Letters in High Energy Physics
ISSN: 2632-2714
Volume 2024

Impact of Green Finance on High-Quality Economic Development: A Panel Data Regression

Bochun Ma

walten7777@163.com

College of Business, Economics&Law, The University Of Queensland, St Lucia QLD 4072

Abstract:

Sustainable environmental practices must be combined with economic prosperity. This is due to the possibility that an excessive amount of economic growth might harm the environment. This research looks at how green financing may help to advance sustainable, high-caliber economic growth. The sample's duration is dispersed over many nations. Global strategies go from expansion at a quick pace to sustainability. As a result, environmental factors are being taken into account more and more in the calculation of important economic metrics including trade liberalization, GDP growth, and foreign direct investment (FDI). The research draws attention to how economic activity has a detrimental influence on the environment. It focuses on emissions of carbon dioxide particularly and the significance of green financing to lessen these impacts. The goal of green finance, which backs projects like energy from renewable sources, is to minimize environmental damage while promoting economic stability. by the introduction of a model to systematically determine the CO2 emissions drivers. Policymakers may benefit greatly from the insights this study offers. The results highlight how crucial it is to control energy use and cut emissions while preserving economic growth.

Key Word: Sustainability, Green Finance, GDP, FDI , STIRPAT model

Chapter 1: Introduction

The focus of most of the developing and developed countries' economic strategies has shifted from quick growth to high-quality, sustainable development. With a focus on advancing sustainable economic advancement, the main goal is to strike a balance between economic expansion and environmental concerns. Governments worldwide have been actively promoting foreign direct investment (FDI) inflows, Gross Domestic Product (GDP) growth, and trade liberalization as key indicators of economic stability and prosperity (Anser, 2019). The advancement of this indicator terms as economic development. The entrance of FDI provides a country's economy with much-needed capital, boosting economic activity and supporting job creation. Additionally, it frequently introduces cutting-edge managerial know-how, boosting productivity and competitiveness in domestic industries. Through the opening of borders to foreign markets and the lowering of trade obstacles, trade liberalization gives consumers access to a greater range of goods at competitive costs. It encourages cost-effectiveness, specialization, economies of scale, and wealth generation (3). Countries can maximize resources and increase production while promoting diplomatic ties and international cooperation by facilitating international trade. Therefore, FDI inflow, GDP growth, and trade liberalization are all favorable economic indicators that contribute to a country's economic prosperity and development. Governments support these variables because they boost a country's ability to compete internationally, raise living standards, create jobs, and drive economic activity.

Economic growth must be balanced with environmental sustainability since too much economic expansion can have a negative influence on the environment. Although trade liberalization, GDP growth, and foreign direct investment (FDI) all unquestionably advance economic development, experts are growing increasingly worried about the negative effects these factors may have on the environment. The status of economic and political institutions, population expansion, energy consumption, and economic growth have all been cited as major anthropogenic causes of

environmental deterioration in several studies (4). Scientists agree that greenhouse gases, particularly carbon dioxide (CO2) emissions, play a major role in this occurrence, which is essentially what is causing this increased concern. The environment is vulnerable to global warming. The increasing concern over global warming and environmental deterioration has prompted think tanks to advocate for approaches, tactics, funding, and investment alternatives aimed at minimizing this impending danger to the greatest extent feasible Hence, while focusing on continuous GDP growth, there should be an inclusion of environmental aspects to the production process of the GDP. The goal of green finance is to advance environmental sustainability. It has established itself as a funding strategy that is advantageous to the environment and the economy as a result of the global movement toward massive decarbonization. Green finance's main goal is to provide economic stability by promoting investments in green initiatives and laws that support sustainable practices (5). Supporting waste management and recycling, preserving biodiversity, improving water sanitation, reducing industrial pollution, promoting renewable energy, putting policies in place to combat climate change, issuing green bonds, and promoting environmental goods and services are just a few of the activities covered by green financing and investments. The goal of this idea also referred to as green development, is to increase economic production while minimizing unfavorable ecological effects for a specific resource investment. It therefore provides a precise indicator of the viability of economic growth. To achieve green development, however, it is necessary to identify the funding sources and establish plans to improve their efficient use. Against this backdrop, the present study intends to analyze the impact of green finance on high-quality economic development in several countries.

