FINANCIAL PERSPECTIVE ON GREEN ENERGY

ALİ CAN YÜZBAŞIOĞLU

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ALİ CAN YÜZBAŞIOĞLU

THESIS ADVISOR: PROF. DR. BERNA AYDOĞAN

Master's Exam Jury Members
Prof. Dr. Berna Aydoğan
Prof. Dr. Gülüzar Kurt Gümüş
Prof. Dr. Gülin Vardar

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Approval of the Graduate School

Prof. Dr. Mehmet Efe BİRESSELİOĞLU

I certify that this thesis satisfies all the requirements as a thesis for a Master's degree.

Prof. Dr. Gülem ATABAY

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for a Master's degree.

Prof. Dr. Berna AYDOĞAN

Master's Exam Jury Members

Prof. Dr. Berna AYDOĞAN
Izmir University of Economics

Prof. Dr. Gülüzar KURT GÜMÜŞ
Dokuz Eylül University

Prof. Dr. Gülin VARDAR
Izmir University of Economics

ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have carried out my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

Name, Surname: Ali Can Yüzbaşıoğlu

Date:27.12.2024

Signature:

ABSTRACT

FINANCIAL PERSPECTIVE ON GREEN ENERGY

Yüzbaşıoğlu, Ali Can

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Advisor: Prof. Dr. Berna Aydoğan

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Energy production and the use of energy from renewable sources are one of the most critical issues of today. The increasing population and consequently the increase in the energy need of industrial facilities, and the recent Russia-Ukraine war also emphasize the importance of energy security and energy today and in the future. Therefore, energy demand will increase in the future and it will become a necessity to meet this demand safely. The production of energy has become one of the most important indicators of financial index and financial development. This thesis investigates whether is there a significant long-term relationship between electricity output and the financial index and financial development for a panel of 144 countries spanning the period 1991–2020. In the findings of the research, it was observed that electricity produced from renewable energy sources has a long-term positive impact on financial development and financial index.

Keywords: Green Energy, Financial Development, Renewable Energy, Green Finance.

ÖZET

YEŞİL ENERJİ ÜZERİNE FİNANSAL BAKIŞ

Yüzbaşıoğlu, Ali Can

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Yenilenebilir enerji üretimi ve yenilenebilir kaynaklardan enerji kullanımı günümüzün en kritik konularından biridir. Artan nüfus ve buna bağlı olarak sanayi tesislerinin enerji ihtiyacının artması ve son dönemde yaşanan Rusya-Ukrayna savaşı da enerji güvenliğinin ve enerjinin bugün ve gelecekte önemini vurgulamaktadır. Dolayısıyla gelecekte enerji talebi artacak ve bu talebin güvenli bir şekilde karşılanması bir zorunluluk haline gelecektir. Enerji üretimi finansal endeksin ve finansal gelişmişliğin en önemli göstergelerinden biri haline gelmiştir. Bu tez, 1991-2020 dönemini kapsayan 144 ülkeden oluşan bir panel için elektrik üretimi ile mali endeks ve mali gelişme arasında uzun vadeli anlamlı bir ilişkinin olup olmadığını araştırmaktadır. Araştırmanın bulgularında yenilenebilir enerji kaynaklarından üretilen elektriğin finansal gelişme ve finansal endeks üzerinde uzun vadede olumlu etki yarattığı gözlemlenmiştir.

Anahtar Kelimeler: Yeşil Enerji, Finansal Kalkınma, Yenilenebilir Enerji, Yeşil Finans.

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ADF: Augmented Dickey-Fuller test

BRICS: Brazil, Russia, India, China, and South Africa

CD: Cross-sectional Dependence

DCC: Dynamic Conditional Correlation

DOLS: Dynamic Ordinary Least Squares

EKC: Environmental Kuznets Curve

FMOLS: Fully Modified Ordinary Least Squares

GARCH: Generalized Auto Regressive Conditional Heteroskedasticity

GDP: Gross Domestic Product

GLS: Generalized Least Squares

IMF: International Monetary Fund

KPSS: Kwiatkowski – Phillips – Schmidt – Shin

MENA: The Middle East and North Africa

NP: NG and Perron

NYSE: New York Stock Exchange

OECD: Organization for Economic Co-operation and Development

PP: Phillips–Perron test

SDG: Sustainable Development Goals

SEM: Structural Equation Modeling

The U.K.: United Kingdom

The U.S.: United States

TWh: Terawatt Hour

VCC: Varying Conditional Correlation

SVAR: Structural Vector Autoregressive

VAR: Vector Autoregressive

CHAPTER 1: INTRODUCTION

Energy and climate change have become a trending topic of pressing concern all over the world. These concerns have increasingly given way to measures due to social and political pressure in society. With the increase of these measures, energy obtained from traditional sources, especially petroleum products and coal, has increasingly been replaced by green energy Wang et al. (2023). On the other hand, fossil energy resources largely depend on countries' natural resources capacities. Therefore, it is not possible a country with limited resources to be fully independent. As an example, a series of recent international events, such as the Russia-Ukraine conflicts, have demonstrated the potential for energy to be used as a strategic weapon and impact market conditions. As a response to the prevailing circumstances, nations across the globe have shifted their focus towards generating energy from renewable sources, which they perceive as a viable remedy to the current situation IEA (2023).

In addition to energy strategies as a major driver for renewable energy adoption, climate change has heightened the urgency of transition sustainable renewable energy sources use. The actions of United Nations' (2015), especially the Sustainable Development Goals (SDG)[1] adopted in 2015 and together with the limit global warming to 2 degrees Celsius by reducing excess carbon dioxide (CO_2) emissions in the Paris Agreement (2015), represent important efforts to mitigate climate change. However, the most recent analysis by the Copernicus Climate Change Service (2023) shows that the global warming threshold is highly close to 1.5 degrees. The unanticipatedly rapid rise in temperature necessitates a reevaluation of CO2 emissions and temperature reduction initiatives and targets. To accomplish these objectives, interest in green power capacities should increase rapidly. This transition framework should be designed with the active involvement of all relevant stakeholders to ensure that it aligns with and addresses the diverse expectations of all parties involved.

[1] United Nations (2015) set sustainable goals to achieve several objectives by 2030. These goals include establishing affordable, reliable, and modern energy services globally, significantly increasing the use of renewable energy sources in the global energy mix, and improving energy efficiency. Additionally, they aim to strengthen international cooperation to combat climate change.

According to research published in the Renewable Global Status Report (REN21, 2023), approximately 30% of electricity produced worldwide today is obtained from clean energy. Furthermore, according to British Petroleum's projections and goals (BP, 2023), by 2050, solar and wind energy will %66 of the total global energy production, and demand for renewable energy is predicted to rise quickly. Additionally, the electricity will constitute 75% of the total demand within this increasing demand. In the light of this transition to renewable energy production will undoubtedly increase, however substantial financial mechanisms are needed to promote renewable energy technology.

Globalization[2] and financial developments[3] are crucial for a sustainable future and a country's economy. The financial markets are constantly evolving, and the demand for renewable energy is growing rapidly. Financial globalization and development impact the country's economics and development. It is closely related to financial markets and investments in countries by ensuring the flow of capital, goods and services within countries. In 2022, renewable electricity received an investment of 29.4% of power fuel supply and facilities investments (REN21, 2023). Over the years, the investments on renewable energy resources have been increasing. In the International Finance Corporation report (FY23, 2023), it was stated that the total investment commitment made in global markets in 2023 was 43.7 billion USD, while 14.4 billion USD were allocated to climate finance. This total investment amount can affect more countries, companies, and investors and increase interest in renewable investment. This interest can be examined as financial markets and money flow. Growing investment is one example of a financial indication of a country's development.

