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The impact of green finance on environmental protection

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Abstract Green finance, in contrast to traditional finance, has a close relationship with the environment and offers several advantages. This is why the study tries to illustrate how green financing affects environmental protection and evaluates its contribution to reducing environmental pollution. Green finance is an innovative method of funding with the goal of preserving the environment. It is crucial, widely discussed, and has caught the interest of many academics. They include programs that stimulate spending on initiatives aimed at minimizing adverse environmental effects. This study highlights the importance of green finance in environmental protection for the 36 OECD countries for the 11 years from 2010 to 2021. Panel data is used to derive results by applying models such as OLS, OLS Robust, Fixed effect, Random effects, and GMM. Empirical results according to the GMM method show that green finance has a positive impact on environmental protection, so the growth of green finance affects the reduction of carbon dioxide emissions.

Keywords: CO2, green finance, environmental protection, GMM

1. Introduction

Spending on environmental protection has begun to grow and is perceived as an increasingly important priority in the countries of the Organization for Economic Co-operation and Development (OECD) in recent decades. Over the years, the development of awareness of the impact of environmental pollution and destruction, as well as the need to improve the quality of life of citizens and the sustainability of development, has led to increased investments and expenditures for environmental protection.

Spending on environmental protection in the countries of the Organization for Economic Co-operation and Development (OECD) varies from country to country and varies to different degrees, but generally includes different investments to preserve and improve the environment in different aspects. The OECD is an international organization that includes developed industrialized countries and has a strong focus on economic and social development policies, including environmental aspects.

Environmental protection expenditures otherwise known as "green finance" include all costs and investments that are made to preserve, protect and improve the state of the natural environment and the interaction of people with the environment.

As a new form of financing with the aim of protecting the environment, green finance is essential and the most discussed and has attracted the attention of many researchers. They include mechanisms that encourage investments in projects that aim to reduce the negative impact on the environment. Green finance is vital for financing renewable and clean energy projects to degrade carbon emissions and their harmful impacts on human health and environmental sustainability (Bom, 2019).

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Green finance is a procedure or a model that is designed to allocate financial resources for environmental development (Hemanand, 2022). Green finance, in contrast to traditional finance, has a close relationship with the environment and offers several advantages. This is why the study tries to illustrate how green financing affects environmental protection and evaluates its contribution to reducing environmental pollution.

As an effort to reduce the impact of carbon dioxide emissions and to keep the increase in temperature below 2 degrees C, the Paris Agreement was created.

The countries of the Organization for Economic Cooperation and Development, also known as more developed countries, are making their efforts so that their national strategies take a special place in this agreement. Of course, the rate of industrial development of the countries has caused the countries to have a high level of environmental pollution and here it has influenced that these large industrial growths lead to the speed of environmental degradation, among the biggest

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polluters in the world it is considered to be carbon dioxide emissions However, many countries are not on track to meet their targets and the agreement does not address other forms of environmental degradation (Umar, 2023a).

The big industrial growths have caused the speed of environmental degradation, among the biggest polluters in the world is considered to be the emission of carbon dioxide. Therefore, there is an urgent need to provide a reliable, affordable, and environmentally friendly solution that will help limit global warming, which is necessary for the survival of mankind (Iqbal, 2021a).

Environmental protection requires time and continuous financing, as such green finance is the main way of financing. The construction of environmental protection should consider the establishment of the mechanism of an efficient green financing system that coordinates the relationship between ecology and finance (Wang Y. &., 2016).

The purpose of the study is to analyze the impact of green finance on environmental protection in OECD member countries. The study also aims to analyze how green financial development, population density and trade affect the protection of the living environment. Since green finance is now a better way to influence economic growth, it also takes into account issues that affect the preservation and improvement of the living environment.

The research questions of the study are:

1. How does green finance affect the protection of the environment in OECD member countries?
2. Does population density affect the protection of the living environment?
3. Does trade affect the reduction of carbon dioxide emissions?

The objective of the study is the importance and influence of green finance in the protection of the living environment.

The hypotheses of the study are:

H1: Green finance has a positive impact on the protection of the living environment in OECD countries.