This study adds a number of important pieces to the body of literature already in existence. First, it offers a model that can be used to identify the primary causes of CO2 emissions in a methodical manner. Future researchers who want to use similar methods to analyze emissions in various places can learn a lot from this model. Our research also advances the field by breaking down CO2 emissions. For policymakers and government representatives working to manage the rising energy demand while reducing the excessive CO2 emissions brought on by economic activity, the findings of our study are of utmost significance. A review of the literature is given in the next section, and information on the data used in our econometric models is given in the third section. The results are then presented in section four, which also provides a commentary on them. Finally, in the fifth section, we provide the study's concluding remarks.

2. Literature Review

2.1. Theoretical Review

A financial tool that incorporates the ideas of environmentally friendly development is known as green finance. The development of high-quality production companies and the facilitation of investment in environmentally friendly technologies can be facilitated by green financial advances due to its crucial responsibilities in the capital provision, fostering innovation, regulating green initiatives, and distributing risk. Additionally, it can control business practices, promoting the wise use of green capital to improve the seamless integration of green technology development, environmentally conscious business operations, and the shift to a green economy (6). As a result, high-quality economic development is promoted while also advancing economic growth and environmental improvement in a balanced manner. A financial tool that actively promotes and incorporates green development methods is known as "green finance." It functions by performing crucial tasks such as facilitating capital funding, encouraging innovation, assuring green oversight, and reducing risk. By encouraging scale effects within high-quality production firms and providing essential financial support for the evolution of innovative environmentally friendly production methods, the development of green finance can have a significant economic impact. The rapidly growing green financial sector serves as an essential "capital pool" for businesses that produce environmentally friendly goods. This successfully resolves the issue of inadequate funding for green activities. These monies can be used to support initiatives to reduce pollution and restore the environment, continuously boosting the positive environmental effects of economic growth and promoting high-quality development (7). By implementing policies like limiting financing alternatives and raising financing

costs for highly polluting and energy-intensive businesses, the banking sector and other financial institutions can send strong signals to the market. This leads to a shift in financial resources away from "two high" businesses that are known for their high levels of energy and pollution consumption. Businesses are urged to share information about their green development projects in a green financial system. This covers the evaluation of pertinent data both beforehand and afterward (8). Based on an organization's dedication to green practices and its environmental performance, investors can deploy their resources more wisely and make more informed judgments. As a result, it is crucial for promoting environmentally friendly company practices and the wider economy. It fosters transparency and accountability in green practices, encourages industries to switch to environmentally friendly technologies, and makes it easier for money to flow to green initiatives.

It may appear as though GDP, FDI inflow, trade openness, nuclear energy consumption, urbanization, and green financing have no connection to one another. Nevertheless, these elements are interrelated when taking into account their influence on the environment. These aspects need to be integrated using a dynamic model. In order to clarify these links, several models and hypotheses have been proposed. the outcome of years of investigating how environmental factors and economic development interact in various contexts. The STIRPAT model, or "Stochastic Impacts by Regression on Population, Affluence & Technology," is the primary emphasis of this study. Understanding the interactions between several variables is made feasible by the theoretical framework that this model provides (9). The STIRPAT model is an essential conceptual structure in research that helps to understand the complex interactions. This relates to the interactions between human conduct and the environment. The four main determinants are population, resources, technology, and the impact on the research environment. They may impact the effectiveness of this method. The model also requires data on population size and growth rates as additional input variables. the level of wealth as determined by economic metrics and advancements in technology. The primary objective of the model is to predict and measure the effects on the environment. Take deforestation or CO2 emissions, for instance. It is by looking at how the outcome is affected when these input factors are changed. Extending the STIRPAT framework and drawing inspiration from the work of Chikaraishi et al (2015). He used the framework in their study and included a moderator variable. An expanded analysis is the goal of the research. Green investment and finance will be utilized as a moderator (MOD) variable in this research. The investigation may now look into the relationships between green money and investments. The main goal of the research is to determine how the environment is impacted by the availability of green money and investments. This in turn was impacted by economic and technical development. This will provide our study a major new angle and aid in our comprehension of this intricate interaction.

