suggesting that the fixed effect model is preferred to the random effect model. The Lagrangian Multiplier test is used to determine whether to pick the random effect model or the common effect model. The Lagrangian multiplier test yields a probability of $0.0000 < 0.05$, indicating that random effect model is more appropriate than common effect model. Based on the results of the three tests conducted on the selection process for the model involving all nations, it can be concluded that the fixed effect model approach is the most appropriate model to utilize.

Table 4. 7 Model Specification Test Results for Model 2

Chow Test (Prob > F)	Hausman Test (Prob > chi2)	Lagrangian Multiplier Test (Prob > chibar2)	Best Model
0.000	0.000	0.000	Fixed Effect Model

Data processed by author

Table 4.7 displays the most appropriate model employed for model 2. The results of the Chow Test show a probability of $0.000 < 0.05$, leading to the rejection of the null hypothesis. Consequently, the model chosen is the fixed effect model. The results of the Hausman test show a probability value of $0.000 < 0.05$ concluding that rejecting the null hypothesis and the fixed effect model is more appropriate to utilize than the random effect model. The Lagrange Multiplier Test is also employed, yielding a P-value of $0.000 < 0.05$. This indicates that the null hypothesis should be rejected and the random effect model should be utilized. Therefore, based on the results of the three selection tests, it can be concluded that the fixed effect model is the most appropriate approach to be used in observations of OECD member countries (model 2).

Table 4. 8 Model Specification Test Results for Model 3

Chow Test (Prob > F)	Hausman Test (Prob > chi2)	Lagrangian Multiplier Test (Prob > chibar2)	Best Model
0.000	0.000	0.010	Fixed Effect Model

Data processed by author

Table 4.8 displays the most appropriate model for model 3 in the study. The results of the Chow Test show a P-value of $0.000 < 0.05$ indicating rejection of the null hypothesis

with the conclusion that the fixed effect model is more appropriate to use compared to the common effect model. Based on the results of the Hausman Test with a p-value of $0.000 < 0.05$, indicating acceptance of the alternative hypothesis and suggesting that the most appropriate model to choose is the fixed effect model, while the results of the Lagrange Multiplier Test show a P-value of $0,010 < 0,05$ indicating rejection of the null hypothesis and suggesting the selection of the random effect model. Therefore, from the three selection tests that have been carried out it can be concluded that the fixed effect model is the most appropriate model to use in model 3, specifically for observations of non-OECD countries.

4.6 Outcomes Derived from Fixed Effect Model

Table 4. 9 Regression Results for FE Model 1

Variable	Coefficient	Drisc/Kraay std. error	Prob
_cons	-6.96629	0.925868	0.000***
Government size	0.071352	0.026948	0.024**
Legal system	-0.04365	0.025921	0.123
Sound money	0.000255	0.004835	0.959
Log (GDP)	2.764531	0.248097	0.000***
GDP2	-0.14402	0.014493	0.000***
Urbanization	-0.04266	0.004185	0.000***
Log (Technology)	0.068149	0.01784	0.003***
Trade	-0.00208	0.000729	0.017**
N	396	R-Squared	0.326
Countries	36	Prob > F	0.0000***

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The mathematical framework for model 1 is derived from the table above in the following manner:

$$\text{Log (Greenhouse gas emission)} = -6.966 + 0.071 \text{ Government size} - 0.043 \text{ legal system} + 0.0002 \text{ Sound money} + 2.764 \text{ log (GDP)} - 0.144 \text{ GDP2} - 0.04 \text{ Urbanization} + 0.068 \text{ log (Tecnology)} - 0.002 \text{ Trade} + \epsilon$$

Table 4.9 presents the results of the estimation achieved using the FE for model 1, which includes all observations from both OECD and non-OECD countries. The purpose of model 1 is to analyze the influence of economic freedom on greenhouse gas (GHG) emissions. The statistical testing yielded the following results: The R-squared, F-statistic, and t-statistic values may be found in table 4.9. The coefficient of determination (R^2) of 0.326 indicates that 32.6% of the variation in GHG emissions can be accounted for by the model, while the remaining 67.4% is attributable to external factors that were not

considered in the model. Furthermore, the calculated F-statistic value is $0.000 < 0.05$, indicating that it is lower than the 5% significance level. This suggests that the independent variables in the model as a whole possess the capacity to explain GHG emissions. The model predicts that GHG emissions will be -6.966 when all independent and control variables have a value of zero. When the independent parameters in the model have no effect, the baseline value of the natural logarithm of GHG emissions is -6,966.

The t-statistic test reveals that the variable with a significant impact on GHG emissions in all country observations is government size, which has a positive and significant effect. The coefficient value of 0.071 indicates that a 1-point increase in government size will result in a 7,1% increase in per capita GHG emissions, assuming all other variables remain constant. On the other hand, the legal system and property rights variables have a coefficient of -0.043, suggesting that a 1-point increase in this variable will lead to a 4,3% reduction in GHG emissions per capita but this effect is statistically not significant. On the other hand, sound money has a coefficient of 0.002. This indicates that a 1-point rise in sound money would result in a 0.02% increase in GHG emissions, but this relationship is not considered significant.

