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RELATIONSHIP BETWEEN THE GREEN FINANCE INDEX, CO2 EMISSION, AND GDP

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Abstract

Green technology innovation and effective use of green financing tools are very important in order to ensure sustainable economic and environmental development without environmental degradation, and to decarbonize all sectors. Evaluating the green investment process together with the inputs, outputs and the factors involved in the process will make important contributions in terms of determining the current situation, developing new and effective policies and raising awareness on green finance. For all these reasons, it is aimed to reveal the interaction mechanisms between GFI, CO_2 emissions and GDP in this study. GFI, CO_2 emissions, and GDP variables covering 26 countries between 2018-2021 were analyzed using panel data analysis with a fixed effects model. Firstly, it is found that CO_2 emission had a negative effect on GFI, but GDP had a positive effect on GFI, and the effect of CO_2 was greater than GDP. Secondly, GFI was found to have negative effects on CO_2 emissions whereas GDP had positive effects, with GFI benefiting slightly more than GDP from these effects. Thirdly, GDP was shown to be positively affected by both GFI and CO_2, and the analyses revealed that the effect of CO_2 was much greater than that of GFI. The findings are considered important in terms of making predictions in terms of understanding and developing green finance and its effects.

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Introduction

Achieving sustainable economic and environmental development and preventing environmental degradation while doing this, reaching the goals related to economic and climate policies, shifting both energy and goods and service production resources to alternative, innovative, and green sources, decarbonizing all sectors, investing in low-carbon production infrastructure and creating financial resources for this has become very important. The use of green technology innovation and green finance can reduce CO2 emissions and promote the sustainability of economic development.

Green finance encompasses financing investments to be made in environmental goods and services and the prevention of harm to the environment and the climate, financing government policies that have an environmental focus and aim to reduce environmental damage or support the implementation of adaptation projects and initiatives in these areas, and green investments. Green finance creates a unique financial system designed for green investments (Lindenberg, 2014).

It is emphasized that green finance is a key component in financing renewable and green energy projects to reduce carbon emissions in terms of sustainability and the detrimental effects these emissions have on health, to build cities with climate-resistant infrastructures, and to ensure environmental sustainability (Taghizadeh-Hesary & Yoshino, 2019).

Activities that can support environmentally friendly production have become very important all over the world. These include green finance funding. Financing fundings that support environmentally friendly production emerge at this stage. In this sense, several green finance indices (GFI) have been developed to measure the ability of businesses, cities, and countries to be environmentally friendly in all their activities, to draw attention to this issue, to encourage such activities with green finance funding, and then to ensure the continuity and sustainability of this process. With these indices, reference data that can constitute a basis for green finance are obtained, and these data can be used for the purpose of raising awareness in the allocation of green finance funds and by creating sensitivity in investors and directing their investments to such instruments.

Among the most important outputs of this process are economic development and the reduction of CO2 emissions. One of the indicators of the reflection of economic development on a country basis is Gross Domestic Product (GDP). Revealing the structure of the dynamic between GFI, CO2, and GDP is considered important in terms of understanding how changes in one or more of the variables will affect the others and making predictions for the future.

Based on this idea, this study aims to reveal how GFI has an effect on CO2 and GDP, CO2 on GFI and GDP, and GDP on GFI and CO2. With this aim, the following hypotheses have been established.

H1 (Hypothesis 1): GFI is affected negatively by CO2.
H2 (Hypothesis 2): GFI is affected positively by GDP.
H3 (Hypothesis 3): CO2 is affected negatively by GFI.
H4 (Hypothesis 4): CO2 is affected positively by GDP.
H5 (Hypothesis 5): GDP is affected positively by GFI.
H6 (Hypothesis 6): GDP is affected positively by CO2.

In this context, the results of studies examining how green finance, green investment, GDP in terms of growth indicators, and CO2 emissions affect each other will provide important scientific contributions to the literature both for understanding the effects of current approaches and for developing policies for the future.

Literature review

By concentrating on the key components of financial systems prior to, during, and following the global financial crisis of 2008, Batrancea et al., (2020) analyzed green finance projects in the USA, Canada, and Brazil. According to the study's results, domestic bank loans are not enough to finance green investments, and the financial sector must take a bigger part in financing green projects if we are to prevent global warming and climate change while also boosting economic growth. Additionally, the data show that domestic financial sector credit has a positive impact on green finance and that CO2 emissions have a negative impact on GDP levels.