2.2 Empirical Research

It is evident from the body of research already in existence that promoting environmental sustainability is the main goal of green funding. This is accomplished through making investments in eco-friendly businesses, and technologies, or by actively aiding eco-friendly projects. The current study intends to analyze green financing's role as a moderator in addition to examining its direct effect on lowering CO2 emissions. The study specifically wants to know whether the presence of green financing, when combined with elements like GDP, trade openness, urbanization, and nuclear energy consumption, either increases or mitigates the effects of these elements. It is still to be determined how green funding affects the links between economic indicators, such as urbanization and nuclear energy use, and environmental factors. The study draws conclusions about its potential moderating influence based on earlier groundbreaking research that clarified the definition and direct effects of green funding on the environment.

2.2.1 Development, FDI, Trade Openness, and Carbon Emission:

The research on this subject has produced varying and perhaps contradictory conclusions because the relationship between economic growth and the environment is complex and varied. These economic indicators are frequently linked to broader measures of economic progress, and Foreign Direct Investment (FDI) and trade openness are frequently

seen as key contributors to economic growth and stability. A host country's economy can profit greatly from FDI in several ways. expanded commerce, increased capital investment, and technological transfer. However, as indicated in reference to Xing and Kolstad (2002), it's crucial to understand that while FDI might have positive economic benefits, it can also have negative environmental repercussions. Green financing can support inclusive economic expansion. This study examines how many factors affect environmental carbon emissions using panel data spanning the years 1971 to 2013. It focuses specifically on how per capita energy use, wealth inequality, and economic growth affect environmental results. The main conclusion of the study is that green finance has the potential to promote inclusive economic growth. In plainer terms, it is possible to produce economic growth that benefits a larger range of society when financial processes prioritize ecologically friendly acts. This research demonstrates the potential of green financing to stimulate economic expansion. It simultaneously addresses environmental challenges and reduces economic inequalities. Numerous contaminants and foreign direct investment (FDI) have been connected by researchers. CO2 emissions are included in this. It was implying that environmental deterioration may be influenced by FDI. Scientists have shown a positive correlation between foreign direct investment (FDI) and environmental conservation. In their 2009 research, Stretesky and Lynch claimed that FDI may provide productive and ecologically beneficial industrial techniques. There may be less air pollution as a consequence. Merican and colleagues found that increased pollutant levels were a result of foreign direct investment (FDI). This has occurred in the Philippines, Malaysia, and Thailand. They found that FDI and pollution were negatively correlated in Indonesia. The Atici research from 2012 examined a subset of ASEAN countries. Regarding the connection between FDI and CO2 emissions, he himself reached the same result. Atici, however, found no evidence of a significant relationship between FDI and CO2 emissions in Thailand, Malaysia, Indonesia, or the Philippines. Similar findings were made in 2021 when Mujtaba et al. discovered a negative correlation between FDI influx and carbon emissions. Long- and short-term increases in carbon emissions were caused by a positive shock to FDI. The Environmental Kuznets Curve (EKC) and contamination haven theory have been used in study (Hamid et al., 2022). There has been an increase in interest lately in the impact of trade openness on environmental quality. Allevi et al. (2019) classified the impacts of trade liberalization into three categories. This effect is linked to the trade-off between increased production and environmental damage. Trade liberalization increases efficiency, according to Appiah-Konadu (2013). There's a chance that environmental deterioration may accelerate similarly. This result demonstrates that environmentally friendly manufacturing techniques and technology may be adopted during trade liberalization. The goal is to aid in environmental conservation (Appiah-Konadu, 2013). Technology and manufacturing methods are the main topics. As stated by Krueger and Grossman (1995). Liberalizing trade has altered the economic structure, which has an impact on this effect. It suggests that the composition of the economy shifts. It may result in a greater focus on tertiary sectors or novel technology, which might have an effect on the environment. It suggests that the frame of the economy is evolving. It can lead to an increased emphasis on tertiary sectors or cutting-edge technologies. These might be having an impact on the ecosystem.