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[2] Tobin (1999) describes the globalization "*increasing connections and communications among people regardless of nationality and geography*." Financial globalization describes the control and flow of capital in financial markets all over the world. As stated by Levine (2004), he included in his studies the effects of finance on the economy at a time when the effects of finance on the economy were discussed for years and stated that finance had a significant effect on economic growth. As Tobin (2000) says, "*Globalization of financial markets affects assets and debts - securities, bank loans and deposits, titles to land and physical capital.*" He stated the importance of financial globalization and demonstrated the effects of finance on development and growth.

[3] IMF Financial Development Index is an economic index that separates countries into financial institutions and financial markets, measures depth, access and efficiency, and evaluates the development of these countries according to these criteria.

Previous studies indicate that the effect of financial indicators on electricity production was not directly investigated in the early studies in this sector. Pioneering researchers were influenced by the study of concepts such as income and growth. As the importance of energy increased, they began to investigate its impact on the economy. Kraft and Kraft (1978), have revealed that energy consumption is the main element in ensuring economic growth and called it the growth hypothesis. Yu and Hwang (1984) investigated the linkage among energy consumption, economic activity level and GDP using the current data set. Lately, the number of financial studies investigating the impacts of energy, financial developments, and globalization has increased gradually. However, the impacts of the development and globalization of renewable electricity production as a clean energy source have still not been adequately researched. Over the past five years, energy infrastructure, rising energy demand, and the capital required for its development have emerged as critical factors in shaping national economies and financial systems. The increasing capital flow and investments is a direct response to the escalating energy needs.

1.1. Aim and Contrubition of Thesis

This thesis examines and assesses the effects of renewable electricity on financial markets, along with the reciprocal influence of this markets on renewable electricity. Although previous studies have shown a correlation between economic growth and consumption, there are not enough studies investigating directly green electricity production with financial development and globalization. Consequently, examining this relationship will be a more compelling and underexplored area of study compared to previous research.

This thesis conduces to the current literature in three different manners. Firstly, this study is pioneering on a global scale because it examines not only the linkage among such as sustainable clean electricity together with finance but also takes into account carbon dioxide emissions. While previous studies focused on national or regional scopes and were usually limited to 8 to 10 countries, this study is conducted on a global scale as it includes 144 countries. By carrying out this study, a detailed analysis of differences and trends between countries is provided, providing a broader perspective and thus enriching the literature on this subject.

Secondly, this study used a large time period to observe the long-term impact of finance and carbon dioxide emissions on green electricity production. Thus, more robust results that are less affected by short-term changes were obtained. Moreover, the dataset covers approximately 30 years from 1991 to 2020. A comprehensive perspective on the strong relationship between variables is provided.

Lastly, delves into various aspects of the linkage enclosed by green electricity production and financial markets, including the impact of green energy policies, market trends and dynamics, the role of financial incentives, thereby providing valuable insights for policymakers, investors, and non-governmental organizations. Thanks to the outcomes of this study are expected to conduce to improved consideration of the connection between green electricity production financial markets as well as to the creation of strategies and regulations that encourage profitable and sustainable investments in renewable energy.

This study also contributes to multiple stakeholders. It provides investors and business leaders the opportunity to identify and invest in high-profit renewable energy projects, while it offers policymakers opportunities for financial stability and social development. Additionally, this study supports non-governmental organizations in their environmental protection efforts by providing data that underscores the benefits of renewable energy investments.

In conclusion, with the aim of making a significant contribution to the existing literature, this thesis studies renewable electricity generation, polluting emissions and finance. This integration to pave the way towards a future that is both economically sustainable and environmentally responsible in the future, finance and green electricity concepts should be closely linked to make it possible to achieve the 2030 SDG targets. The study introduces a new framework for financing and developing renewable energy, which encourages the swift adoption of renewable energy solutions, ultimately benefiting all stakeholders involved.

1.2. Structure of the Thesis

Organization of this study includes seven sections. The introduction presents the scope and aim of this research. The second section covers the literature review, summarizing the existing studies relevant to the topic and highlighting gaps this thesis aims to fill. The third section outlines the statistical tests. In the fourth section, econometric methodology is explained. Section five represents the summary statistics along with the data, offering an overview of the key variables and their distributions. Finally, there is a conclusion section explaining the implications and application of the study and about future studies. This section also reflects on the contributions of the thesis to the broader academic and practical discussions.

CHAPTER 2: LITERATURE REVIEW

Over the years, governments have been conducted to achieve energy independence. The aforementioned studies have given rise to an academic field of study that examines the financial implications of energy independence and its relationship to key indicators. Consequently, numerous academic studies have been done on the subject of energy and finance, focusing on both historical and contemporary contexts.

2.1. Energy Consumption and Economic Growth

In spite of conflicting outcomes, a comprehensive review of previous research demonstrates a strong connection between growth and energy consumption. According to energy and financial activities, researchers commonly use energy and GDP. Its common use is because clean and traditional energy use is strongly linked to growth and economic activity as in any economy. This relationship has been studied in existing literature over the years and is categorized under four findings. The most common results that emerged in the results of previous studies is the growth hypothesis, which states that energy consumption increase GDP. Compared to the growth hypothesis, the causality between the variables occurs in the opposite direction, and only has a significance from growth to consumption, is called conversation theory. If there is mutual causality between variables, this is called feedback theory. In this theory, energy and economic growth have simultaneous effects. The theory that has no relationship between the variables is called the neutrality hypothesis.

When the first studies in the literature are looked through, studies mostly were focused on factors affecting the economic growth for a single country. Pioneer researchers who are best-known Kraft and Kraft (1978) investigated the linkage between consumption and growth. Results of their research that conducted on the America example, it was concluded that consumption and growth seriously affect each other. Besides that, it was revealed that only GDP affects EC. In short, it is found the conversation theory that we mentioned before. Akarca and Long (1980) removed the war year data from the same data set that Kraft and Kraft's used and their findings exhibited no causality in either direction. In order to compare these two studies, Yu and Hwang (1984) tested the dataset using Sims and Granger techniques and their test results demonstrate no relationship between GNP and energy consumption. They also included the employment parameter in their tests and found a relationship only between from employment and energy consumption.

Yu and Choi (1985) slightly differentiated their research and used the standard Granger method. They carried out this research with five countries instead of using single country for sample. In addition, energy consumption was investigated in detail and whether other types of energy had an effect on growth. As a result, except for a few analyses no causality was found between variables. A significant relationship with GDP was observed in some of the subcategories of energy consumption. Abosedra and Baghestani (1989), carried out to observe how GDP affects consumption on the American sample using Granger causality method. The result of the research was consistent with some studies, but different from others. It was understood the linkage between variables and this linkage was defined as only from GDP to consumption.

Stern (1993) conducted his research with Granger methodology together with 1947-1990 US data. The results showed linkage was identified among GDP and consumption. Cheng (1995) searched for causality between growth and consumption for the United States by stationarizing the data set and using cointegration techniques and found the linkage among variables. With these studies, unit root test step by step began to be used more in data sets. Masih and Masih (1996), who studied on the same methodology, added the real income parameter to their research. The breadth of the research increased thanks to this study, which found the causality among energy and GDP. Glasure and Lee (1997) conducted causality studies on South Korea and Singapore example. When they evaluated results, they found a strong linkage between consumption and GDP.