H2: Income per capita has a positive effect on the protection of the living environment.

To verify the hypotheses, we used econometric models such as the method of least squares, the method with fixed effects, the method with random effects and the GMM method. The data of the study belong to the panel data and were obtained from the database of the World Bank and Climate Data.

In the following, the study is organized as follows: Part 2 shows a summary of the literature on green finance and its impact on environmental protection, part 3 shows the data and methodology of the study, Part 4 shows the results of the empirical study and discussions and Part 5 indicates the end of the study.

2. Literature review

Green finance is seen as a main driver to influence the protection of the environment. Green finance, or investments and spending on projects and initiatives that have a positive impact on the environment and sustainability, has received increased attention in recent years. These financings are used to promote environmental sustainability in various economic sectors and to address the challenges of pollution, climate change, biodiversity loss and other environmental problems. Many studies and scientific articles have analyzed the aspects of green finance and their impact on environmental protection.

In this part, we look at the empirical results regarding the impact of green finance on environmental degradation, focusing on OECD countries.

Much research focuses on the environmental impact of green finance. First, the green finance market is a credit intermediary for the movement of environmental protection capital (Rahman, 2022; Ivanova, 2021) in his study, he concluded that green financing offers investments in projects that enable the greening and decarbonization of the economy. Using the green finance index, the study shows that green financing significantly promotes the reduction of environmental pollution (Iqbal, 2021)b. Also The study by (Sikder, 2024) shows that green financing can prevent the emission of carbon dioxide.

The study by (Muganyi, 2021), shows the policies related to green finance that have significantly affected industrial gas emissions. By studying the impact of green finance and innovation on carbon dioxide emissions for OECD countries in the period 1990-2020 (Umar, 2023), it shows that green finance significantly reduces carbon dioxide emissions, therefore it suggests policymakers and regulators focus on green finance and green innovations to mitigate carbon dioxide emissions for OECD countries. Findings according to the GMM system technique for 38 OEDC countries in the period 2013-2021 from (Jin, 2023), show that the growth of green finance and green energy consumption influence the improvement of carbon neutrality. The study by (Wang T. U., 2023), examines the impact of green finance and environmental taxes on carbon dioxide emissions for 21 OECD countries for the period 1990-2020 and highlights that green finance serves as a significant mitigating force of carbon dioxide Carbon.

The study by (Feng, 2023), found that higher CO2 levels are the result of higher GDP per capita and higher levels of human capital. Green financing and government spending as well as GDP per capita squared have been associated with lower emissions and carbon emissions have been reduced as a result of government spending, suggesting that the government is careful with its money. The study by (Bilalli, 2024) for developed European countries shows a negative and not statistically significant level between income per capita and carbon dioxide emissions. The study by (A'yun, 2023) analyzed the effect of gross domestic product and population density on environmental quality for the period 2013-2018 and concluded that GDP

has a negative and significant relationship with environmental quality while population density does not show a significant level of quality environmental.

The empirical evidence of the study by (Rasoulinezhad, 2022), shows that green financing can help countries reduce CO2 emissions in the long term while playing a fundamental role in accelerating GDP per capita in the short term.

By choosing multiple regions of China for the period 2010 to 2020, the study (Xia, 2022) proves that green finance accelerates the reduction of carbon dioxide emissions, also the findings show that a sustainable environment is achieved only by increasing the performance of green finance. According to the authors (S. S. Wang 2022), making the shift from traditional sources of production to renewable energy, green finance had an important role for E7 countries.

Using data from 34 Chinese provinces to investigate the relationship between green finance and environmental degradation, the study (Xiong, 2023), points out that green investment and green innovation are the main conditions for the relationship between green finance and environmental degradation (Falcone, 2020), emphasizes that green finance plays a key role in accelerating the transition phase from the traditional economy to the green one. According to (Cadogan-Cowper, 2011), the main purpose of expenditure on environmental protection is to avoid or minimize the impact of economic activity on the environment - reducing or eliminating air emissions, reducing or treating waste and wastewater, etc.