. According to Onder (2012), as trade liberalization increases people's incomes, they have a tendency to favor ecologically friendly goods. In addition, Mujtaba et al. (2022) found that in upper-middle-income nations, there was a bad correlation between trade openness and carbon emissions. Regarding the impact of trade openness on environmental quality, the literature, however, offers conflicting conclusions. In scholarly research, the Environmental Kuznets Curve (EKC) idea has garnered significant interest. the intricate connection between GDP and environmental impact.This is especially true for air quality indices such as NO, SO2, and CO2. It has been the focus of a lot of studies. It's crucial to remember that the EKC's prevalence might vary greatly throughout countries and environmental factors. Considering the contradicting study findings mentioned before, theories are proposed to account for the complexity.

H1: Macro-Economic variables (FDI inflows, Trade Openness & GDP) indicating development have a significant impact on CO2 emissions

2.2.2 Green financing & Carbon Emissions

Green finance and environmentally friendly investments are often used synonymously. It is a thorough concept with a wide range that addresses many financial endeavors. This means giving money to enterprises and programs that respect the environment. It supports initiatives that advance renewable energy and encourages the creation of environmentally friendly products and services. Plans for reaching the ultimate objective of an economy that is sustainable are being developed. The concept of "green financing" includes all facets of environmentally conscious finance, according to Höhne and Fekete (2012). The term "green investment" is often used interchangeably. It covers a wide spectrum of financial endeavors dedicated to advancing sustainability across several domains. The 2018 Poberezhna study provides clarification on the concept of the "green economy". Additionally, he outlines possible consequences for environmental degradation. In today's world, it is crucial to comprehend how green finance helps to lessen environmental problems. Concerns about climate change and sustainable development are critical in this context. in order to emphasize the need for green funding even more. According to Gianfrate and Peri (2019), green bonds are essential to reaching carbon reduction targets. Green finance's dedication to addressing the carbon emission problem is one of its main features. Initiatives aimed at lowering the release of greenhouse gases increasingly need financial backing. The perfect example of a financial tool for funding environmental projects and activities is a green bond. These kinds of bonds are only available for use in environmental advocacy initiatives. The creation of ecologically friendly infrastructure and energy from clean sources falls under this category. Further details about potential benefits of green bond promotion are given by Glomsrd and Wei (2018). They draw attention to the fact that green financing may also be utilized to support renewable energy sources. It is intended to decrease emissions of carbon dioxide. one of the primary methods that countries are using to combat climate change. The use of renewable energy sources improves the sustainability of our environment. Green funding helps to reduce greenhouse gas emissions by promoting investments in renewable energy projects. Hence it is hypothesised

H2: Green financing has a significant impact on CO2 emissions.