Regarding the control variable, it is observed that GDP per capita has a positive and significant impact on per capita GHG emissions, with a coefficient of 2.764. This implies that a 1 percentage increase in GDP per capita will result in a 2.7% increase in per capita GHG emissions. On the other hand, GDP2 has a negative and significant effect on GHG emissions, with a coefficient of -0.144 indicated that when the GDP per capita increases by 1 percent, it is associated with a decrease in per capita GHG emission by 0.14%. This indicates the presence of an environmental kuznets curve in this model. In simpler terms, at the initial stages, an increase in GDP per capita leads to an increase in GHG emissions. However, once a certain point is reached, further increases in GDP per capita actually lead to a reduction in per capita GHG emissions.

Additionally, the control variables of urbanization and trade have a negative and significant impact on per capita GHG emissions. This implies that a rise in 1 percentage of any of these factors will result in a reduction of per capita GHG emissions by 4% and 0,2% respectively. While the technology variable has a significant and positive influences per capita GHG emissions, indicating that a 1 percentage increase in technological advancement denoted by number of patents within a country leads to a corresponding rise in per capita GHG emissions by 0.06%.

Table 4. 10 Regression Results for FE Model 2

Variable	Coefficient	Drisc/Kraay std. error	Prob
_cons	-21.906	5.7466	0.003***
Government size	0.11442	0.029262	0.003***
Legal system	-0.04664	0.019279	0.036**
Sound money	-0.03069	0.009717	0.010**
Log (GDP per capita)	5.702116	1.125979	0.000***
GDP2	-0.29028	0.058365	0.001***
Urbanization	-0.04688	0.009381	0.001***
Log (Technology)	0.04646	0.022653	0.067*
Trade	-0.00302	0.001163	0.027**
N	286	R-Squared	0.428
Countries	26	Prob>F	0.0000***

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

The mathematical framework for model 2 is derived from the table above in the following manner:

$$\text{Log (Greenhouse gas emission)} = -21.906 + 0.114 \text{ Government size} - 0.046 \text{ Legal system} - 0.030 \text{ Sound money} + 5.702 \text{ Log (GDP per capita)} - 0.290 \text{ GDP2} - 0.046 \text{ Urbanization} + 0.046 \text{ Log (Technology)} - 0.003 \text{ Trade} + \epsilon$$

Table 4.10 displays the estimation results of the FE model for model 2, encompassing all OECD nations. Statistical testing reveals that the R^2 value in model 2 is 0.428, signifying that 42.8% of the variance in per capita GHG emissions can be accounted for by the model, while the remaining 57.2% is attributed to external factors not included in the model. In addition, the F-statistic value obtained is 0.000, less than a significance level of 5%, indicating that the explanatory variables in the model are collectively capable of explaining per capita GHG emissions. The estimated value of per capita greenhouse gas (GHG) emissions, when all independent and control variables in the model are set to zero, is a constant value of -21.906. When the independent parameters in the model have no effect, the base value of the natural logarithm of GHG emissions is -21.906.

The magnitude of the t-statistic test shows that the variables that significantly affect per capita GHG emissions in model 2 are government size has a positive and significant effect on GHG emissions, with a coefficient value of 0.114 which means that when government size increases by 1 point it is associated with an increase in per capita GHG emissions by 11.4% holding other variables constant, Legal system and property rights also has a significant effect on GHG emissions with a negative effect of -0.046 indicates that

when legal system increases by 1 point, it decreases per capita GHG emissions by 4.6%, while sound money has a statistical significant effect with value of -0,030 on per capita GHG emissions indicates that a rise 1 point of sound money will decreases per capita GHG emissions by 3%.

The study found that there is a clear and meaningful relationship between GDP per capita and GHG emissions in the OECD nations examined. Specifically, GDP per capita has a positive and significant impact on per capita GHG emissions, whereas GDP2 has a negative and significant impact. These findings support the existence of the Environmental Kuznets Curve in the analyzed countries. A 1 percent rise in GDP per capita will result in a 5.7% increase in per capita GHG emissions. However, if a certain threshold is reached, further increases in GDP per capita will actually lead to a decrease in GHG emissions due to the negative coefficient of GDP2.

The coefficient of -0.04 indicates that urbanization has a significant and negative impact. Specifically, a 1 percent increase in the urban population in OECD nations will result in a 4% reduction in per capita GHG emissions. Technology also has a positive and significant impact. Specifically, a 1 percent increase in the number of patents filed leads to increase the amount of emissions by 0.04%. On the other hand, trade negatively affects GHG emissions by -0.003, means that a 1 percent increase in trade leads to decrease the amount of emissions by 0.3%.

Table 4. 11 Regression Results for FE Model 3

Variable	Coefficient	Drisc/Kraay std. error.	Prob
_cons	-3.84837	1.356584	0.018**
Government size	0.015655	0.023358	0.518
Legal system	-0.09895	0.072195	0.200
Sound money	0.019494	0.010933	0.105
Log (GDP per capita)	2.224048	0.591922	0.004***
GDP2	-0.14907	0.09459	0.146
Urbanization	-0.02884	0.003051	0.000***
Log (Technology)	0.161044	0.027074	0.000***
Trade	0.001527	0.000757	0.071*
N	110	R-Squared	0.344
Countries	10	Prob>F	0.000***