Environmental protection expenditure (EPE) is defined as the sum of money spent on all intentional activities aimed directly at preventing, reducing, and eliminating pollution or disturbances resulting from production processes (or consumption of goods and services) (Broniewicz, 2011).

3. Econometric, Methodology and Data

3.1. Sample

In order to analyze the impact of green finance on environmental protection, the study used panel data for the 36 OECD member countries for the period from 2010 to 2021. The two countries such as the USA and Mexico, although members of the OECD, are not included. In study. Table 1 shows us the variables as definitions and sources. The data were taken from the World Bank database and Climate data.

The data includes 396 observations for 36 OECD countries (Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxemburg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom).

The methods used are the method of least squares, the method of fixed effects, the method of random effects, and the method of generalized moments GMM. The Generalized Methods of Moments (GMM) popularized are the ones that are preferred to be used (Arellano, 1991). Moreover, the GMM offers more accurate and dependable projections than other econometric techniques.

Table 1 Description of variables.

	Variable	Measure	Source
Environment degradation	LnCO2	CO2 emissions (kt)	World Development Indicator
Green Finance	LnGF	Expenditure on biodiversity & and landscape Protection	Climate Data
Controls	LnGHE	Total greenhouse gas emissions (kt of CO2 equivalent)	World Development Indicator
	LnGDPC	GDP per capita (constant 2015 US$)	World Development Indicator
	LnP	Population density (people per sq. km of land area)	World Development Indicator
	T	Trade (% of GDP)	World Development Indicator

3.2. The Model of Estimation

The econometric model takes the following form:

$$CO2 = \beta_o + \beta\,(GF) + \beta\,(GHE) + \beta\,(GDPC) + \beta\,(P) + \beta\,(T) + \mu i$$

Where CO2 (carbon dioxide emissions) is the dependent variable and represents environmental degradation. The independent variable is GF (green finance) and in our study, it is measured through expenditure for environmental protection. While other control variables are GHE (greenhouse gas emission), GDPC (gross domestic product per capita), P (population density), and T (trade).

The natural logarithm is used to measure carbon dioxide, green finance, household greenhouse gas emissions, GDP per capita and population density.

Further, all of these variables can play a role in protecting the environment, but they are not the only factors to consider. Other factors, such as changes in government policy, global economic conditions, and other specific factors may also influence the improvement of environmental quality.

4. Empirical results

The results begin with the statistical description of the variables for the study states.

Table 2 Summary statistics.

Variable	Mean	Std. Dev.	Min (Country, Year)	Max (Country, Year)
CO2	11.18	1.48	7.27 (Iceland 2020)	14.05 (Japan 2013)
GF	22.77	2.44	17.79 (Latvia 2010)	29.54 (Japan 2020)
GHE	11.48	1.42	7.88 (Iceland 2020)	14.11 (Japan 2013)
GDPC	10.27	0.66	8.55 (Colombia 2010)	11.59 (Luxemburg 2016)
P	4.32	1.32	1.05 (Australia 2010)	6.27 (South Korea 2018)
T	102.48	60.06	28.49 (Japan 2010)	377.84 (Luxemburg 2019)

Source: STATA Author's Calculation; Data from the World Bank and Climate Data.

The table above presents the descriptive statistics of the study variables for all the countries of the study. We have 36 member states of the OECD for 11 years, so we have 396 observations. The USA and Mexico have left the research due to the lack of a larger number of data. The model states have an average of 11.18 Kt of carbon dioxide emissions, green finance accounts for an average of 22.77%. Greenhouse gas emissions make up an average of 11.48% of carbon dioxide emissions, the states of the study have positive economic performance and the gross domestic product per capita makes up an average of 10.27%, the population density makes up an average of 4.3 inhabitants per square km and the level of trade is an average of 102.48% of the gross value of local production.

Of the 36 countries of the study, the highest level of carbon dioxide emission is in the state of Japan with an average of 14.05%, while the lowest level is in the state of Iceland with an average of 7.27%. The country with the highest expenditure for environmental protection is Japan with an average of 29.54%, while the country with the lowest expenses for environmental protection is Latvia with an average of 17.79%.

Table 3 Matrix of correlation.