A dynamic panel data model was used in a study by Wang et al. (2021) to assess the CO2 emission reduction benefits of various green finance instruments under various environmental regulation intensities. The study's findings indicate that green finance instruments can be utilized in compliance with environmental standards to promote the reduction of carbon emissions and that these tools have a considerable impact on reducing the intensity of CO2 emissions.

Tran (2021) conducted a study utilizing multivariate time series analysis to investigate the relationship between green finance, economic growth, renewable energy usage, energy imports, and CO2 emissions in Vietnam. According to the findings, using renewable energy effectively and making wise investments in green finance can lower CO2 emissions and improve Vietnam's environmental position.

The relationship between public expenditure on R&D and green economic growth and energy efficiency was investigated in the study of Zhang et al., (2021). According to the findings, public green financing encourages green economic growth, expenditure on human resources and green technology research and development fosters green growth, and the expansion and innovation of human resources are crucial for green growth.

In their research, Wu et al., (2021) sought to forecast the long-term dynamics of a cleaner environment in advancing the gross domestic product of E7 and G7 nations. A 1% rise in the green finance index improves environmental quality in G7 nations by 0.375%, and in E7 countries by 0.3920%, according to the study's findings, which also demonstrated that green finance practices assist to clean the environment. In the research, it was also noted that, in order to prevent environmental pollution, the production of energy should be changed to alternative, creative, and green resources.

Sharif et al. (2022) research how green technical innovation and green finance might help the G7 countries reduce their CO2 emissions. The results show that emissions have a positive long-term correlation with both GDP and SGLO (social globalization). Emissions are adversely correlated with green technology innovation (GINV) and green investment (GFIN). SGLO has positive effects on emissions and GDP but negative but significant effects on GFIN and GINV emissions in G7 nations.

In their study, Rasoulinezhad and Taghizadeh-Hesary (2022) examined the relationship between CO2 emissions, energy efficiency, green energy index (GEI), and green finance in the top ten economies that support green finance. The study's findings indicate that using green bonds to support renewable energy projects can help cut CO2 emissions significantly over the long term and can accelerate both the short- and long-term growth of GDP per capita.

Zhang et al., (2022) conducted a study to determine how green finance affects the prevention of climate change. The findings demonstrate that environmental CO2 emissions are decreased by green finance, investments in renewable energy, and technological advancements, whereas environmental CO2 emissions are increased by factors including economic growth, energy consumption, trade, and foreign direct investment.

Green finance is measured as "climate mitigation finance" by Khan et al., (2022), who also look at how it affects the environment. Empirical research demonstrates that green finance looks to be environmentally beneficial and minimizes its ecological footprints.

A study by Liu et al., (2022) examined the effects of green finance, FinTech, and financial inclusion on the study's findings, such financing methods are crucial for energy efficiency, and green financing is also discovered to be the most suitable and helpful financing method for energy efficiency.

Method

Variables of the study

There are three main variables of the study. The first one is GFI, the second is CO2 emissions and the third is GDP. In the study, The Global Green Finance Index (GGFI) data were used as GFI. The annual data of the variables belonging to a total of 26 countries including Australia, Austria, Belgium, Canada, China, the Czech Republic, Denmark, France, India, Ireland, Italy, Japan, Luxembourg, Malaysia, Mexico, Morocco, Netherlands, Poland, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, and the United States for the years 2018 and 2021 were used in this study. In order to increase the accuracy of the analyses and to ensure the continuity of the data in the date range considered, the countries where all three variables can be obtained completely from the data sources are included in the analyses.

The global green finance index (GGFI)

Global Green Finance Index (GGFI) is a factor evaluation index based on instrumental factors identified as a result of a series of quantitative metrics and financial professionals' worldwide assessments of the quality and depth of green finance offered in financial centers (Wardle et al., 2022). The first component of the GGFI is depth, which refers to the prevalence of green financial services and products in financial centers, and the second component is quality, which refers to the quality of green finance products and services offered. In this study, GGFI data is used. The green financial center ratings using a ten-point scale and instrumental factors are two independent sets of inputs used to create the GGFI by factor rating methodology (Longfinance, 2022). The business environment, human capital, infrastructure, and sustainability are the four key categories in which GGFI's 149 instrumental factors are grouped. The theoretical minimum and maximum values of ratings for the GGFI are 100 and 1,000. GGFI data are accessed by the reports 2018-2021 (Wardle et al., 2018, 2019, 2020, and 2021).