2.2.3 CO2 emissions as a moderator on Green Financing

It is obvious that green financing functions as a crucial tool with the primary goal of supporting eco-friendly activities and investments in light of the available literature and the expanding significance of environmental sustainability. Green financing has several facets and includes direct financial support for sustainable projects as well as investments in environmentally friendly businesses and technologies. However, this paper intends to explore its possible role as a dependent variable with CO2 emission acting as the moderator of macroeconomic variables on reducing environmental difficulties. The key issue at hand is whether CO2, when combined with elements like FDI inflow, GDP, trade openness, urbanization, and nuclear energy usage, enhances or reduces their effects on the environment. The moderating function of CO2 emission is still largely researched, especially with regard to the interconnections between economic indicators, urbanization, nuclear energy usage, and environmental results. It is reasonable to assume that CO2 emission functions as a buffer in the relationships between independent variables (FDI, GDP, trade openness, urbanization, and nuclear energy consumption) and the dependent variable (environmental impact), thereby reducing their negative impact on the environment, based on significant prior research that highlights the definition and direct effects of green financing (Poberezhna, 2018). Essentially, this broad theory contends that green financing is crucial to mitigating the environmental effects of many economic and developmental issues, promoting a future that is more environmentally conscious and sustainable.

H3: CO2 emission moderates the instrumental variable and Green financing relationships in the present study.

3. Data and Methodology

3.1 Data

The goal of the current study is to determine the effects of a number of independent variables on the dependent variable, CO2 emissions. These independent variables include FDI inflow, GDP,

trade openness (TRA as a percentage of GDP), urbanization (URB as a percentage of population), and nuclear energy consumption (NEC as a percentage of total energy usage). The possible moderating impact of green financing (GF), assessed in terms of US dollar investments in the renewable energy sector, is also taken into account in this analysis. The empirical analysis focuses on information on nations during the period of 2000 to 2021. The nations in the sample were chosen based on two criteria: first, they had to be acknowledged as nuclear power powers, and second, they had to actively produce and use nuclear energy. The sample comprises eleven countries. The GDP per capita is computed using constant US dollars from 2017. The total dollar amount of incoming foreign direct investment divided by GDP is used to compute FDI. Specifically, these countries are referred to as nuclear power states. A comprehensive analysis of the complex connection is the focus of the present research work. It is situated amid several environmental and economic factors. This empirical study's primary objective is to comprehend how many important independent factors interact to influence carbon dioxide (CO2) emissions. An essential indicator for assessing environmental sustainability is this one. A moderator variable called CO2 emission is included. It is believed to moderate the relationships between GF (Renewable Energy Consumption) and the independent parameters. Additionally, the research adds a fascinating dimension to its analysis. The study's variables have been carefully selected and are relevant. The World Bank data website was the primary source of the data utilized in this study. It is anticipated that the findings would inform policy decisions and broaden the corpus of knowledge on conservation. It gives us an understanding of how green finance may contribute to a future that is more environmentally conscious.

3.2 Methodology

The present study incorporates the Dietz and Rosa STIRPAT model (Dietz & Rosa, 1997)

The empirical model will be

$$CO_{2it} = f(FDI_{it}; GDP_{it}; TRA_{it}; URB_{it}; NEC_{it}; GF_{it})$$

$$CO_{2it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 GDP_{it} + \beta_3 TRA_{it} + \beta_4 URB_{it} + \beta_5 NEC_{it} + \beta_6 GF_{it} \ldots\ldots\ldots\ldots 1$$

Finally, the empirical model which established the impact impact of green finance on high-quality economic development

$$GF = \beta_0 + \beta_1 FDI_{it} + \beta_2 GDP_{it} + \beta_3 TRA_{it} + \beta_4 URB_{it} + \beta_5 NEC_i + \beta_6 (FDI_{it} * CO_{2it}) + \beta_7 (GDPit * CO_{2it}) + \beta_8 (TRA_{it} * CO_{2it}) + \beta_9 (URBit * CO_{2it}) + \beta_{10} (NECit * CO_{2it}) + \mu_{it} \ldots\ldots\ldots\ldots 2$$