Thanks to the developing testing techniques and the easier acquisition of data compared to the past, Soytas and Sari (2003) carried out a causality test by adding more sample countries top 10 emerging markets and G-7 to their research. Although causality emerged between GDP and energy in all countries included in the research, they do not all show the same causality characteristics. This means that different results can be obtained between variables on a country basis. Instead of just time series analysis, panel studies have started to accelerate using the 1975-2001 period data. In this context, Lee (2005) has presented a detailed panel analysis study. In this study, stationary control was performed and FMOLS cointegration methods were applied. Panel causality tests revealed that it is existing relationship between GDP and consumption.

Yang (2000) used causality method to analyze Taiwan's energy consumption data between 1954 and 1997, breaking it down into four categories: electricity, natural gas, coal, and oil. When energy resources are examined separately and in total, it is revealed that they are correlated to GDP. Morimoto and Hope (2004) used power production, economic growth variables between 1960 and 1998 discovered a substantial link for Sri Lankan case. Oh and Lee (2004) examined Korea's contribution of labor and capital to GDP and energy from 1970 to 1999. As an additional illustration, Lise and Montfort (2007) researched the connection between Turkey's economic expansion and energy usage. Turkey will thus strategically develop as an energy corridor and be in a strong position to join the EU in the future.

Prior to the early 2000s, research relied on datasets from multiple nations to identify the meaningful correlation and cointegration between GDP and energy use. Using a large-scale data collection that included GDP and energy consumption Huang et al. (2008) investigated panel data analysis. In this research, it has a large number of countries compared to other studies and countries were grouped according to their income. While there is a significant relationship in the high and low income countries, no relationship is found in the other country groups. In 16 Asian nations, Lee and Chang (2008) conducted research from 1971 to 2002 in an effort to establish causality among GDP and consumption. The results showed a favorable correlation between GDP and energy use. In their study conducted between 1980 and 2004, Apergis and Payne (2009) used GDP and energy consumption data for six Central American nations. Wolde-Rufael (2009) investigated the connection between energy and revenue by utilizing Pesaran and Shin test method on African countries. Ozturk et al. (2010) carried out to investigation the connection between energy and growth using panel data spanning 1971–2005. In contrast to earlier research, no correlation was found between energy and growth.

Belloumi (2009) utilized the Johansen cointegration method to study the causal linkage among GDP and energy for Tunisia and state a meaningful linkage between the variables. Apergis and Payne (2011) examined a panel study of the link between GDP and green and traditional energy resource consumption. The research found a two-way directional causality among growth and consumption in high-income and upper-middle country groups. Nevertheless, they fail to recognize the causal relationship in low-income nations. Apergis and Payne (2012) also researched the linkage between GDP and consumption by adding other variables such as labor force and real gross fixed capital formation.

Nayan et al. (2013) examined a panel study using cointegration technique. This study investigated the causality between consumption and GDP. According to the first model, there are significant and strong positive interaction both ways. Caraiani et al. (2015) examined 5 emerging countries in Europe, including Bulgaria, Hungary, Poland, Romania, and Turkey, between 1980 and 2013. Mahalingam and Orman (2018) carried out a thorough panel data analysis of a dataset that covered all states in the United States. They employed four different methods during this analysis for understanding the linkage among energy consumption and GDP, providing a more comprehensive and nuanced understanding of this complex relationship. There is a significant link between GDP and energy consumption in all states, but the direction and magnitude of causality varies across states. However, a small number of states have found no significant correlation between energy consumption and GDP. Khan et al. (2021) carried out a panel study by adding variables such as population growth and financial development to their studies, as they may have a significant impact in addition to energy consumption and GDP. As a result of the study, meaningful relationship was found between GDP and energy consumption.

Afzal (2017) conducted a panel understand how energy consumption affected the GDP with using 35 emerging countries between 1981 and 2013. As a result of this panel, causality was determined between economic growth and consumption.

Zeeshan et al. (2021) examined the correlation between GDP and traditional energy in Latin American countries from 1990 to 2018. Employing In a different way using structural equation modeling, they stated that GDP and energy consumption are affected.

Ghafoor et al. (2024) conducted a panel study to examine the linkage between energy consumption and GDP in Asian nations from 1998 to 2022. The results indicate a moderately positive correlation between energy consumption and GDP. However, the meaningful among GDP and direct investment is more significantly positive.

2.2. CO2 And Financial Development

Researchers' attention has switched to the connection between a nation's economic indicators and the environment as a result of rising CO2 emissions. In the early research, Shafik (1994) used direct GDP and CO2 studies to undertake a panel regression analysis and created an environmental quality indicator by gathering factors like the availability of clean water, urban sanitation, and ambient levels of sulfur oxides (SO2). It was discovered that certain indicators, such CO2 and solid waste, were negatively impacted by income rise. Eakin and Selden (1995) used a worldwide panel data approach to examine the link between carbon emissions and GDP. They stated that this link is a negative link between carbon emissions and GDP.

Zarzoso and Morancho (2004) conducted a study Environmental Kuznets Curve (EKC) analyzing 22 OECD countries between 1975 and 1998. In this study, the standard EKC model was applied and showed significant heterogeneity between countries. Liu (2005) conducted a panel study on 24 OECD countries using the years 1975-1990. In the model, he included GDP and CO2 jointly into the equation and suggested that there was a negative relationship between the two.

Ang (2007) carried out a comprehensive study in France to delve into the link between CO2 and GDP during the period between 1960 and 2000 and found carbon emissions did not affect the GDP, but the GDP significantly affected CO2. Furthermore, a bidirectional causality relationship was found between CO2 and GDP. Overall, these findings suggest that policies aimed at reducing CO2 emissions should focus on promoting energy efficiency and sustainable economic growth. Chang (2010) investigated the existence of correlation between energy consumption, CO2, and GDP in China with the Granger causality tests and found only energy consumption significantly and GDP. Furthermore, this research demonstrated that it was revealed that an increase in GDP generates an increase in CO2 and consumption.

Using the 1980-2000 period data Al-mulali et al. (2012) performed a study on carbon dioxide emissions, energy consumption, and urbanization in seven zone consisting of Central Asia, The Pacific, East Europe, East Asia, the Middle East, North Africa and Latin America. A significant relationship was found between consumption, urbanization and CO2 in all zones. Shahbaz et al. (2013), in the Malaysian example, delved into the effects of the development of financial on carbon emissions. Using variables such as real GDP, real trade, and real foreign direct investment per capita added to the model, they observed that these variables reduce CO2 emissions. Sousa

(2015) employed the linkage among carbon and GDP in Portugal between 1960 to 2010. The investigation which also included crude oil, fuel price, temperature, and precipitation, observed that environmental factors positively impacted GDP to a certain level.

Dogan and Aslan (2017) investigated the linkage among tourism and carbon emissions in addition to energy consumption, with a panel of EU member and candidate countries between 1995 to 2011 and they found two-way directional causality. Arouri et al. (2012) investigated the 12 MENA countries covering the years 1981 to 2005 linkage among CO2, consumption, and growth utilizing the panel analysis and observed a long-run positive linkage between consumption and CO2. Additionally, Lotfalipour et al (2010) employed the Granger causality test for the linkage among consumption and GDP, using Iran's database adding nonrenewable energy resources and their products between 1967 to 2007 and they found no causality between them.