When the GGFI Reports are examined, it is seen that while the GGFI variable which is understood to be calculated as the sum of GGFI depth and GGFI quality values is included in 2021 and later, there is no separate GGFI value calculated as the sum of GGFI debt and GGFI quality values in the previous years. In addition, the numerical magnitudes of the individual GGFI values in 2021 and later reports are at the level of the GGFI depth and GGFI quality values in the previous reports. For these reasons, GGFI depth values for 2018, 2019, and 2020 and GGFI values for 2021 were used to ensure the compatibility of the values in the study. Since other variables in this study were on an annual basis, all GGFI values used in this study were derived from second reports published in October or November for each year.

Carbon dioxide emissions (CO2)

Emissions of carbon dioxide and other greenhouse gases are the most important driving force of climate change and one of the most urgent problems in the world. Carbon dioxide emissions (CO2) are a measure of how much emissions countries emit each year. Data on CO2 Emissions is accessed by Our World in Data (Ritchie et al., 2020). The CO2 emission variable used in the study will be expressed as CO2. The unit of CO2 variable is in million tons.

Gross domestic product (GDP)

Gross Domestic Product (GDP) data is an indicator expressed in current US dollars based on buyer prices, calculated by adding all product taxes to the gross value added of all resident producers in the economy and subtracting all subsidies not included in the value of products. These data were accessed from the World Development Indicators (World Bank, 2022). The unit of GDP variable is US dollars.

Statistical analysis

GFI, CO2 emissions, and GDP variables covering 26 countries between 2018-2021 were analyzed using panel data analysis with a fixed effects model. Since this study consists of a micro-panel data set covering 26 cross-sections and 4-time dimensions, the stationarity and cross-section dependence of the variables were not investigated.

In the first stage, Descriptive Statistics were made for the variables. Then, the correlation study was carried out in order to be able to determine the linear relationships between the variables and to be used as a reference for the models to be established. Then the model was created with the help of Correlation Analysis and VAR Granger Causality/Block Exogeneity Wald Tests, the selection of the fixed effects model was decided with the help of Hausman Tests, and the Cross-section fixed was selected for the model established in the last stage. Panel Least Squares Method Analyses were performed using Panel EGLS (Cross-section weights) method.

Results

Descriptive statistics of the GFI, CO2, and GDP variables within the scope of the study are shown in Table 1.

Table 1: Descriptive Statistics of Variables

	GFI	CO2	GDP
Mean	452.89	948.13	2.51E+12
Median	452.50	286.17	7.57E+11
Maximum	574.00	11472.37	2.30E+13
Minimum	307.00	8.10	7.02E+10
Std. Dev.	70.22	2254.07	4.81E+12
Skewness	-0.07	3.58	3.10
Kurtosis	1.89	15.41	11.63
Jarque-Bera	5.44	890.25	489.08
Probability	0.07	0.00	0.00
Sum	47101.00	98605.53	2.61E+14
Sum Sq. Dev.	507923.80	5.23E+08	2.38E+27
Observations	104.00	104.00	104.00

Source: Own elaboration.

It can be seen from the table that the GFI varies between 307 and 504 and its average is 452.894. The table also shows that CO2 has an average value of 948.130 and a range of 8.097 to 11472.370, while GDP has an average value of 2.510E+12 and a variation of 7.020E+10 to 2.300E+13. Looking at the Skewness values of the variables in Table 1, it is seen that the GFI is less than zero, so it is left-skewed, and CO2 and GDP are right-skewed. When the Kurtosis values in the table are examined, it is found that CO2 and GDP are leptokurtic (pointier than a normal distribution) and the GFI variable is platykurtic (flatter than a normal distribution). All variables do not have a normal distribution, as can be shown by looking at the probability values in Table 1 ($p < .10$).

The mean, maximum and minimum values of the variables on a country basis are given in Table 2.