In this instance, "i" stands for particular nations, and "t" for particular periods. The phrase "(It)" denotes the mistake. It considers arbitrary or unreasonable variations in the data for every country and historical era. The natural logarithms of these variables are often calculated in order to convert them. It occurs when panel data regression is used, and various variables have various scales for measuring them. This helps to standardize the data and addresses the issues brought about by different units and magnitudes. Before starting to examine the panel data, panel unit root tests and panel co-integration tests must be performed. Preventing false regression traps requires taking these first steps. It ensures that the subsequent regression analysis will be accurate. For each variable, a correlation matrix and descriptive statistics are calculated. The main patterns in the data are succinctly summarized by these statistics. It will illuminate the connections between the variables as well. To evaluate the stationarity of the variables, four-panel unit root tests are used. These tests include the Im-Pesaran test, the Levin, Lin, and Chu test, the Phillips-Perron test, and the Augmented Dickey-Fuller test. Each of these tests ascertains if the variables exhibit time-varying stationary behavior. One important premise in time-series analysis is stationarity. The reason for this is because non-stationary data may lead to inaccurate regression results, which inflate the significance of correlations that are not. Long-term correlations amongst the variables are looked at once stationarity has been confirmed. Panel co-integration tests, such as those developed by Pedroni and Kao, are used for this. A continuous long-term link between the factors in question is suggested by co-integration. It's critical to comprehend their interactions. The process then proceeds to estimate the values of the regression coefficients. It comes after making sure the components' long-run co-integration exist. The fully modified OLS (FMOLS) method, which Phillips and Hansen first used in 1990, is used in this work. It accounts for both the main effects of the variables and their interaction

effects, making FMOLS a reliable method for estimating regression coefficients in the presence of co-integration. Apart from that panel data regression method was used to analyse the fixed effect and random effect for this model. The present study uses STATA software for the empirical analysis.

4. Findings

The data gives a thorough summary of the statistical analysis done on a group of variables and provides information on their traits and correlations. The reader is given summary statistics in Table 2, including mean, median, and standard deviation values, which act as preliminary indicators of the central tendency and variability of the variables. The emphasis in Table 3 now switches to the correlation coefficients and the probabilities that go along with them,. Correlation coefficients are essential for illuminating any potential linear correlations between pairs of data. The correlation scale ranges from +1 (signifying a perfect positive correlation) to -1 (signifying a perfect negative correlation), with 0 at the midpoint suggesting absolutely no linear link.

One of the main problems with data analysis is multicollinearity. This is so because it stresses in the paragraph. Multicollinearity is the outcome of significant correlations between independent variables in a model. This may make it challenging to interpret how each variable affects the dependent variable in a different way. This section establishes a threshold to address this problem. Factor of Variance Inflation." In a regression study, multicollinearity is evaluated using a statistical metric called VIF. For this test, five is the threshold value. The lack of considerable multicollinearity in the model under examination is the main conclusion of this investigation. The correlation matrix and the results of the VIF test demonstrate this. This implies that there isn't much of a correlation between the variables being studied. This is due to the fact that multicollinearity is unimportant. This outcome is significant because it provides researchers with assurance that they may proceed with more analysis. Regression modeling is one instance of this. This is not unduly impacted by multicollinearity's aggravating effects.

Variable	Obs	Mean	Std. Dev.	Min	Max
log_GDP	231	4.364599	.4176952	3.410127	4.803702
Log_Trade	231	1.68955	.1505313	1.29136	2.023525
Urbanpopul~l	231	1.271721	1.091683	-1.601972	4.198001
CO2emissio~P	219	.3105872	.1647429	.0936156	.8374868
Foreigndir~i	231	2.024283	1.876641	-3.60894	12.7315
Alternativ~y	231	38.59226	41.57809	1.12028	99

Figure 1: Descriptive Statistics

	log_GDP	Log_Tr~e	Urbanp~l	CO2emi~P	Foreig~i	Altern~y
log_GDP	1.0000					
Log_Trade	0.4645	1.0000				
Urbanpopul~l	-0.7564	-0.4560	1.0000			
CO2emissio~P	-0.2818	-0.0069	0.3219	1.0000		
Foreigndir~i	0.0928	0.1754	0.0593	0.1338	1.0000	
Alternativ~y	0.1813	0.0339	-0.1735	-0.2747	-0.0735	1.0000