Mikayilov et al. (2018) analyzed the linkage among CO2 and growth by panel test and stated that this link is a positive link between carbon emissions and GDP. Al-Mulali et al. (2015) delved into the linkage among carbon and GDP adding the development of financial using a data set including 23 European countries and they concluded that CO2 and economic growth have a positive correlation. Okoma (2022) studied China's foreign direct invest and GDP relationship on CO2 emissions and found a positive relationship between all variables.

Pao and Tsai (2010) carried out a panel study covering BRIC countries excluding Russia between 1971 and 2005 and investigated whether there was a significant relationship between GDP, carbon emissions, and consumption. In conclusion, a significant linkage was found among GDP, carbon emissions, and consumption. Baek (2015) studied 12 nuclear energy-producing developed countries in a panel cointegration analysis. Furthermore, delved into the effect of nuclear energy, GDP and energy consumption, on carbon emissions. Unlike other studies, the EKC curve between carbon emissions and growth was not supported. On the contrary, a constant inverse relationship was observed.

Khan et al. (2020) researched many variables such as green energy consumption, carbon emissions, labor force and development of financial, and trade openness as ap panel data analysis of 192 countries. The result demonstrated that this link is a positive correlation among carbon dioxide emissions, clean energy consumption, and the development of financial. It also showed that sustainable resources are closely related to environmental impacts. Boluk and Mert (2014) the linkage among fossil energy consumption, green energy, GDP and carbon output with a panel on the EU. They examined the EKC hypothesis in their study on 16 EU countries between 1990 and 2018. As a result of the research, they found that carbon emissions are inversely affected by green energy and there is no correlation between carbon emissions and GDP.

Okafor (2022) researched the CO2 and GDP linkage using the EKC with 15 North and South American countries between 1967 and 2016. Results stated that this link is a positive significant link between carbon emissions and GDP. As a difference example, EKC analysis is studied by Bouznit and Romero (2016) by adding control variables such as consumption, export, and import to the linkage among CO2 and economic growth and they stated a strong positive linkage between them.

International Energy Agency (2023) stated that they predict that 80% of the available energy will be met from renewable energy sources in 2030. This increase as sufficient in the part of clean energy sources in the energy sector has been found in research. The importance of research on the utilization of clean energy resources and their effect on economic growth and financial markets has increased.

2.3. Renewable Energy and Financial Development

Renewable energy has become an increasingly prominent topic in recent research. Studies examining the relationship between energy and economic growth have produced controversial results leading researchers to study clean energy consumption more thoroughly. Apergis and Payne (2011) examined the linkage between use clean energy use and growth by conducting a panel data analysis of the USA between 1980 and 2006. Economic growth and utilization of energy have directly proportional and clear relationship. Silva (2012) used data from 1960 to 2009 to research the linkage between clean energy sources, GDP, and CO2 in Portugal and Spain. The findings demonstrated an absolute linkage between CO2 and GDP with an opposing linkage among CO2 and clean energy. Kasman and Duman (2015) used a panel analysis to research the linkage between growth, utilization of energy and urbanization, carbon emissions. Unidirectional causality is observed exclusively from GDP, carbon emissions and utilization of energy. Chien and Hu (2007), considering that use of energy from exhaustible source may create energy scarcity in the future investigated the relationship between GDP and clean energy with labor and capital stock and they found an absolute linkage between GDP and sustainable clean energy. In their next study, Chien and Hu (2008) used the relationship between GDP and clean energy sources to investigate using the Structural Equation Modeling (SEM) model and they revealed a major linkage among these variables. Menyah and Rufael (2010) carried out to explain the linkage between the use of growth and clean energy, through the Granger causality test of the USA between 1960 and 2007. Thus, they revealed unidirectional causality from GDP toward the utilization of clean energy.

Utilizing a panel analysis covering 20 OECD countries between 1985 and 2007, Apergis and Payne (2010) investigated the linkage between growth and use of clean energy. Their findings showed that energy consumed from clean energy sources has a major relationship with growth. Later, Apergis and Payne (2010) included 13 nations from Eurasia in panel data sets from 1992 to 2007 examine further whether the use of clean energy can affect growth. The outcomes demonstrate a causal linkage between clean energy resources and GDP. Additionally, illustration Paramati et al. (2017) studied to demonstrate the connection between financial activities and the use of clean energy in an analysis of a panel of the G20 countries and they revealed growth causes a rapid in clean energy consumed.

2.4. Electricity and Financial Development

Acaravci and Ozturk (2010) examined a long-run relationship and causality study between electricity consumption and GDP in fifteen countries. It differs from other study results because they did not find any causality between electricity consumption and GDP. Uninterrupted electricity has been an integral part of daily life for many years, becoming indispensable in modern society. Particularly renewable electricity consumption plays a major role in the growth levels of countries. Al-Mulali et al. (2014) investigated the effects of electricity use on GDP, in 18 Latin American countries and the findings showed that compared to other energy sources, the GDP was more significantly impacted by renewable electricity. Bélaïd and Zrelli (2019) conducted a study using panel analysis data such as GDP, carbon emissions, and non-renewable and renewable electricity consumption and tested 9 Mediterranean countries in this study. According to the research results, it was observed that there is a connection between GDP and renewable, and non-renewable electricity consumption. It was stated that this connection is a bidirectional causality and exist in the short and long term. For the example of India, Ghosh (2002) studied Granger causality and showed that there is a connection between GDP and electricity consumption. It was stated that this connection is a unidirectional causality from growth and toward electricity used. For the case of China, Shiu and Lam (2004) examined Granger causality test between 1971 to 2000 and showed that there is a link between real GDP and electricity consumption. They stated that this link is one-way causality from consumption to GDP. Khanna and Rao (2009) studied the linkage between GDP and electricity and found that electricity consumption is affected by seasonal processes as well as GDP. Odhiambo (2009) examine the linkage between GDP and consumption in Tanzania between 1971 to 2006 and stated that this link is a unidirectional causality from consumption to GDP. Kasperowicz (2014) In Poland between 2000 to 2012, examined a study to investigate the linkage between consumption and growth and found a causal linkage between growth and electricity.

Halkos and Tzeremes (2014) studied the linkage between renewable electricity consumption and growth in 36 countries between 1990 and 2011. Their findings show that electricity consumption has a positive effect on economic growth. Using the form 1960 to 2009 period data, Atems and Hotaling (2018) researched the linkage between the increasing demand for GDP and electricity by adding foreign aid, trade, and inflation rates. They conducted a study using panel analysis covering 174 countries. According to the research results, it was observed that there is a positive linkage between GDP and electricity. In their study, Bélaïd and Youssef (2017) revealed the linkage between GDP and renewable and non-renewable electricity. They stated that this link is one-way causality from GDP toward non-renewable electricity consumption in the short run. Li et al. (2021) searched for a significant causality between clean electricity output along with clean energy resources investments, the green finance index, and economic growth for China between 1990-2020. They found a one-way causality between electricity output, clean energy investments, and GDP. Hu et al. (2023) examined the Canadian data between 1984 and 2021 demonstrating the relationship between electricity and GDP. They found financial development and clean electricity affect GDP.

CHAPTER 3: STATISTICAL TEST

3.1. Cross Section Dependency

Cross section dependency is an econometric model method used in panel data series. In a panel data analysis, countries can affect each other in cases of economic financial crisis and shock by reason of the interaction of some section. To prevent any confusion in panel analysis the CD test should be meticulously carried out whether sections are dependent or not among sections. For this reason, cross-sectional dependency tests are performed in panel data analysis. Panel data series consist of time series with more than one cross-section (different countries, companies). Cross-section dependency is related to whether the observations in a cross-section are related to other cross-sections or whether they are affected by other cross-sections. There are two different main approaches. Methodology of Breusch and Pagan (1980) is lead study for controlling dependency among sections. Another method belongs to Pesaran (2004) which is improved and suitable version.