Table 2: Country-Based Descriptive Statistics

	GFI			CO2			GDP		
Country	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Australia	469.75	530.00	403.00	405.94	416.36	391.19	1.42E+12	1.54E+12	1.33E+12
Austria	461.25	531.00	388.00	65.29	67.94	62.04	4.53E+11	4.77E+11	4.33E+11
Belgium	470.00	531.00	408.00	96.35	99.87	90.37	5.50E+11	6.00E+11	5.22E+11
Canada	463.75	522.00	395.00	562.40	584.71	534.86	1.78E+12	1.99E+12	1.65E+12
China	473.75	539.00	409.00	10880.86	11472.37	10353.88	1.51E+13	1.77E+13	1.39E+13
Czechia	420.25	473.00	364.00	99.09	106.34	91.85	2.57E+11	2.82E+11	2.45E+11
Denmark	496.00	558.00	433.00	30.89	34.73	28.28	3.64E+11	3.97E+11	3.48E+11
France	487.00	545.00	423.00	306.23	322.53	280.03	2.77E+12	2.94E+12	2.63E+12
India	399.50	483.00	307.00	2595.40	2709.68	2445.01	2.84E+12	3.17E+12	2.67E+12
Ireland	442.25	502.00	383.00	37.26	39.01	35.15	4.27E+11	4.99E+11	3.85E+11
Italy	441.25	508.00	375.00	329.80	349.01	302.28	2.02E+12	2.10E+12	1.89E+12
Japan	458.75	528.00	382.00	1089.76	1143.41	1042.22	5.03E+12	5.12E+12	4.94E+12
Luxembourg	497.25	553.00	432.00	8.94	9.75	8.10	7.54E+10	8.67E+10	7.02E+10
Malaysia	413.00	506.00	330.00	262.94	269.16	256.05	3.58E+11	3.73E+11	3.37E+11
Mexico	404.75	474.00	349.00	436.59	475.27	391.71	1.22E+12	1.29E+12	1.09E+12
Morocco	464.00	515.00	407.00	66.73	70.58	63.01	1.21E+11	1.33E+11	1.15E+11
Netherlands	510.50	574.00	435.00	147.64	158.63	137.85	9.39E+11	1.02E+12	9.10E+11
Poland	408.25	468.00	359.00	321.91	337.05	303.52	6.14E+11	6.74E+11	5.87E+11
South Africa	419.00	475.00	367.00	443.48	466.92	435.24	3.87E+11	4.20E+11	3.35E+11
Spain	441.25	512.00	382.00	242.22	270.05	213.34	1.38E+12	1.43E+12	1.28E+12
Sweden	492.25	550.00	423.00	38.86	42.10	35.85	5.65E+11	6.27E+11	5.34E+11
Switzerland	496.50	571.00	415.00	35.70	36.87	34.24	7.58E+11	8.13E+11	7.32E+11
Thailand	394.75	492.00	328.00	282.05	290.24	277.37	5.14E+11	5.44E+11	5.00E+11
Turkey	392.25	467.00	329.00	420.98	446.20	401.72	7.69E+11	8.15E+11	7.20E+11
U. Kingdom	501.00	571.00	432.00	354.38	379.73	326.26	2.93E+12	3.19E+12	2.76E+12
U. States	457.00	534.00	380.00	5089.71	5376.66	4715.69	2.14E+13	2.30E+13	2.05E+13

Source: Own elaboration.

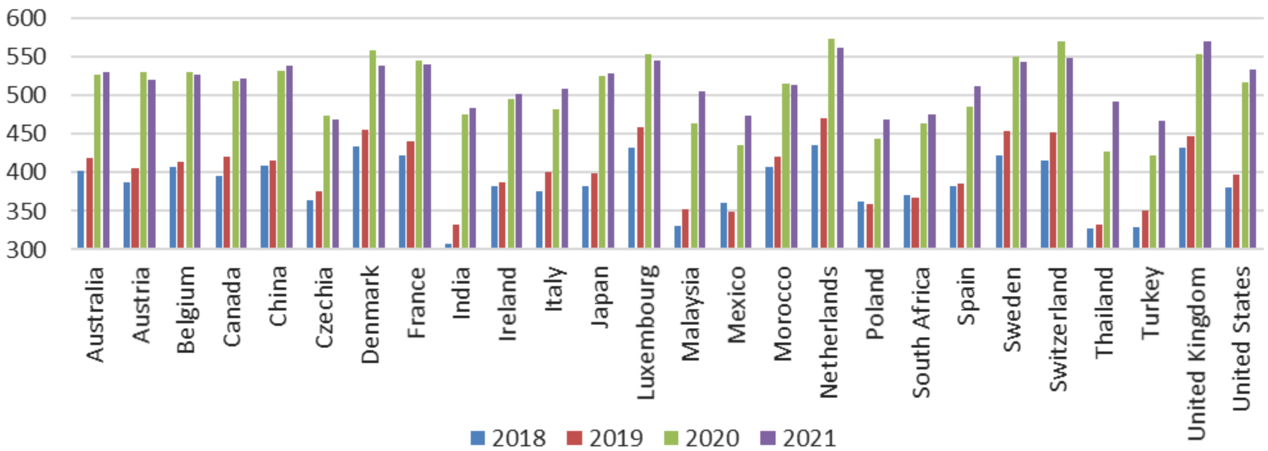
According to the mean GFI values in the table, the five countries in the lowest ranking are Turkey, Thailand, India, Mexico, and Poland, and the top five countries in the highest ranking are Netherlands, Luxembourg, United Kingdom, Switzerland, and Denmark. Luxembourg, Denmark, Switzerland, and Ireland are the five nations with the lowest CO2 emission rankings, whereas China, the United States, India, and Japan are the top five. In terms of GDP mean values, in the examined time period, the United States, China, Japan, and the United Kingdom are in the top five, while Luxembourg, Morocco, Czechia, and Malaysia are in the bottom five. Mean values and % change of the variables are evaluated in Tables 3, 4, and 5, and the graphs of the variables according to years on a country basis are given below (Figures 1, 2, and 3).