Figure 2: Correlation Table

Variable	VIF	1/VIF
Urbanpopul~l	2.56	0.390595
log_GDP	2.54	0.393624
Log_Trade	1.37	0.728244
Foreigndir~i	1.10	0.912131
Alternativ~y	1.05	0.954602
Mean VIF	1.72	

Figure 3: Multicollinearity test

The study defines multicollinearity as a weekly correlation between the independent variables in a regression model. Every variable in the model has a VIF value that is less than the conventional cutoff criterion of 5. It suggests that they still keep a fair amount of separation from one another. For "Log_Trade," "Foreigndiri," and "Alternativy," the corresponding VIF values are 1.37, 1.10, and 1.05, accordingly. They are very consoling. Despite "Urbanpopull" and "log_GDP" having considerably higher VIF values (2.56 and 2.54, respectively). They still fall well inside the permitted range. These figures are unremarkable and can have a negligible impact on the coefficient of variation computations. The model's tolerable level of multicollinearity is further demonstrated by the average VIF across all variables, which was calculated to be 1.72. With these values, the variables in the model have little multicollinearity, which means that their individual contributions are distinct and are not masked by correlations with other predictors. The information presented in Table 4 summarizes the findings of a thorough cointegration analysis conducted on a panel dataset consisting of 11 panels observed during 19 different time periods. The goal of cointegration analysis, a crucial tool in time series econometrics, is to determine whether there is a stable, long-term link between different time series variables, which would indicate that they move in lockstep over a long period of time. the p-values assigned to the provided test statistics. There have been several cointegration tests performed, including modified Dickey-Fuller and unadjusted Dickey-Fuller tests. The null hypothesis of no cointegration is consistently rejected across all of these tests at conventional significance levels (e.g., p 0.05), providing strong support for cointegration between the panels.

	Statistic	p-value
Modified Dickey-Fuller t	2.5933	0.0048
Dickey-Fuller t	3.0023	0.0013
Augmented Dickey-Fuller t	3.3143	0.0005
Unadjusted modified Dickey-Fuller t	2.6565	0.0039
Unadjusted Dickey-Fuller t	3.1348	0.0009

Figure 4: Cointegration test

Using Fully Modified Ordinary Least Squares (FMOLS), the baseline cointegration regression model explores the complex long-run connection between CO2 emissions per kilogram of purchasing power parity (CO2emissionskgper2017PPP) and a number of significant independent variables. The model first and foremost shows a strong negative correlation between CO2 emissions and log-transformed GDP (log_GDP), indicating that as a country's GDP increases, its emissions per unit of PPP tend to decrease. In contrast, Log_Trade has a positive correlation, demonstrating that rising commerce is associated with rising emissions. Urbanization is important, and annual expansion in the urban population has a significant detrimental effect. Reduced emissions are associated with slower urban population growth. Urbanization is important, and annual expansion in the urban population has a significant detrimental effect. Reduced emissions are associated with slower urban

population growth. Additionally, a switch to renewable energy is linked to fewer emissions, as shown by renewable energy consumption. Additionally, foreign direct investment (Foreigndirectinvestmentneti) may help reduce emissions by transferring technologies and enhancing efficiency. Additionally, using nuclear and alternative energy sources has a detrimental effect on emissions (Alternativeandnuclearenergy).