A panel data model mentioned below and i refers to cross section dimension use for time series.

$$y_{\mathrm{it}} = a_{\mathrm{i}} + \beta'_{\mathrm{i}} x_{\mathrm{it}} + u_{\mathrm{it}}\,, for\ i = 1,2,\ldots,N; t = 1,2,\ldots,T, \tag{1}$$

Pesaran (2004) can be applied to smaller sample groups also it can be applied to larger sample groups compared to other test methods. Pesaran (2004) panel data analysis used the following model for CD testing

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1} \sum_{J=i+5}^{N} \hat{P}_{iJ}\right) \cdot \tag{2}$$

According to CD Test results, unit root tests differ depending on panel data cross-section independency. In case of no cross section, the tests that should be applied are

Fisher ADF, Levine et al. (2002) and Breitung (2000) which these are grouped first generation unit root tests. In the event that data set is cross-section dependent, Bai and NG or Pesaran CIPS second generation tests are applied.

3.2. Unit Root Test

In panel analysis, the fact that the data set contains a unit root over time affects the results of the analysis. However, the same type of unit test cannot be performed in all cases. After the Pesaran (2004) test, determining the dependency of the cross sections, the acceptance of the null hypothesis indicates the situation where is no cross-section. Unit root selection is made according to the criteria described above. With unit root tests, it is possible to observe the statistical differences of dataset over time. In order for models to provide more accurate results, the stationarity of the series over time is a parameter that must be taken into account. The selection of unit root test after cross-section dependency test is carried out. Depending on the cross-section dependency result, two different generation unit root tests can be applied. First generation tests[4] are applied to series that do not have cross section dependence while second generation tests [5]are applied to series with cross section dependence.

In this thesis, since cross section dependence time series will be studied, it was deemed appropriate to perform the second unit root test. ADF statistics were used to represent the following.

$$\Delta Y_t = \beta, + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \varepsilon_t \tag{3}$$

Pesaran (2007) IPS (2003) statistics based on the average of individual CADF are called IPS (CIPS) with an increased cross-section. It is expressed as follows.

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF_i \tag{4}$$

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[4] The first-generation unit root tests mentioned in the literature are divided into as Nonstationarity tests such as; Levin and Lin (1992), Levin et al. (2002), Harris and Tzavalis (1999), Im et al. (1997), Maddala and Wu (1999) and Choi (1999) and Stationarity test as Hadri (2000).

[5] The second-generation unit root test factor structure has been defined as Bai and Ng (2001), Moon and Perron (2004), Phillips and Sul (2003), Pesaran (2003) and Choi (2002). Other appoaches consist of O'Connell (1998) and Chang (2002) tests.

Pesaran (2003) enlarged his model to serially correlated residuals.

$$\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + c_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij}\, \Delta\bar{y}_{t-j} + \sum_{j=0}^{p} \beta_{ij} \Delta y_{t-j} + \mu_{it}. \quad (5)$$

The stationarity of the series is decided when the CIPS and CADF values calculated in the equations are compared with the critical cable values in the Pesaran (2007) study.

CHAPTER 4: METHODOLOGY

To understand the linkage between green energy, financial development as well as carbon emissions, it has been created balanced panel data. While this panel method is creating, it has been taking into consideration the panels dynamic features. 144 country is involved in balanced panel data which means largely analysis data is formed. Baltagi (2001) has worked on panel data analysis in detail. The model he has established has been preferred because of its approach to heterogeneity and reliability. Kasman and Duman (2015), Apergis and Payne (2010) also used this technique. A cointegration method based on the standard log-linear form of the variables is employed to examine long-term relationships. Additionally, this study investigates the linkage between electricity output and CO2 emissions, providing a comprehensive understanding of their interaction. The model equation is represented as below:

$$REO_{it} = a_i + \gamma_i t + \beta_{1i} FIN_{it} + \beta_{2i} FID_{it} + \beta_{3i} COE_{it} + \beta_{4i} REC_{it} + \beta_{5i} EC_{it} + \varepsilon_{it} \quad (8)$$

$i = 1, 2, ..144$ indicate the countries, to idendicate data set time period $t = 1991, .. 2020$ is used, the parameters a_i and γ_i represent country-specific fixed effect and deterministic trends, β_i denotes the coefficients of REO represent renewable electricity output, FIN financial globalization index, FID financial development, REC renewable energy consumption, COE CO2 emissions EC energy consumption, ε_{it} denotes the estimated residuals deviated from the long-run relationship. This research aims to quantitatively test the relationship between renewable electricity output and financial development. Firstly (2004) cross-section dependency is examined. After determining the cross-section results, Peseran CIPS unit root test should apply due to control data set whether stationary or not. Then, a meaningful relationship between the variables is determined by performing co-integration tests. As a result of the test, cointegrating vectors are found between the variables. These vectors reveal a significant correlation among REO, FIN, FID, COE, EC and REC. Kao (1999) and Pedroni (1999, 2004) applied and developed cointegration tests due to understand long-term relationships among data series. Like many previous studies, after Kao (1999) cointegration test, FMOLS and DOLS tests were conducted to ensure greater accuracy and consistency. Although the results are different, previous studies have generally demonstrated long-term correlated on positively among financial development, globalization and green energy. The opposite effect was found between CO2 and green energy. In this study, it is similarly expected that the relationship between the renewable electricity output examined and financial indicators will be positive. The increasing level of financial development and indispensable way of all over the world is globalization. Undoubtly, these facts will increase investments in green energy sector. It is predicted that financial development will also reduce CO2 emissions indirectly.

CHAPTER 5: DATA AND SUMMARY STATISTIC

In this section, the dataset is explained, and analysis methods are presented. For this series analysis, Eviews econometrics software is used.

5.1. Data Description

The panel dataset utilized in this study encompasses a large dataset covering 144 countries worldwide between 1991 and 2020. A balanced panel analysis with the data set including complete data for all variables across the selected countries for the entire time frame, was conducted. In this way, provided more accurate and certain analysis results. Countries with missing data were excluded from the study, thereby enhancing the accuracy and consistency of the findings.

Figure 1. Sample Countries

During data sources scanning many different sources in the literature were used. Although the number of countries in the study was large, all data example meticulously were scanned, compiled and collected completely. The data used in this study is meticulously compiled from different sources. The most commonly used data source is IEA. For collection of REO, COE, EC and REC, IEA archive has been scanned. FID is retrieved from the IMF database. FIN is taken from the KOF (Konstanz Center for Financial Research) database. All data is presented in detail in Table 1.