Table 3: Mean Values and % Change of GFI

Date	GFI	% GFI Change
2018	386.73	-
2019	402.23	4.01
2020	506.58	25.95
2021	516.04	1.87

Source: Own elaboration.

Figure 1: GFI's Country-By-Country Change Chart by Year



Source: Own elaboration.

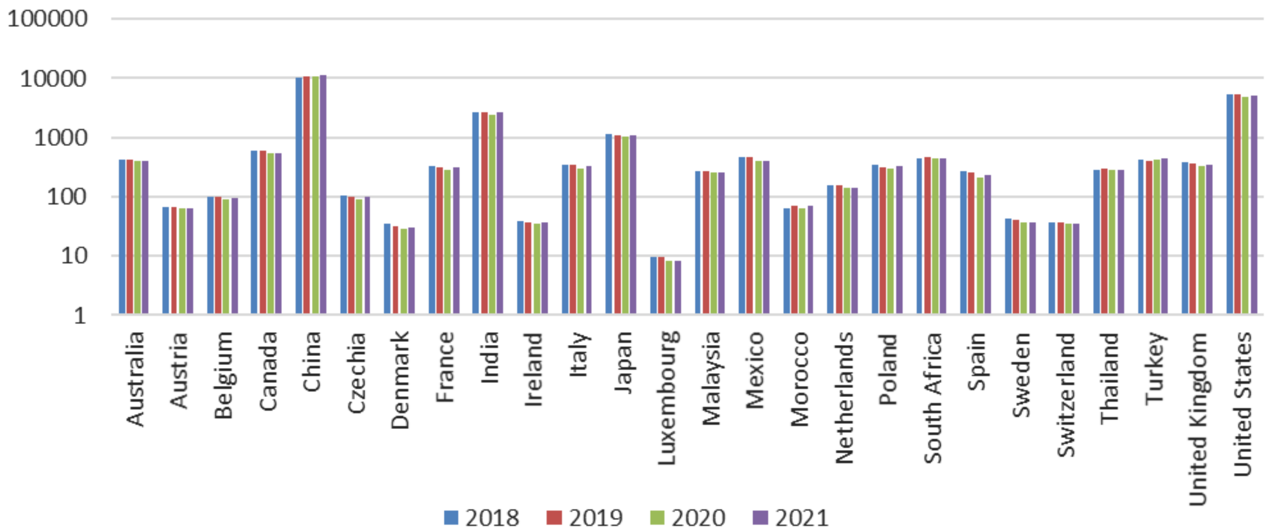
When Table 3 is evaluated, it is understood that the GFI variable increased as the years progressed and this increase was at very high levels between the years 2019-2020, and this increase remained at very low levels for the other years. The country-based changes shown in Figure 1 also support these findings.

Table 4: Mean Values and % Change of CO2

Date	CO2	% CO2 Change
2018	948.94	-
2019	956.55	0.80
2020	918.70	-3.98
2021	968.33	5.40

Source: Own elaboration.

Figure 2: CO2's Country-By-Country Change Chart by Year



Source: Own elaboration.