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

The mathematical framework for model 3 is derived from the table above in the following manner:

$$\begin{aligned} \text{Log (Greenhouse gas emission)} = & -3.848 - 0.015 \text{ Government size} - 0.098 \text{ Legal system} \\ & + 0.019 \text{ Sound money} + 2.224 \text{ Log (GDP per capita)} - 0.149 \text{ GDP2} - 0.028 \text{ Urbanization} \\ & + 0.161 \text{ log (Technology)} + 0.001 \text{ Trade} + \epsilon \end{aligned}$$

Table 4.11 shows the FE model estimation results for model 3, which includes all non-OECD countries. The results of this regression show an R-squared value of 0.344, which means that 34.4% of the variation in per capita GHG emissions can be explained by the model, while the other 65.6% is explained by other factors outside the model. Furthermore, the F-statistic value obtained is 0.000, less than the 5% significance level, which means that the explanatory variables in the model are simultaneously able to explain per capita GHG emissions. The constant value of -3.848 is the predicted value of per capita greenhouse gas (GHG) emissions, when all independent and control variables in the model are zero. when there is no influence from the independent factors involved in the model, the base value of the natural logarithm of GHG emissions is -3.848.

The magnitude of the t-statistic test shows that significant variables affect per capita GHG emissions in model 3. The variable legal system and property rights have a negative impact on per capita GHG emission by 0.098 indicates that a 1 point increase in legal system index has the potential to decrease per capita GHG emissions in non-OECD countries by 9.8%, but the impact is not significant, sound money has a positive and insignificant effect on GHG emissions with a coefficient of 0.019 which means that a 1 point increase in sound money has the potential to increase GHG emissions in non-oecd countries by 1.9%, while the government size variable has a positive impact on GHG emissions but insignificant.

The variables GDP and GDP2 exhibit a positive and negative relationship, respectively, with GHG emissions, suggesting the presence of an Environmental Kuznets Curve (EKC) pattern characterized by an inverted U-shaped curve. However, the statistical significance of the squared GDP is not significant. The positive sign of GDP per capita indicates that there is a 2.22% increase in GHG emissions per capita when GDP per capita rises by 1%. On the other hand, urbanization has a negative and statistically significant impact on GHG emissions. Specifically, a 1 percent increase in the urban population leads to a 2.8% decrease in per capita GHG emissions. Additionally, trade in non-OECD countries has a positive and significant effect on per capita GHG emissions, with a 1 percent increase in trade resulting in a 0.1% increase in emissions. Technology has a positive and significant impact on per capita GHG emissions in non-OECD countries. A 1 percentage increase in patent issuance leads to a reduction in emissions by 0.16%.

4.7 Discussion

4.7.1 The Impact of Government Size on Greenhouse Gas Emissions

The regression findings for each model indicate similarity of results in the impact of government size on per capita greenhouse gas (GHG) emissions. Model 1, which encompasses data from all nations, reveals that there is a significant correlation between government size and GHG emissions, with government size having a positive impact on emissions. This indicates that countries with freer economies, represented by a higher government size index, which is often indicated by lower government decision-making compared to individual decisions, including lower government spending such as transfers and subsidies, lower levels of taxes imposed on the public and more assets owned by the private sector, are associated with higher greenhouse gas (GHG) emissions. This conclusion remains constant when applied to the sample of OECD countries. This indicates that overall, less government intervention has the potential to increase GHG emissions.

Nevertheless, this study found positive correlation between government size and GHG emissions per capita in non-OECD countries but the impact is not significant. This result may implicate that, in non-OECD member countries, a lesser role of government may lead to an increase in GHG emissions, suggesting that the involvement of government is also necessary in addressing environmental issues. However, this result needs to be taken into account due to the insignificance of the estimation results.

This finding can be explained by examining the composition of the OECD countries included in this study, which primarily consist of European countries. In these countries, the government plays a significant role in formulating policy regulations, including those pertaining to environmental sustainability. A report published by the Fraser Institute reveals that several OECD member countries, such as Japan, France, Sweden, and other European nations, have a relatively low government size index, negating that economic freedom in this section is small, due to the large size of government.

Most OECD countries typically enforce more stringent environmental regulations and exhibit greater government intervention to reduce emissions and safeguard the environment. Such as high taxes imposed on the public where the revenue is allocated for public purposes such as health facilities, education facilities, and infrastructure related to environmental preservation. Thus, social welfare and high quality of life can be achieved due to higher government intervention.

In addition to the policies of OECD governments regarding subsidies, one such policy involves providing financial assistance to the agricultural sector through a combination of direct payments to farmers, implementation of policies that impact agricultural commodity prices, and other forms of support that have specific objectives related to adaptation to climate change in agriculture, food security, social welfare, or environmental conservation. Some subsidies are funded through government-imposed taxes, with the OECD playing an active role in overseeing these subsidies through monitoring and evaluation. This ensures that the government achieves its progressive objectives and avoids any adverse consequences. Therefore, a smaller government size may hinder the implementation of effective environmental policies and the oversight of private sector compliance with rigorous environmental standards.

This may align with the idea of market failure, the theory that establishes a connection between economic freedom and the environment, as described by Shahnazi & Shabani (2021) in their research. In this theory, it is explained that the lack of government involvement in the market enhances economic freedom, but also leads to an increase in market inefficiency. For instance, the absence of government involvement can result in detrimental market practices such as monopolies and environmentally harmful business activities that negatively impact human well-being, especially increasing emissions. This is due to the lack of government's role in monitoring and evaluating business practices in the market. Therefore, this result implicitly demonstrates the necessity of government intervention in market regulation. Especially in implementing strict regulations related to environmental conservation in the business sector. This is necessary to achieve a balanced equilibrium between economic growth and environmental performance.