Table 1: The variables used in the models (Source: World Bank, KOF Swiss Economic Institute, IMF Database, EIA Database)

Variables	Definition	Units
Renewable Electricity Output	Electrical energy obtained from renewable sources such as solar, wind, hydroelectric, geothermal and biomass is a sustainable and environmentally friendly form of production. The amount of electricity produced from these sources represents a type of energy that is naturally renewable and continuous. It is crucial to measure a country's dependence on renewable energy and thus how much it reduces its carbon footprint. The use of renewable energy also plays a critical role in the transition to a more sustainable energy mix.	MWH
Financial Development Index	The Financial Development Index is a comprehensive indicator that measures the overall soundness, functioning and stability of a country's financial system. This index considers various factors such as ease of access to financial services, depth of financial markets, soundness of financial institutions and effectiveness of legislation regulating financial activities. Offering comparative analysis between different economies, the Financial Development Index provides important information about the capacity and effectiveness of a country's financial system to support economic development, investment opportunities and general stability.	(0-100 scale)
Financial Globalization Index	The Financial Globalization Index is an indicator designed to measure the extent of financial connectivity and integration between countries. This index considers various factors such as cross-border capital flows, international investment positions and the presence of financial institutions in global markets. It is used to quantitatively evaluate how involved countries are in the global financial space and the level of integration of their financial systems with the world.	(% 0-100 scale)
Carbon Dioxide Emissions	It is a greenhouse gas produced by burning fossil fuels (coal, oil and natural gas), industrial production processes, destruction of forests and burning of organic materials. Carbon dioxide is emitted into the atmosphere as a greenhouse gas, trapping heat, leading to global warming and climate change. Adverse environmental impacts such as rising temperatures, changing weather patterns, and ocean acidification are directly related to increased CO2 emissions. Therefore, monitoring and reducing carbon dioxide emissions is vital for mitigating the effects of climate change and transitioning to a more sustainable future.	(% of GNI)
Non-Renewable Energy Consumption	It is the consumption of energy produced from fossil fuels such as coal, oil and natural gas, as well as nuclear energy. Unlike renewable energy sources, non-renewable forms of energy are limited in quantity and take millions of years to form. Therefore, the use of non-renewable energy resources causes serious environmental problems such as air and water pollution, greenhouse gas emissions and depletion of natural resources.	(% of GNI)
Renewable Energy Consumption	Resources such as sunlight (solar energy), wind, water (hydroelectricity), geothermal heat and biomass are examples of renewable energy. Unlike fossil fuels, renewable energy sources are constantly renewed and cause minimal damage to the environment. Therefore, renewable energy sources play an important role in efforts to reduce greenhouse gas emissions and transition to sustainable energy systems.	(% of GNI)

Financial globalization index is an indicator developed by KOF and the Swiss Economic Institute Gygli, by Haelg et al. (2019). This index is calculated by combining different components is showed at Table 2 according to certain weights. This index facilitates understanding the issues such as monitoring globalization trends in the world by comparing the financial systems of countries and evaluating the impact of financial globalization index, where each component represents a different financial aspect, consists of components demonstrated at Table 2. Foreign direct investments indicate the amount of foreign investment that enters a country, and these investments generally include long-term investments such as factories and facilities. Some researchers have tried to reveal the importance of foreign direct investment. Foreign direct investment is too crucial for the financial standing of countries together with their international trade Cole et al. (2017). It has also critic role with economic growth Borensztein et al. (1998). However, portfolio investment indicates investments made in financial investments such as bonds and stocks in that country. This index includes not only investments made in that country but also payments such as international debt and international income payments. In general, a comprehensive index is created for a country's financial situation.

Table 2 shows the construction of financial globalization with their weights.

Table 2: KOF Financial Globalization Index Structure and Weights (Source: KOF, 2019)

Financial Globalization	**Weights (%)**
Foreign Direct Investment	% 25,7
Portfolio Investment	% 15,3
International Debt	% 29,9
International Reserves	% 0,5
International Income Payments	% 28,6

International Monetary Fund (IMF) is an international organization that follows and guides the economic developments of countries and tries to increase their development in more than different way. The development index FIN which is among studies of this institution, is an indicator that measures the financial systems of 180 countries around the world from different financial aspects. These aspects are calculated by taking into account two main factors. One of the main factors named financial institutions involves financial measures as percentage of GDP. The other factor is financial market. We can see index content in the Table 3. These two main factors are divided into three different subgroups. In this way, it becomes possible to compare the financial situations and systems of competitors with theirs and monitor changes over time.

In order to provide an overview of other parameters that form the basis of financial development, the parameters are explained separately here and the index structure is shown in Table 3. **Financial institution depth** is the proof of financial strength and infrastructure qualities. These variables not only reflect the soundness of financial system but can also determine management strategies. A sound financial system contributes to economic stability and resilience against fluctuations. **Financial institution access** measures the quality and availability of financial services infrastructure. Providing insights into how accessible financial services and system quality are evidenced within a country, by the breadth of the commercial bank sector. **Financial institution efficiency** evaluates the overall performance and effectiveness of financial institutions. Financial institution efficiency evaluates the overall performance. This performance determines how often the financial instruments in the market are used. For example, net interest margin emerges as a factor determining bank profitability and financial activity can be activated by this factor. Return on equity is an example of investment profitability.

Table 3: IMF Financial Development Index General Structure (Source: IMF, 2016)

Financial Development (FD)	
Financial Instution (FI)	Financial Markets (FM)
Depth (FID), Access (FIA), Efficiency (FIE)	Depth (FMD), Access (FMA), Efficiency (FME)

Financial market depth significantly affects market development and linear financial development. **Financial market access** measures the openness of financial markets, giving an idea of how easily various entities can participate. Lastly, **financial market efficiency** is evaluated using metrics such as stock trading volume or the turnover ratio, which reflect the ease and speed with which assets can be bought and sold in financial markets.

5.2. Descriptive Analysis

Descriptive statistical analysis is performed to assess the characteristics of the data set and to evaluate the appropriateness of the model employed. Table 4 provides the summary statistics for the key variables under study, which include Renewable Electricity Output (REO), Financial Development (FIN), Financial Institution Depth (FID), Carbon Dioxide Emissions (COE), Renewable Energy Consumption (REC), and Electricity Consumption (EC), across 144 countries.

Table 4. Descriptive Statistics

	REO	FIN	FID	COE	REC	EC
Mean	26.867	55.337	0.299	189.000	0.280	109.987
Standard Deviation	100.463	18.119	0.232	785.809	1.071	444.101
Min	0.000	0.000	0.000	0.000	-0.168	0.000
Max	2174.558	98.256	1.000	10841.55	19.003	7115.077
Skewness	0.000	0.134	0.000	0.000	-0.168	0.000

According to the descriptive statistics, the skewness value for all variables are either zero or close to zero, indicating that the data set is nearly perfectly symmetric. A symmetric distribution is advantageous due to its reliability and ease of estimation. As a result, descriptive analysis method is used to present the general summary of the data.

Additionally, the standard deviation serves as an indicator of the reliability of the study. This test shows the distance between the data and the mean. Variables such as Renewable Electricity Output (REO), Carbon Dioxide Emissions (COE), and Electricity Consumption (EC) exhibit higher standard deviations, suggesting greater variability in these variables. In contrast, Financial Institution Depth (FID) and Renewable Energy Consumption. While these findings offer initial insights, it would be beneficial to perform further statistical tests for a more detailed and comprehensive analysis.

CHAPTER 6: EMPIRICAL RESULTS

This section examines the preliminary tests for panel data analysis, including cross-section dependency and CIPS test, to ensure the robustness and validity of the dataset. Besides, it presents the emprical results of the linkage among green electricity output, CO2 emissions, financial globalization and financial development. In addition, these variables, the non-renewable energy consumption and renewable energy consumption data are added for ensuring test reliability. To explore these linkage, Pedroni and Kao cointegration tests are employed, followed by FMOLS and DOLS analyses. These methods help identify the strength and direction of the long-term associations among the variables and provide more accurate estimates of the relationships.