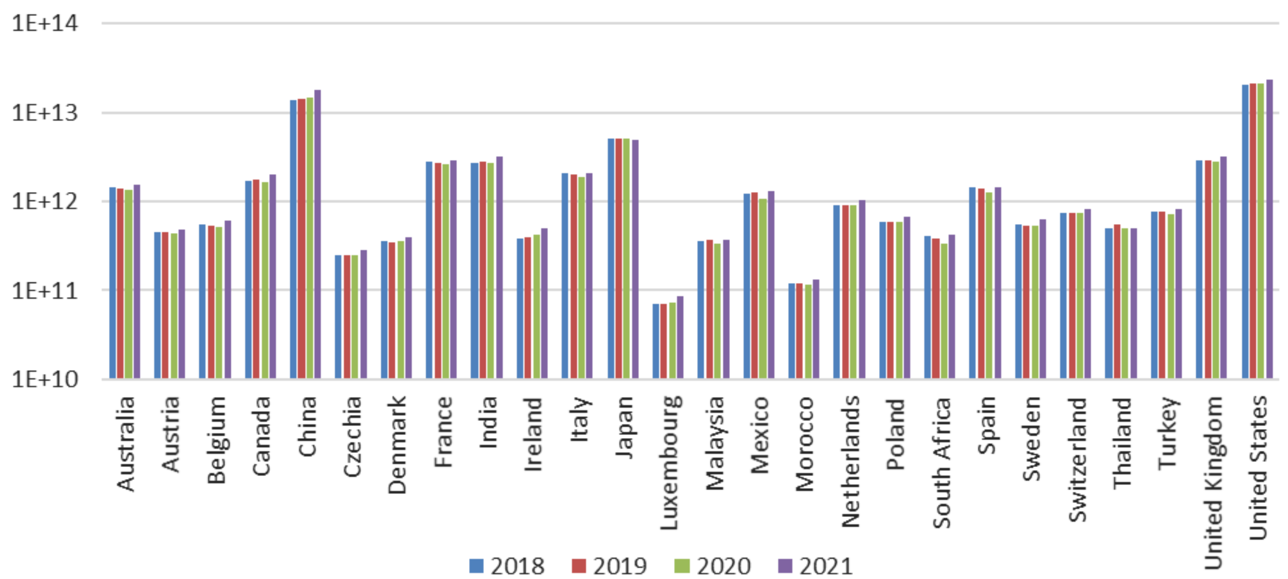
According to Table 4, while the CO2 variable showed a low increase in 2019, it showed a downward trend in 2020 and this trend reversed in 2021. Although Figure 2 indicates a few differences by country, the general trend supports these findings.

Table 5: Mean Values and % Change of GDP

Date	GDP	% GDP Change
2018	2.410E+12	-
2019	2.460E+12	2.08
2020	2.410E+12	-2.03
2021	2.730E+12	13.28

Source: Own elaboration.

Figure 3: GDP's Country-By-Country Change Chart by Year



Source: Own elaboration.

Table 5 demonstrates while the GDP variable exhibited a minor increase in 2019, this gain was followed by a decreasing trend in 2020 and a strong rise in 2021. Although Figure 3 shows some minor country-based differences similar to Figure 2, the general trend supports these findings.

In the following part of the analysis, the logarithmic values of the variables are used. In order to reveal the correlation dynamics between variables, correlation analysis between the variables is established and the results of the analysis are given in Table 6. The probability values of the analysis results in Table 6 reveal that there are correlations between GFI and CO2, and CO2 and GDP.

Table 6: Correlation Statistics

Variable	GFI	CO2	GDP
GFI	1.00	-	-
CO2	-0.20 (p = 0.05**)	1.00	-
GDP	0.04 (p = 0.72)	0.85 (p = 0.00*)	1.00

Note: * p < .01, ** p < .05, *** p < .10.

Source: Own elaboration.

VAR models were created between the variables in accordance with the hypotheses generated based on the study's assumptions in order to disclose the cause-and-effect dynamics, and the analysis's findings are shown in Table 7.