This result confirms the previous findings studied by Carlsson & Lundström (2001), the study asserts that in countries with high income, the relationship between economic freedom and CO₂ emissions is significant and positive. In countries with low income, the impact is negative. López & Palacios (2010) investigated the relationship between government spending and ecological taxes on CO₂ emissions in Europe, the results concluded that a high government role in increasing government spending contributes to environmental preservation by reducing air pollution levels. Affirmation is also given in Chen's (2022) study which concludes that the role of government in OECD countries plays an important role in effectively managing CO₂ emission levels. As in certain countries, the role of government is considered to be highly significant, especially in the establishment of policies related to strict environmental protection. Example are

effective waste management programs, stricter pollution control policies or incentives for the development of renewable energy sources.

4.7.2 The Impact of Legal System and Property Rights on Greenhouse Gas Emissions

Model 1, which includes all nations, shows that a rise in the legal system and property rights index leads to a drop in per capita GHG emissions. The findings are also comparable in model 2 and model 3, which specifically examines OECD nations and non-OECD nations. According to Jain & Kaur's (2022) findings, implementing a more equitable and efficient legal system can lead to a decrease in greenhouse gas (GHG) emissions. However, the findings in model 1 and 3 are not significant.

This suggests that high protection of private property and rights, integrated legal system, impartial courts, less military interference in the rule of law, and trustworthy political and police forces can significantly reduce emission levels in OECD countries as evidenced by statistical significance. However, when examining the relationship between overall countries and non-OECD countries, the effect is not statistically significant. This suggests that there is not enough evidence to conclude that the negative effect of legal system and property rights on GHG emissions in non-OECD countries that might be caused by high variability in non-OECD data or other external factors.

In most cases both in OECD and non-OECD countries, when property rights are protected and laws are fairly enforced, it fosters confidence for businesses to develop their businesses including the expansion of infrastructure. This, in turn, results in a rise in the utilization of natural resources and energy to sustain industrial facilities. The robust property rights and legal safeguards may result in heightened utilization of land for industrial and agricultural purposes or forests and waters, if there are only robust legal and property safeguards without any regulation on the utilization of natural resources, this may result in causing environmental harm, such as excessive deforestation, high emissions and water pollution that damages marine ecosystems. So that individuals tend to take action for the benefit of certain individuals or groups.

In underdeveloped nations, such as most of the non-OECD member countries in this study, environmental protection policies are less stringent compared to developed nations. This is primarily due to limited resources in developing countries, which hinder their ability to adopt clean energy technologies due to high operational expenses. Additionally, these countries often prioritise economic growth, poverty reduction, and other socio-economic challenges, leading to a tendency to disregard environmental

protection concerns. Therefore, in the absence of suitable environmental policies and inadequate compliance with environmental rules, the absence of property rights protection and legal enforcement might potentially harm the environment, for instance by contributing to the rise in greenhouse gas emissions.

4.7.3 The Impact of Sound Money on Greenhouse Gas Emissions

The sound money index, which measures the government's capacity to manage inflation and uphold currency stability, has different effects on per capita greenhouse gas (GHG) emissions under different observation models. In Model 1, which include all nation data, a strong sound money index has a positive but statistically insignificant effect on GHG emissions as well as its impact on the observation of non-OECD countries. When the government successfully maintains low inflation and monetary stability, it often leads to an increase in per capita greenhouse gas (GHG) emissions. While the observed effect lacks statistical significance, the findings indicate that economic stability might potentially stimulate economic activity, such as heightened output and consumption, resulting in an increase in greenhouse gas (GHG) emissions.

In the case of non-OECD countries, this may imply that when the government effectively regulates the inflation rate and oversees the expansion of money supply, while ensuring convenient access for its citizens to foreign currency bank accounts tend to an increase in per capita greenhouse gas (GHG) emissions. The argument that may underlie this feasibility is non-OECD nations are frequently in a phase of economic advancement that may give precedence to economic expansion rather than environmental measures. Therefore, when there is economic stability, there is a higher likelihood of industrial expansion and infrastructural development, which may not prioritize environmental considerations and consequently lead to an increase in greenhouse gas (GHG) emissions. However, it is important to be highlighted that there is a lack of evidence to confirm this finding due to the insignificant influence.

Different outcomes were seen in the OECD countries. The findings indicate that a higher sound money index tends to decrease per capita GHG emissions. OECD countries tend to have economic stability characterized by price stability and low inflation which in turn will provide convenience and confidence to investors to invest long-term in the development of efficient and environmentally friendly technology to create higher competitiveness, which in turn encourages emissions to fall. The conclusions of this study are in opposition to the results of (Hashmi & Alam, 2019), however they have parallels with the findings of (Alola, Alola, et al., 2022).

4.7.4 The Impact of GDP on Greenhouse Gas Emissions

Based on the regression results, it can be concluded that GDP per capita has a positive impact on per capita greenhouse gas (GHG) emissions in all observation models, including all nations, OECD member countries, and non-OECD member countries. Similarly, GDP² has a negative impact on all models, but the impact of squared GDP per capita on non-OECD nations is not significant.