	CO2	GF	GHE	GDPC	P	T
CO3	1					
GF	0.4877	1				
GHE	0.9916	0.5156	1			
GDPC	0.0106	-0.1718	-0.0226	1		
P	0.2671	0.0743	0.2172	-0.0382	1	
T	-0.4596	-0.4639	-0.5101	0.2273	0.2567	1

Source: STATA Author's Calculation; Data from the World Bank and Climate Data.

In this table, we have presented the analysis of the correlation matrix to understand the relationship between the variables that we have studied. Based on the results, green finance (r=0.48), household gas emissions (r=0.99), gross domestic product per capita (0.01) and population density have a positive relationship with carbon dioxide emissions while trade (r =-0.45) has a negative relationship with the emission of carbon dioxide.

While in order to determine how all these factors affect the protection of the environment, we will continue with the results of the econometric models.

The table above shows the results of five econometric models. Based on the Hausman test where the value P=0.00 means that the difference in the coefficient is systematic and it is preferable to use the model with fixed effects, but for the interpretation of the results the GMM model has been selected, this model has been selected as the most suitable model for the analysis of these results the work. The GMM, Arellando-Bond model shows statistically significant P=0.0000.

The interpretation of the statistical results is made according to the Ceteris Paribus assumption: The coefficient of green finance is negative (0.006), so for every 1% increase in green finance, carbon dioxide emissions decrease by 0.006%. This negative trend of green finance shows us the progress of OECD member countries to have economic growth based on the objectives of international agreements towards climate change, and having a better environment. The greenhouse gas emission coefficient as an indicator of the challenges of environmental protection and pollution control is positive at 1.17, so for every 1% increase in greenhouse gas emissions, carbon dioxide emissions increase by 1.17% on average, this coefficient is significant on the 1% level and shows that the rapid increases in greenhouse gas emissions are also influenced by increases in the level of carbon dioxide emissions in the atmosphere, causing significant climate changes and other negative impacts on the environment. The coefficient of gross domestic product per capita is positive 0.03, so with a 1% increase in income per capita, carbon dioxide emissions increase by 0.03%. The significance level for this coefficient is 10%. The study by (Begum, 2015) shows the same results for the period 1980-2009, disproving the fact that carbon dioxide emissions increase with the increase of the domestic product per capita. The population density coefficient is negative (0.10), so for every 1% increase in population

density, carbon dioxide emissions decrease by 0.10% and the coefficient is significant at 5%, emigration has also had a negative impact on the structural changes of the population (Gollopeni, 2016). The trade coefficient is positive but with a very low value of 0.0005, which means that for every 1% increase in trade, carbon dioxide emissions increase by 0.0005% and this coefficient has a significance level of 1%.

The VIF test is presented to test the data for multicollinearity, according to the data, multicollinearity does not exist, as the mean of the VIF is less than 5.

Table 4 Results of econometric models.

	OLS	OLSR	FE	RE	GMM
	Coef / t-stat	Coef / t-stat	Coef / t-stat	Coef / t-stat	Coef / z-stat
GF	-0.00977*	-0.00977*	-0.0119	-0.0257***	-0.00662
	(-2.37)	(-2.06)	(-1.60)	(-4.33)	(-0.93)
GHE	1.050***	1.050***	1.183***	1.148***	1.173***
	(130.42)	(164.32)	(85.57)	(96.92)	(68.67)
GDPC	0.0556***	0.0556***	-0.0141	-0.00649	0.0389*
	(4.31)	(4.21)	(-0.84)	(-0.41)	(2.25)
P	0.0481***	0.0481***	-0.0481	0.0146	-0.109**
	(6.65)	(8.02)	(-1.14)	(0.72)	(-2.68)
T	0.000698***	0.000698***	0.000297*	0.000341*	0.000575***
	(3.71)	(3.69)	(2.12)	(2.42)	(3.40)
L.CO2					0.0297
cons	-1.510***	-1.510***	-1.813***	-1.442***	-2.470***
	(-9.00)	(-10.67)	(-6.72)	(-6.39)	(-9.08)
Hausman test=0.00					
N	381	381	381	381	312
R-squared	98%	98%	97%	98%	
VIF=1.56					

*Notes: ***Statistically significant at 1% level, **statistically significant at 5% level, *statistically significant at 10% level. Source: author's calculation.*

5. Discussion

The main focus of the study is to highlight the role and importance of green finance in increasing the quality of the environment. The results of the study show that green finance has a negative relationship with carbon dioxide emissions which means that the more green finance, the less carbon dioxide emissions and the better the quality of the environment.