Table 7: VAR Granger Causality/Block Exogeneity Wald Tests Statistics

Dependent variable: GFI			
Excluded	**Chi-sq**	**df**	**Prob.**
CO2	12.05	2	0.00*
GDP	13.87	2	0.00*
All	19.44	4	0.00*
Dependent variable: CO2			
Excluded	**Chi-sq**	**df**	**Prob.**
GFI	49.23	2	0.00*
GDP	5.40	2	0.07***
All	58.22	4	0.00*
Dependent variable: GDP			
Excluded	**Chi-sq**	**df**	**Prob.**
GFI	64.80	2	0.00*
CO2	5.08	2	0.08***
All	110.87	4	0.00*

Note: * p < .01, ** p < .05, *** p < .10.

Source: Own elaboration.

The probability values of the analysis results in Table 7 reveal that GFI is affected by GDP and CO2, CO2 is affected by GFI and GDP, and GDP is affected by GFI and CO2. With the results of this analysis and hypotheses, three different models were established to be examined within the scope of the study. Details of all models are given in the table Table 8.

Table 8: Established Models

Model	Dependent Variable	Independent Variable 1	Independent Variable 2
Model 1	GFI	CO2	GDP
Model 2	CO2	GFI	GDP
Model 3	GDP	GFI	CO2

Source: Own elaboration.

For each model, the regression equations are constructed in accordance with equation (1) below.

$$Dependent\ vairable_{it} = c + \alpha_1 Independent\ vairable1_{it} + \alpha_2 Independent\ vairable2_{it+\varepsilon it} \quad (1)$$

In this equation, c is the constant term, α_1 and α_2 are the coefficients of the independent variables, and ε is the error term. The i and t indices represent the values of the variables for each cross-section (country) and time series (period), respectively.

Table 9: Hausman Test Statistics

Test Summary	Cross-section random		
	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Model 1 (Dependent: GFI)	62.50	2	0.00*
Model 2 (Dependent: CO2)	66.49	2	0.00*
Model 3 (Dependent: GDP)	20.01	2	0.00*

Note: * p < .01.

Source: Own elaboration.

In panel data analysis, the Hausman test was applied in order to reveal whether the fixed effects model or the random effects model is a better model. The test results are in Table 9. It is concluded that the fixed affixes model is suitable for all models because the probability values are $p < .01$.

Regression analyses for all models were performed by selecting "cross-section fixed" as the effect specification. In order to avoid possible autocorrelation problems that may occur, analyzes were made using the Panel EGLS (Cross-section weights) method in the selection of cross-section fixed for all models.

Table 10: Model 1 (Dependent: GFI) Panel EGLS (Cross-section weights) Method

	Effects Specification	Independent Variables	Coefficient	Std. Error	t-Statistic	p
Model 1	Cross-section fixed (Panel EGLS (Cross-section weights)	c	-2.43	1.24	-1.97	0.05**
		CO2	-1.76	0.10	-17.77	0.00*
		GDP	0.77	0.10	7.51	0.00*
		Weighted Statistics				
		Root MSE		0.04	R-squared	0.88
		Mean dependent var		4.18	Adjusted R-squared	0.84
		S.D. dependent var		2.54	S.E. of regression	0.04
		Sum squared resid		0.18	F-statistic	21.03
		Durbin-Watson stat		1.76	Prob(F-statistic)	0.00
		Unweighted Statistics				
		R-squared		0.62	Mean dependent var	2.65
		Sum squared resid		0.19	Durbin-Watson stat	1.31

Note: * $p < .01$. ** $p < .05$.

Source: Own elaboration.

The results of the analyses for Model 1 are given in Table 10. When the coefficients in Table 10 are examined, it is seen that while the CO2 coefficients are negative, GDP is positive. Since the $p < .10$ value is obtained for all independent variables, it is proven that the established Model 1 is valid. When the coefficients are compared, it is understood that CO2 (α_1 = -1.76) has a 2.29 times greater effect on GFI than GDP (α_2 = 0.77).

Table 11: Model 2 (Dependent: CO2) Panel EGLS (Cross-section weights) Method

	Effects Specification	Independent Variables	Coefficient	Std. Error	t-Statistic	p
Model 2	Cross-section fixed (Panel EGLS (Cross-section weights)	c	0.33	0.60	0.54	0.59
		GFI	-0.28	0.02	-13.77	0.00*
		GDP	0.23	0.05	4.49	0.00*
		Weighted Statistics				
		Root MSE		0.02	R-squared	1.00
		Mean dependent var		3.42	Adjusted R-squared	1.00
		S.D. dependent var		1.95	S.E. of regression	0.02
		Sum squared resid		0.03	F-statistic	11252.06
		Durbin-Watson stat		1.93	Prob(F-statistic)	0.00
		Unweighted Statistics				
		R-squared		0.99	Mean dependent var	2.37
		Sum squared resid		0.03	Durbin-Watson stat	1.51

Note: * $p < .01$.