This indicates the presence of an Environmental Kuznets Curve (EKC) in all observed countries as well as in OECD nations. Therefore, during the first phases of a nation's economic advancement, the rise in per capita greenhouse gas (GHG) emissions will be directly proportional to the increase in gross domestic product (GDP) per person. Once a specific threshold is reached, a rise in GDP per capita will lead to a decrease in GHG emissions. This finding is comparable to Hamit-Haggar's (2012) discovery of a non-linear correlation between income and GHG emissions in a group of Canadian sectors.

Regarding nations that are not members of the Organisation for Economic Co-operation and Development (OECD), the U-shaped connection is supported, but the EKC hypothesis is not proven because to its lack of statistical significance in the squared GDP. However, GDP per capita shows a positive correlation and has a significant effect, therefore, it is considered that, as GDP per capita increases in non-OECD countries, GHG emissions per capita will increase. Other researchers, like Aslanidis (2009), have also found similar outcomes in their studies while investigating 77 non-OECD nations and found no evidence of the EKC phenomenon. Alper & Onur (2016) conducted a study which found that EKC is inadequate for explaining the overall carbon dioxide (CO₂) emissions in China, specifically in respect to the connection between emissions and GDP development. Similarly, Lacheheb et al. (2020) research findings did not validate the existence of the Environmental Kuznets Curve (EKC) due to the absence of supporting evidence.

This finding is indirectly in line with the second phase of the Environmental Kuznets Curve theory which explains that at a certain stage, the growth of GDP per capita will also raise public awareness regarding the importance of environmental sustainability. One perspective is the environment is seen as a luxury good, meaning that when income continues to rise and individuals are more discerning about their primary needs, they will start to prioritize spending money on a cleaner environment and a healthier life. The relevance of this may be greater when considering OECD countries with more developed economies and robust environmental laws as well as a higher level of public awareness

regarding the need for a healthy and pleasant lifestyle. As a consequence, the decrease in environmental degradation occurred despite an increase in GDP per capita.

In the case of non-OECD countries, which are generally emerging countries in the early stages of industrialization, economic expansion is often accompanied by an increase in greenhouse gas emissions. The potential factors might be the high dependence on heavy industry and inefficient energy consumption, the scarcity of eco-friendly resources and technologies, or less stringent environmental regulations.

4.7.5 The Impact of Urbanization on Greenhouse Gas Emissions

In model 1, which covers all countries, urbanization shows a negative and significant relationship with greenhouse gases. Similar findings are also found when the analysis is conducted on OECD countries and non-OECD countries. This shows that an increase in urban population implies a decrease in GHG emissions per capita.

The results of this study are similar to those of Fan et al. (2006) who found that urbanization has a negative correlation with CO₂ in the countries he observed. S. S. Sharma (2011) also corroborated the results of this study by reporting the same findings. Showing that urbanization has a negative relationship with CO₂ emissions in countries with varying income levels. Likewise with the findings of Effiong's (2018). It is explained that the decline in emission levels can be attributed to several factors, such as enhancement of energy efficiency, establishment of green infrastructure, and broader application of green technology in OECD countries.

The results of this study may be in line with the theory of urbanization described by Burton (2000), known as the compact city theory. This idea elucidates that the degree of urbanization in some countries might be advantageous to the ecological ecosystem. The increase in urban population necessitates adjustments in infrastructure, particularly in public transportation, by expanding public transportation options, the reliance on private vehicles decreases, leading to a reduction in pollution levels. The results of this study contradict Poumanyvong & Kaneko (2010) findings which suggest that high levels of urbanization are often associated with an increase in environmental degradation due to significant emissions.

4.7.6 The Impact of Technology on Greenhouse Gas Emissions

Technological advancement in this study is measured through patent issuance in each observation country, as has been done by Allard et al. (2018). The findings on this variable have similar results across country observations, in all countries, OECD and non-

OECD. The results show that there is a positive relationship between technological advancement and GHG emissions per capita. And all these correlations are statistically significant. This implies that in all country observations, both OECD and non-OECD, an increase in the number of patents issued as an indication of technological advancement has the potential to harm the environment by increasing the amount of GHG emissions per capita.

The results of this study exhibit significant similarities to other studies, such as the investigations done by Awan & Azam (2022), these studies demonstrate that in the observed countries, the rise in the number of patents issued can escalate emissions, so posing a hazard to the environment. Allard's (2018) findings support this assertion, particularly in the context of countries possessing veto powers. The results indicated a direct and positive relationship between urbanization and environmental degradation.

A potential explanation behind this result is that the proxy employed in this study pertains to technology as a whole, specifically the number of patents, rather than patents that target environmental sustainability. Thus, the technological progress in this study may include certain patents that support environmental technologies, while others have the potential to harm the environment. Contrary to these findings, Balsalobre et al. (2015) highlights that the more advanced technology has a positive impact on the environment by reducing emission levels.

4.7.7 The Impact of Trade on Greenhouse Gas Emissions

The trade variable in this study represents the total value of export and import sales expressed as a percentage of GDP. The results show that trade has a statistically significant impact in all countries (model 1) and OECD countries under model 2. As for the correlation between trade and GHG emissions per capita in model 1 and model 2, the relationship is negative. This indicates that as trade increases and becomes more open, there is a possibility to decrease GHG emissions per capita in OECD countries. The results of this study are in line with the results of Al-Mulali et al. (2015) who found that freer trade in practice contributes to environmental improvement by reducing the level of CO₂ emissions.