6.1. Stationary Test

In order to understand the effect of countries on each other based on variables used in dataset, Pesaran (2004) test was applied. The test results are demonstrated in detail with Table 6. According to the findings if the null hypothesis is accepted, it will be interpreted as there is no cross-section dependency.

Table 5. Cross-Sectional Dependence Test Results

Variables	**Statistic**	***p*-value**
Renewable Electricity Output	306.729	0.000*
Financial Development Index	166.448	0.000*
Financial Globalization Index	258.262	0.000*
Carbon Dioxide Emissions	172.910	0.000*
Non-Renewable Energy Consumption	240.164	0.000*
Renewable Energy Consumption	373.855	0.000*

Notes: The CD test is based on Pesaran (2004) methodology.
* denotes statistical significance at 1% level.

The CD test result demonstrated that, the null hypothesis (H0) is strongly rejected, indicating significant cross-sectional dependence within the series and model. This result suggests that the financial development or crisis in certain countries may have repercussions on other countries. Consequently, when formulating policies, countries must consider not only their own economic and financial policies but also those of other nations, as well as the environmental factors influencing these countries. Due to the emergence of cross-section dependency on all variables, second-generation unit root tests should be performed to check the stationary of the series.

The CIPS second generation unit root tests are applied on both the level and first differences of the time series, utilizing two distinct specifications: one with an intercept and the other with a trend correction. The test results, presented in Table 5, demonstrate that, on average, the variables do not exhibit a unit root at either level or first difference. This outcome suggests that the series maintain a constant mean and variance. Consequently, this result indicates that the series do not show permanent responses to shocks and are suitable for econometric modeling.

Table 6. CIPS Second Generation Panel Unit Root Test Results

Variables	Level		First Difference	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
REO	-2.013	-2.466	-4.310*	-4.348*
FIN	-2.52**	-2.875*	-4.281*	-4.434*
FID	-2.414	-2.757*	-4.458*	-4.165*
COE	-2.676*	-2.406	-3.791*	-4.206*
REC	-2.127	-2.804*	-4.222*	-4.144*
EC	-1.910	-2.285	-8.930*	-9.139*

Notes: t-statistics are reported. The critical values CIPS with intercept and trend: 1% (–2.65), 5% (-2.55) and 10% (–2.50).
*, and ** denote statistical significance at 1%, and 5% level.

Table 5 indicates that some variables are not stationary at the levels. After the first difference of all variables are taking, all variables turned the stationary. This observation implies that the variables possess a constant mean and variance over time and do not exhibit permanent responses to shocks. The significance of this finding lies in its implications for econometric modeling and analysis. Models constructed with stationary variables are generally more robust and yield more reliable results, thereby enhancing the validity of empirical findings.

6.2 Cointegration Test

After the CD and CIPS unit root tests, the study proceeds to examine the relationship with the cointegration test technique. For this purpose, two different tests were conducted. One of the tests is developed by Pedroni (2004) test other one is Kao (1999) tests. The test results are given in Table 7 and explained under two different headings: within-dimension and between-dimension approaches. The within dimension type includes panel v-stat, panel rho-stat, panel PP-stat, panel ADF tests, while the between dimension type includes group rho-stat, group PP-stat and group ADF-stat tests.

Table 7. Pedroni's (2004) Residual Cointegration Test Results

	No deterministic trend				
Statistics	**Within-dimension**		**Statistics**	**Between-dimension**	
No deterministic trend	**Statistics**	***p*-value**		**Statistics**	***p*-value**
Panel v-stat	-1.661	0.9517			
Panel rho-stat	5.179	1.000	Group rho-stat	8.010	1.000
Panel PP-stat	-2.813	0.002*	Group PP-stat	-1.656	0.048**
Panel ADF-stat	-3.806	0.001*	Group ADF-stat	-4.183	0.000*
	Deterministic Intercept &Trend				
Statistics	**Within-dimension**		**Statistics**	**Between-dimension**	
No deterministic trend	**Statistics**	***p*-value**		**Statistics**	***p*-value**
Panel v-stat	-2.821	0.997			
Panel rho-stat	9.244	1.000	Group rho-stat	9.674	1.000
Panel PP-stat	0.301	0.618	Group PP-stat	-4.644	0.000*
Panel ADF-stat	-1.379	0.083***	Group ADF-stat	-7.282	0.000*
	No deterministic intercept or trend				
Statistics	**Within-dimension**		**Statistics**	**Between-dimension**	
No deterministic trend	**Statistics**	***p*-value**		**Statistics**	***p*-value**
Panel v-stat	-3.432	0.999			
Panel rho-stat	3.619	0.999	Group rho-stat	5.85	1.000
Panel PP-stat	-2.248	0.012**	Group PP-stat	-6.193	0.000*
Panel ADF-stat	-4.522	0.000*	Group ADF-stat	-6.835	0.000*

Notes: The null hypothesis is that the variables are not cointegrated. Lag selection is based on Schwarz Info Criterion (SIC).
*, ** and *** denote statistical significance at 1%, 5% and 10% level.

After the Pedroni (2004) test was applied, it indicated the significant cointegration within the model. It means that there is a relationship between the analysis variables within the model.

Table 8. Kao's (1999) Residual Cointegration Test Results

	t-stat	*p*-value
ADF	-13.29652	0.000*

Notes: The null hypothesis is that the variables are not cointegrated. Lag selection is based on Schwarz Info Criterion (SIC).
* denotes statistical significance at 1% level.

Additionally, for comparison and control purposes with Pedroni (2004) test results, Kao (1999) cointegration test is applied. The results are outlined in Table 8. The null hypothesis case shows that there is no cointegration among variables. According to the test results, p values are 0.00 which means strongly rejects the null hypothesis. This shows that there is a strong cointegration among the variables. The findings from Kao's test align with those of Pedroni's, supporting the presence a positive and significant linkage among variables.

Following the establishment of a long-run relationship, as evidenced by the Pedroni and Kao cointegration test, renewable electricity consumption, financial globalization, financial development, CO2 emissions, non- renewable and renewable energy consumption are estimated using FMOLS and DOLS estimation methods. The outcomes are presented in Table 9.

Table 9. Results of FMOLS and DOLS Tests

Variables	FMOLS		DOLS	
	Coefficient	t-statistics	Coefficient	t-statistics
FIN	0.001	0.101	0.052	0.681
FID	1.673	1.192*	8.863	-3.046**
COE	-0.019	-1.74*	-0.090	-3.596**
REC	94.81	64.25***	99.886	39.218***
EC	0.014	1.129	0.025	0.997

Notes: *, **, and *** denote statistical significance at 1%, 5% and 10% level.

Only FID, COE and REC are indicating a long-rung relationship. FID and COE are significant at %1 level. The results of the tests conducted by Pedroni (2004), explained in Table 9, reveal that with the except for REC and FIN, all results are significant level at %1 level. While a positive relationship exists between REO and financial indexes and energy consumption, a negative relationship is observed with CO2 emissions.

According to the panel FMOLS results, the elasticity of REO with respect to FID is 1.673, indicating that a 1% increase in FID corresponds to a 1.673% increase in REO. On the other hand, as COE increases by 1%, REO decreases by 0.019%, demonstrating that renewables electricity output has a mitigating effect on CO2 emissions. As expected, a 1% increase in REC results in a 94.81% rise in REO.