Source: Own elaboration.

Table 11 presents the findings of the analyses for Model 2. It can be observed from the table that the GDP coefficient is positive and GFI is negative. It is demonstrated that the constructed Model 2 is reliable because p values are significant ($p < .01$) for GFI and GDP. By comparing the coefficients, it can be seen that GFI (α_1 = -0.28) has a 1.22-times bigger impact on CO2 than GDP (α_2 = 0.23).

Table 12. Model 3 (Dependent: GDP) Panel EGLS (Cross-section weights) Method

	Effects Specification	Independent Variables	Coefficient	Std, Error	t-Statistic	p
Model 3	Cross-section fixed (Panel EGLS (Cross-section weights)	c	9.69	0.36	26.98	0.00*
		GFI	0.26	0.05	5.68	0.00*
		CO2	0.68	0.11	6.01	0.00*
		Weighted Statistics				
		Root MSE		0.02	R-squared	0.99
		Mean dependent var		14.78	Adjusted R-squared	0.99
		S.D. dependent var		5.75	S.E. of regression	0.03
		Sum squared resid		0.05	F-statistic	2866.61
		Durbin-Watson stat		2.20	Prob(F-statistic)	0.00
		Unweighted Statistics				
		R-squared		0.99	Mean dependent var	11.98
		Sum squared resid		0.06	Durbin-Watson stat	2.09

Note: * $p < .01$, ** $p < .05$.

Source: Own elaboration.

The outcomes of the analyses for Model 3 are shown in Table 12. The GFI and CO2 coefficients are positive, as seen in this table. Given that both GFI and CO2 have p values less than 0.01 ($p < .01$), the established Model 3 is acceptable. It can be shown from a comparison of the coefficients that CO2 (α_2 = 0.68) has a 2.62-times greater impact on GDP than GFI (α_1 = 0.26).

Discussion

It was concluded that CO2 emission had a negative effect on GFI, but GDP had a positive effect on GFI, and the effect of CO2 was greater than GDP. These findings support the H1 and H2 hypotheses.

GFI was found to have negative effects on CO2 emissions whereas GDP had positive effects, with GFI benefiting slightly more than GDP from these effects. As a result, the H3 and H4 hypotheses are proven to be correct.

GDP was shown to be positively affected by both GFI and CO2, and the analyses revealed that the effect of CO2 was much greater than that of GFI. The H5 and H6 hypotheses are confirmed by these observations.

The increase in GFI manifests itself as a decrease in CO2 emissions, which is seen as a natural result of this process. On the other hand, the increase in CO2 emissions is expected to be in the form of a decrease in GFI. In both cases, a negative relationship between GFI and CO2 emissions is an expected result of the dynamics of the variables.

It is thought that the effect of more green technology use and green investment may cause an increase in GFI, and this effect may be reflected in the form of an increase in GDP. In addition, it can be expected that the increase in GDP could create an opportunity to provide more orientation to green investment, and thus, an increase in GFI could occur.

When the relationship between GDP and CO2 emissions is evaluated, it is expected that both variables will interact in the same way. Considering the increase in GDP as an indicator of the increase in production, this situation can be expected to cause more CO2 emissions. On the other hand, further GDP growth can be expected as more CO2 emissions are released.

When evaluating the GDP-CO2 emission relationship from the perspective of including the use of green finance and green technology, it comes to mind that the relationship between GDP and CO2 emissions may be expected to shift in a negative direction, depending on how much of the GDP is obtained through these ways. If green finance and green technology applications increase and their share in GDP is the majority, it should be taken into account that the dynamics of GDP and CO2 could change.

The fact that the data of the variables considered in the study could be obtained for a limited period of time is an important limitation of the study. Therefore, the work could only be done in a limited time frame. Increasing the time interval will eliminate this constraint of the study and increase the validity of the results obtained.

Conclusion

The study's findings are considered crucial for revealing the dynamics between GFI, CO2, and GDP, for understanding how changes in one or more of the variables may affect the others, and for permitting future-forecasts. With the more effective and widespread use of green finance instruments, it is thought that there may be important social contributions in terms of preventing global warming as a result of both providing GDP increase with green technology tools and reducing CO2 emissions.

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