OECD countries frequently have more complex standards policies regarding the trade of their commodities, such as imported goods from developing countries are required to meet environmentally friendly standards set by these governments by applying carbon tax adjustment. Some OECD countries are also members of the European Union and are involved in the European Union emission trading system. A practice that also ensures that

trade and industrial activities comply with the emission-related standards that have been implemented.

As for the effect of trade on GHG emissions per capita in non-OECD countries, the contrary results were found, that higher levels of trade are positively correlated with GHG emissions per capita, and the effect is statistically significant. Afesorgbor & Demena (2022) has conducted research with similar results, in the countries that observed, an increase in trade leading to higher emissions. Wang et al. (2022) reinforces the results of this study and confirms that trade significantly increases CO₂ emissions, as evidenced by the ecological harm inflicted on the environment.

The results of this study that indicate the negative impact of trade on the environment is in line with the theory of the scale of trade. This theory asserts that as a country, particularly a developing one, engages in increased trade, it frequently harms its environment. This is due to the fact that in less developed countries, regulations related to trade and the environment are usually less stringent. This leniency is maintained to preserve their competitiveness in the international market. Fearing a loss of competitiveness, these countries establish inadequate standards for environmental protection. Thus, environmental rules are often loosened to reduce production costs, as well as maintain competitive prices in the global market.

4.8 Robustness Test

Robustness checks are employed in research to assess the stability of the primary regression coefficients when there are alterations in the regression model, such as revisions including the addition or removal of variables in the regression. Leamer (1983) is a researcher who supports for this approach. He found that if the estimated regression coefficients are unstable or fragile, it suggests errors in the model specification. Therefore, it is strongly suggested to regularly conduct sensitivity analysis, such as robustness checks, to identify and correct any possible misspecifications.

When the test results indicate little changes in the coefficients, it is deemed that the model or coefficients are robust. Moreover, taking into account the sign and size of the coefficients in a fair manner suggests that the estimated regression coefficients may be interpreted with confidence as the actual causal effects of the variables. Robustness is essential in regression analysis to guarantee accurate causal inference. This implies that the coefficients of the crucial core variables should be unaffected by the inclusion or exclusion of variables and modifications in the model's specifications, given that certain requirements are satisfied. Robustness tests serve two important purposes: they enhance trust in the

statistical analysis results and bolster the basis for making well-informed and impactful policy decisions in intricate economic situations (Lu & White, 2014).

To assess the reliability of the findings in this study, the author re-examines the effect of economic freedom on GHG emissions in each country observation, by subtracting some control variables, including GDP and GDP2 using a fixed effects model. This approach is used to test the consistency of the results and coefficients of each economic freedom variable when the regression model changes, specifically when one of the predictor variables in the model is reduced. This test is done to enhance the credibility of the interpretation of the findings of the analysis.

Table 4. 12 Robustness Test Result

Greenhouse gas emissions per capita	Model 1 (ALL)			Model 2 (OECD)			Model 3 (Non-OECD)		
	Coef	D/K SE	Prob	Coef	D/K SE	Prob	Coef	D-K SE	Prob
_cons	2.905	0,257	0,000	6.191	0.503	0.000	-0.629	0.545	0.275
Government size	0.068	0,029	0,042	0.103	0.277	0.004	0.016	0.023	0.495
Legal system	-0.010	0,023	0,658	-0.038	0.212	0.103	-0.007	0.053	0.894
Sound money	0.030	0,011	0,021	-0.030	0.053	0.078	0.042	0.007	0.000
Urbanization	-0.024	0,004	0,000	-0.051	0.008	0.000	-0.013	0.003	0.002
Log(Technology)	0.094	0,024	0,003	0,052	0.260	0.070	0.183	0.033	0.000
Trade	-0.003	0,001	0,004	-0,002	0.001	0.036	0.001	0.001	0.088

Data processed by author

Table 4.12 shows the results of the updated estimation utilized fixed effect model for each country observation in the model (1, 2, and 3). After modifying the model by removing 2 control variables consisting of GDP and GDP2. The association between each economic freedom variable and GHG emissions per capita remains consistent while the model is intact. The estimate findings demonstrate that the impact of economic freedom factors on GHG emissions is consistent and unaffected by the inclusion or exclusion of control variables, especially GDP and GDP2. The resilience of the economic freedom variable is seen by the persistent impact it has.

CHAPTER V

CLOSING

5.1 Conclusion

This study evaluates how economic freedom affects the environmental performance of countries that are among the largest emitters, including OECD and non-OECD using panel data regression with a fixed effect model approach from 2010-2020. three variables are used as a proxy for economic freedom consisting of government size, legal system and property rights and sound money along with several control variables that are considered to have an influence on environmental performance proxied by GHG emissions per capita consisting of GDP per capita, urbanization, technology, and trade.