Based on the econometric results to support the raised hypotheses, we say that:

Hypothesis 1: Green finance has a positive impact on the protection of the living environment in OECD countries - the results support the first hypothesis. In accordance with our findings are also the results of other researchers such as (Bakry)a, who using a sample of 76 developing economies for the period 2010 to 2019 shows that green finance exerts significant and inhibitory effects on CO2 emissions, (Jian, 2023) in the study of G10 economies for the period 2000 to 2018 confirms that green financing promotes carbon neutrality.

Also, the study by (Wu, 2021) based on data from the G7 countries during the period 2010 to 2018 shows that green finance helps to reduce carbon dioxide emissions and in this way affects the mitigation of environmental risks.

According to our study, the gross domestic product per capita shows a positive and statistically significant relationship at the 10% level with carbon dioxide emissions, which shows that the increase in the domestic product per capita causes damage to the environment, affecting the increase in the emission of carbon dioxide.

Hypothesis 2: Income per capita has a positive effect on the protection of the living environment - the results also support the second hypothesis.

Growth-oriented development often ignores aspects of environmental management (Bieth, 2021), in line with our study are other studies such as the study (Otim, 2022), which shows the impact of the domestic product per capita on the emission of dioxide of carbon in Uganda for the period 1986 to 2018 and the results show that gross domestic product per capita has a positive effect on carbon dioxide emissions. And the study (Patiño, 2020) shows the relationship between the gross domestic product per capita and carbon dioxide emissions in Colombia for the period 1971 to 2017 and the empirical analysis shows that there is a positive relationship between the gross domestic product per capita and the emission of CO2.

Population density also comes into consideration demographic changes (Gollopeni, Socio-urban developments in Kosovo: Study case Pristina. , 2016) shows a negative relationship with the emission of carbon dioxide with a coefficient of importance of 5%, as well as the paper (Sepehrdoust, 2017) shows that the density of the population has a negative effect, and that is, on the emission of carbon dioxide.

In our study, trade has a positive impact on CO2 emissions and is statistically significant at the 5% level, in line with our study is also the study by (Ertugrul, 2016), which analyses the impact of the solution on carbon dioxide emissions and comes to the conclusion that trade openness increases CO2.

Based on the presentation of the findings from the statistical analysis and the impact of green finance on the health of the planet and the well-being of society in the third part of the study, it is recommended that countries be more focused on investing in green projects in order to take actions to have cleaner living environment and to fulfill the goals of sustainable development.

6. Conclusions

The study summarizes the data and verifies the fact that green finance is a driving force to improve the quality of the environment. This happens when expenditure on environmental protection is dedicated to reducing carbon dioxide emissions. Some studies show that not necessarily the highest expenditures within the state influence the lower emission of carbon dioxide, this also depends a lot on the level of environmental pollution within the state.

Over the years, OECD member countries saw economic progress but also did significant environmental harm. However, with the introduction of green finance, this deterioration is starting to reverse.

Green financing has provided OECD countries with both a problem and an opportunity to combat climate change and advance sustainable development. These countries have advanced significantly in investments and legislation for a sustainable environment in recent years. For OECD countries, efforts to reduce carbon dioxide emissions are essential.

Green finance in OECD countries is part of major efforts to address environmental challenges and build a more sustainable future.

The empirical results of the study show that green finance has a positive impact on environmental protection, affecting the reduction of carbon dioxide emissions. In order to achieve a pollution-free environment, countries must increase their focus on green financing.

In conclusion, this study aims to raise awareness about the importance of green finance in addressing the environmental challenges of our time.

Ethical considerations

Not applicable.

Conflict of Interest

The authors declare no conflicts of interest.

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