This study supports existing literature regarding the linkage among green electricity output and its financial impacts, corroborating findings from the studies such as Chien and Hu (2007), Chien and Hu (2008), Odhiambo (2009), Apergis and Payne (2011), Silva (2012), Al-mulali et al. (2014), Halkos and Tzeremes (2014), Kasman and Duman (2015), Bélaïd and Youssef (2017), Atems and Hotaling (2018), Bélaïd and Zrelli (2019). Furthermore, concerning the relationship between renewable electricity output and CO2 emission, the results of this study are consistent with previous studies such as Chiu and Chang (2009), Apergis and Payne (2011), Silva (2012), Boluk and Mert (2015), Al-Mulali et al. (2015), Aydogan and Vardar (2019), which highlight the connection between renewable energy and environmental factors.

CHAPTER 7: CONCLUSION

Renewable energy is a commodity with a market structure that can be bought and sold with spot and future features Halkos and Tsirivis (2019). With this feature, countries globally base their strategies on energy. Due to rapidly growing global demands, renewable electricity production in the markets has accelerated in recent years. In 2024, global energy investment exceeded 3 trillion USD for the first time in history. One trillion of these investments will be fossils two trillion consist of clean energy investments IEA (2024). In 2024, more than 80% percent of all new power plants built in the world are renewables IEA (2024). This shows that futures are renewable technology, and their financing is rapidly growing. By 2030, half of all cars sold are expected to be electric, and electric air conditioner sales are expected to increase globally due to global heat waves and rising income levels IEA (2024). In addition, artificial intelligence and data centers are also accelerating the increase in electricity demand. In the light of this expectations, it is crucial to understand impact of green energy transition on entire market, as well as the impact of green electricity directly on markets. Examining renewable electricity productions importance on financial markets is necessary for market management and risk assessment. Although studies in the literature were conducted on individual countries, they may not provide a general perspective. For this reason, they should be examined on a global scale.

This thesis tries to explain the features such as financial development, financial globalization, green energy considering with environmental impacts. Globally 144 countries were included in this panel analysis. The time series choose between 1991 and 2020, covering approximately thirty years. In this research, the econometric method is which applied by Pedroni (1999) and Kao (2004) cointegration test technique.

Before beginning the analysis, the data set was brought to balanced form. Missing data were excluded from the analysis. When all data was completely converted to a balanced panel type, it was checked whether there was any dependency situation between sections. With this controls, misleading results were prevented. In addition, the reliability of the model was increased. After the test, it was concluded that the sections were dependent on each other. In consequence of dependence test, the second-generation unit root test (CIPS) was performed. After that, Pedroni and Kao's cointegration tests were conducted to understand the linkage among variables. There is a positive linkage among green electricity output, financial globalization and development. Besides, it can be said that financial indications are of great importance for renewable electricity production. In addition that, the relationship between CO_2 and other variables are negative correlated as expected. Financial development and globalization will increase electricity production and therefore reduce CO_2 emissions. As a result of the analysis, it has been revealed that green electricity is indispensable for the whole world. It will be a turning point for climate change with the 2030 targets. It can also be said that renewable electricity is very effective in reducing the effects of global warming. New global investments and incentives made for green need to be maximized urgently. In addition, a considerable amount of money needs to be provided for issues such as energy efficiency and smart grid. Also supporting a transparent and effective electricity market structure has great financial importance. It should never be forgotten that all these investments are based on countries economic structures such as financial development and GDP.

This research differs from previous studies by utilizing panel data analysis on a larger scale and over a longer time period to examine the relationship between renewable electricity and financial markets, while also considering their environmental impacts through CO_2 emissions. Moreover, the study identified distinct patterns of investor behavior, reflecting an increasing preference for environmentally conscious investments, which aligns with the expansion of renewable energy initiatives.

The consequences of this study can be interpreted under two main headings. First, the growing global demand for energy will likely lead to increased investments in electricity production and related financial activities. This highlights the potential impact of electricity produced from renewable energy sources on financial economies. In this context, for investors, these increasing investments may offer insights into reducing the costs associated with renewable energy production, particularly in sectors like solar and wind energy. Besides that, it can benefit portfolio investors and international finance managers, and those involved in foreign direct investments. The insights derived from this research can guide decisions regarding financial investments, risk management in portfolios, and profitability, especially when considering new investments in renewable energy sources. Thus, renewable energy presents opportunities not only for reducing environmental impacts but also for shaping global financial strategies.

Secondly, this study can be instrumental in research conducted by global environmental organizations and other non-global entities. The reduction of CO_2 emissions, a key component of the Sustainable Development Goals (SDGs), can be accelerated through a faster transition to renewable electricity sources. This underscores the vital role of renewable energy in achieving environmental targets.

As a result, it is understood that the positive result on the impact of renewable electricity production on financial performance is consistent with most studies in the literature. It has also been confirmed that renewable electricity is the major driver on climate change by reducing CO_2 emissions.

This research investigates the linkage among the green electricity sector, financial dynamics and environmental consequences looking at CO_2 output and it seen that the scope of studies in this area can be further expanded. factors such as financial globalization and financial development stand out as the main financial variables examined in the study. However, considering the rapid expansion of the literature on green electricity, finance and new developments in this field, further research is required. However, issues such as financial risks in the energy transition process, diversification of green investment instruments and climate finance should be examined in more detail in future research.

Moreover, future studies can build upon this research by incorporating additional financial indices, moving from general to more specific measures, and offering new perspectives. This could provide deeper insights into the interactions between green electricity, financial development, and environmental sustainability. Consequently, this study serves as critical research for comprehensively understanding the interconnectedness of renewable electricity, financial markets, and environmental protection.

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APPENDICES

Appendix A - Sample Countries

Albania	Croatia	Latvia	Samoa
Algeria	Czechia	Lebanon	Sao Tome and Principe
Angola	Denmark	Lesotho	Senegal
Argentina	Dominica	Lithuania	Sierra Leone
Armenia	Dominican Republic	Luxembourg	Singapore
Aruba	Ecuador	Madagascar	Slovenia
Australia	Egypt	Malawi	South Africa
Austria	El Salvador	Malaysia	South Korea
Azerbaijan	Equatorial Guinea	Mali	Spain
Bangladesh	Eritrea	Mauritania	Sri Lanka
Belarus	Estonia	Mauritius	Sudan
Belgium	Eswatini	Mexico	Suriname
Belize	Ethiopia	Moldova	Sweden
Benin	Fiji	Mongolia	Switzerland
Bhutan	Finland	Morocco	Syria
Bolivia	France	Mozambique	Tajikistan
Bosnia and Herzegovina	Gabon	Namibia	Tanzania
Botswana	Georgia	Nepal	Thailand
Brazil	Germany	Netherlands	Togo
Bulgaria	Ghana	New Zealand	Trinidad and Tobago
Burkina Faso	Greece	Nicaragua	Tunisia
Burundi	Guatemala	Nigeria	Türkiye
Cabo Verde	Guinea	North Macedonia	Turkmenistan
Cambodia	Guyana	Norway	Uganda
Cameroon	Haiti	Pakistan	Ukraine
Canada	Honduras	Panama	United Arab Emirates
Central African Republic	Hong Kong	Papua New Guinea	United Kingdom
Chile	Hungary	Paraguay	United States
China	Italy	Peru	Uruguay
Colombia	Jamaica	Philippines	Uzbekistan
Comoros	Japan	Poland	Venezuela
Congo-Brazzaville	Jordan	Portugal	Vietnam
Congo-Kinshasa	Kazakhstan	Romania	Zambia
Costa Rica	Kenya	Russia	
Cote d'Ivoire	Kuwait	Rwanda	