The results show that there is a consistent effect of the two economic freedom variables which are government size and legal system and property rights in all observations. The freer the economy, characterized by less government intervention, implies a negative effect on the environment by increasing GHG emissions per capita. Meanwhile, the freer the economy, characterized by stronger legal protection and property protection, has a favorable impact on the environment by reducing GHG emissions per capita in each observation, for both OECD and non-OECD countries. For the last economic freedom variable, which is sound money, on the observation of all countries and non-OECD, its influence on per capita GHG emissions is positive but insignificant, while in OECD it is negative and significant.

The lack of statistically significant relationship between all economic freedom variables including government size, legal system and property rights and sound money on GHG emissions in non-OECD countries may be due to several factors such as a limited sample of non-OECD countries compared to OECD members observed which may lead to a lack of statistical power to confirm the relationship provided by the coefficients. The presence of highly fluctuating policies and economic situations in non-OECD countries might lead to a lack of significance in the statistical analysis, endogeneity problems may also be potential causes for the insignificant relationship.

The Environmental Kuznets Curve (EKC) hypothesis is validated in OECD nations, however in non-OECD countries this correlation exists but lacks empirical significance. Urbanization leads to a drop in emissions in OECD and non-OECD nations. Research consistently shows that advancements in technology lead to higher levels of

emissions, but trade has the opposite effect, reducing emissions in OECD and all nations except for non-OECD countries where it actually raises emissions.

5.2 Policy Recommendation

The results indicate that a small government intervention causes an increase in emissions in all observed countries, both OECD and non-OECD countries. This evidence proves that the limited government involvement, which is often associated with low decisions made by the government in government spending such as transfers and subsidies, as well as low taxation has the potential to increase GHG emissions. This may lead to a lack of strict policies or regulations from the government especially concerning the environment. The limited power of the government might caused more environmental damage with the freedom to exploit resources without strict restrictions on environmental protection policies. This highlight that in the countries observed, the crucial role of government in promoting both economic development and environmental sustainability. The government is expected to enhance its involvement in safeguarding the environment against the negative impacts of expanding economic activity.

However, the attainment of sustainability alongside with economic development necessities coordination and collaboration between the government and the private sector. Policies such as the implementation of carbon tax and emission trading, which may create stringent emission standards and assist the private sector in reducing emissions. Additionally, there should be stringent regulations on waste management, renewable energy subsidies or assistance in green financing schemes that provide low interest rates to promote more projects that support sustainability. Cooperation with the private sector to build more massive green infrastructure, such as city parks, clean water management, or bicycle lanes which may play an important role in environmental management. Furthermore, government spending on research and development (R&D) may also be increased, especially in supporting R&D in the field of green technology. The government's role in impartial law enforcement, particularly in cases related to the environment and protection of property rights, such as transparent collection of land ownership data, needs to be highlighted to create legal certainty and encourage massive investment in more advanced and cleaner technologies.

In order to achieve a reduction in emissions, it is important to have both the government and the private sector functioning together. This collaboration should involve the development of environmentally friendly technologies and other initiatives aimed at

minimizing emissions costs, while also ensuring economic stability and implementing strong environmental safeguards related to greenhouse gas emissions.

The government in both OECD and non-OECD member countries that have committed to the Paris Agreement are anticipated to have a larger and more significant responsibility in the filing of Nationally Determined Contributions (NDCs) which are also implemented properly by integrating them with the country's current legislation to consistently decrease their national emissions, This is to underscore their dedication to addressing climate change and attaining the objective of the Paris Agreement, which is to limit global temperature increase to below 2 degrees Celsius.

5.3 Research Limitation

This study is inseparable from some limitations so that there is a need for improvisation by future researchers to produce more substantial contributions for academics, regulatory and policy purposes. This study does not take into account endogeneity issues that may arise in the panel regression model. This may potentially lead to biased and inconsistent estimates. It might be beneficial for future consideration to use a more suitable approach, particularly when dealing with the potential influence of endogeneity, in order to generate more dependable outcomes. The utilization of three variables as proxies of economic freedom may not cover all aspects of economic freedom and the chosen time frame is limited, which may result in an incomplete representation of emissions patterns that are affected by a broader set of factors and may not account for the most recent regulations.

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APPENDIX

Appendix 1. Multicollinearity Test (Model 1)

Variable	VIF	1/VIF
gdpsq	267.88	0.003733
lngdp	240.29	0.004162
legal	4.93	0.203014
trade	1.86	0.537398
smoney	1.76	0.566893
Intech	1.76	0.567589
urban	1.70	0.588246
govtsize	1.39	0.721979
Mean VIF	65.20	

Appendix 2. Multicollinearity Test (Model 2)

Variable	VIF	1/VIF
lngdp	2153.96	0.000464
gdpsq	2089.81	0.000479
Intech	2.79	0.358467
legal	2.65	0.377719
trade	2.25	0.444754
govtsize	1.96	0.510347
urban	1.88	0.531929
smoney	1.59	0.630872
Mean VIF	532.11	

Appendix 3. Multicollinearity Test (Model 3)

Variable	VIF	1/VIF
gdpsq	1087.46	0.000920
lngdp	1070.90	0.000934
urban	4.72	0.211861
legal	3.93	0.254368
trade	3.11	0.321706
smoney	2.14	0.466272
govtsize	2.05	0.486781
Intech	1.94	0.515664
Mean VIF	272.03	

Appendix 4. Heteroskedasticity Test (Model 1)

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of lnghg

H0: Constant variance

chi2(1) = 11.29
Prob > chi2 = 0.0008

Appendix 5. Heteroskedasticity Test (Model 2)

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of lnghg

H0: Constant variance

chi2(1) = 20.92
Prob > chi2 = 0.0000

Appendix 6. Heteroskedasticity Test (Model 3)

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of lnghg

H0: Constant variance

chi2(1) = 1.96
Prob > chi2 = 0.1620

Appendix 7. Autocorrelation Test (Model 1)

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation

F(1, 35) = 46.636
Prob > F = 0.0000

Appendix 8. Autocorrelation Test (Model 2)

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation

F(1, 25) = 172.116
Prob > F = 0.0000

Appendix 9. Autocorrelation Test (Model 3)

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
F(1, 9) = 34.392
Prob > F = 0.0002

Appendix 10. Cross Sectional Dependence (Model 1)

Breusch-Pagan LM test of independence: chi2(630) = 1890.933, Pr = 0.0000
Based on 11 complete observations over panel units

Appendix 11. Cross Sectional Dependence (Model 2)

Breusch-Pagan LM test of independence: chi2(325) = 917.010, Pr = 0.0000
Based on 11 complete observations over panel units

Appendix 12. Cross Sectional Dependence (Model 3)

Breusch-Pagan LM test of independence: chi2(45) = 64.692, Pr = 0.0287
Based on 11 complete observations over panel units

Appendix 13. Common Effect Model (Model 1)

Source	SS	df	MS	Number of obs	=	396
Model	42.5414878	8	5.31768597	F(8, 387)	=	33.85
Residual	60.7908663	387	.157082342	Prob > F	=	0.0000
				R-squared	=	0.4117
				Adj R-squared	=	0.3995
Total	103.332354	395	.261600896	Root MSE	=	.39634

Inghg	Coefficient	Std. err.	t	P> t	[95% conf. interval]
govtsize	.1021933	.0261583	3.91	0.000	.0507631 .1536236
legal	.2217905	.0292954	7.57	0.000	.1641926 .2793885
smoney	-.0177954	.0277967	-0.64	0.522	-.0724469 .036856
lngdp	.4777187	.101753	4.69	0.000	.2776608 .6777765
gdpsq	-.0374131	.0074248	-5.04	0.000	-.0520111 -.0228152
urban	.0139464	.0017034	8.19	0.000	.0105974 .0172955
lntech	.075329	.0114685	6.57	0.000	.0527805 .0978774
trade	.0025662	.0004699	5.46	0.000	.0016423 .0034902
_cons	-2.647483	.5148177	-5.14	0.000	-3.659673 -1.635293

Appendix 14. Fixed Effect Model (Model 1)

Fixed-effects (within) regression
 Group variable: countries

Number of obs = 396
 Number of groups = 36

R-squared:
 Within = 0.3261
 Between = 0.0575
 Overall = 0.0570

Obs per group:
 min = 11
 avg = 11.0
 max = 11

corr(u_i, Xb) = -0.9593

F(8,352) = 21.29
 Prob > F = 0.0000

lnghg	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
govtsize	.0713516	.0151121	4.72	0.000	.0416303	.101073
legal	-.043651	.0235993	-1.85	0.065	-.0900643	.0027623
smoney	.0002551	.011208	0.02	0.982	-.021788	.0222981
lngdp	2.764531	.3875971	7.13	0.000	2.002233	3.526828
gdpsq	-.144021	.0201078	-7.16	0.000	-.1835677	-.1044744
urban	-.0426622	.0046692	-9.14	0.000	-.0518452	-.0334792
lntech	.0681485	.0214157	3.18	0.002	.0260297	.1102673
trade	-.0020777	.0005804	-3.58	0.000	-.0032192	-.0009362
_cons	-6.966292	1.490638	-4.67	0.000	-9.89797	-4.034615
sigma_u	1.7620055					
sigma_e	.07936833					
rho	.99797512	(fraction of variance due to u_i)				

F test that all u_i=0: F(35, 352) = 265.67 Prob > F = 0.0000

Appendix 15. Random Effect Model (Model 1)

Random-effects GLS regression
 Group variable: countries

Number of obs = 396
 Number of groups = 36

R-squared:
 Within = 0.2662
 Between = 0.0006
 Overall = 0.0010

Obs per group:
 min = 11
 avg = 11.0
 max = 11

corr(u_i, X) = 0 (assumed)

Wald chi2(8) = 81.99
 Prob > chi2 = 0.0000

lnghg	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
govtsize	.0603033	.0162992	3.70	0.000	.0283575	.0922491
legal	.002693	.0244896	0.11	0.912	-.0453057	.0506917
smoney	.0234833	.0115936	2.03	0.043	.0007603	.0462062
lngdp	.8238785	.2000051	4.12	0.000	.4318757	1.215881
gdpsq	-.0485938	.013264	-3.66	0.000	-.0745908	-.0225968
urban	-.0154032	.0035051	-4.39	0.000	-.0222732	-.0085333
lntech	.041408	.0188474	2.20	0.028	.0044677	.0783482
trade	-.0016813	.0005643	-2.98	0.003	-.0027873	-.0005752
_cons	-.4793101	.6128601	-0.78	0.434	-1.680494	.7218737
sigma_u	.43215693					
sigma_e	.07936833					
rho	.96737094	(fraction of variance due to u_i)				