Cointegration regression (FMOLS):

VAR lag(user)	=	0	Number of obs	=	19
Kernel	=	bartlett	R2	=	.9807503
Bandwidth(neweywest)	=	44.9898	Adjusted R2	=	.9711255
			S.e.	=	.0154551
			Long run S.e.	=	.0023956

CO2emissionskgper2017PPP	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
log_GDP	-.6869678	.0203207	-33.81	0.000	-.7267956	-.6471399
Log_Trade	.2998122	.0460403	6.51	0.000	.2095747	.3900496
Urbanpopulationgrowthannual	-.1057101	.0050303	-21.01	0.000	-.1155693	-.0958508
Renewableenergyconsumption	-.0487092	.0047234	-10.31	0.000	-.0579669	-.0394515
Foreigndirectinvestmentneti	-.0066717	.0006103	-10.93	0.000	-.0078678	-.0054756
Alternativeandnuclearenergy	-.0003546	.0000208	-17.04	0.000	-.0003954	-.0003139
_cons	3.181914	.1444253	22.03	0.000	2.898845	3.464982

Figure 5: FMOLS model (Baseline model)

Results from two separate panel data regression models—a fixed-effects (inside) regression and a random-effects regression—are presented in the given output (Figure 6 and 7). In econometrics, these models are frequently used to analyze data that has both cross-sectional and time-series dimensions. They aid in understanding the relationship between a dependent variable (in this case, renewable energy consumption) and independent variables (predictors), while also taking into account potential group-level effects. We are interested in investigating the effects of different independent variables (log_GDP, log_Trade, Urbanpopulationgrowthannual, Foreigndirectinvestmentneti, Alternativeandnuclearenergy, int_GDP1, int_Trade1, int_urban1, int_FDI1, and int_nuc1) on the consumption of renewable energy across 11 different countries using the fixed-effects (within) regression model. This model includes a fixed effect for each nation, effectively removing time-invariant variations between countries from the analysis while accounting for particular country-specific effects. The fixed-effects model's outcomes point to a number of important conclusions. The R-squared value for within-group variance is 0.8058, indicating that the independent variables included within each country account for around 80.58% of the variation in renewable energy usage. Certain variables, such log_GDP, Int_nuc1, Alternative and nuclear energy, have low p-values. It demonstrates that they are very important statistical predictors of renewable energy usage. For example, a significant decline in the utilization of renewable energy is correlated with an increase in log_GDP. Conversely, the random-effects regression model makes the assumption that the distinct impacts of each nation are random. It determines a standard set of coefficients for every nation. Individual variations from the shared set of coefficients are taken into account..

Fixed-effects (within) regression — Number of obs = 158
Group variable: **Country** — Number of groups = 11

R-sq:
within = **0.8058**
between = **0.9145**
overall = **0.9087**

Obs per group:
min = 12
avg = 14.4
max = 15

F(10,137) = 56.85
corr(u_i, Xb) = **-0.6349** — Prob > F = 0.0000

Renewableenergyconsumption	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_GDP	-41.32011	3.49576	-11.82	0.000	-48.23273	-34.40749
Log_Trade	8.668907	5.427503	1.60	0.113	-2.063608	19.40142
Urbanpopulationgrowthannual	1.564272	.5747985	2.72	0.007	.427647	2.700896
Foreigndirectinvestmentneti	-.3183706	.1922993	-1.66	0.100	-.6986292	.0618881
Alternativeandnuclearenergy	.3439692	.1108263	3.10	0.002	.1248179	.5631205
int_GDP1	-5.646079	4.978991	-1.13	0.259	-15.49169	4.199533
Int_Trade1	-4.580978	11.47486	-0.40	0.690	-27.27172	18.10976
Int_urban1	-4.895062	1.502742	-3.26	0.001	-7.86663	-1.923493
int_FDI1	.5635261	.6546667	0.86	0.391	-.7310323	1.858085
Int_nuc1	-2.085368	.4631667	-4.50	0.000	-3.001248	-1.169488
_cons	191.407	10.57531	18.10	0.000	170.495	212.3189
sigma_u	6.1439427					
sigma_e	1.3358862					
rho	.95485774	(fraction of variance due to u_i)				

F test that all u_i=0: F(10, 137) = 95.69 — Prob > F = 0.0000

Figure 6: Panel Data Regression model (Fixed effect)

Random-effects GLS regression — Number of obs = 158
Group variable: **Country** — Number of groups = 11

R-sq:
within = **0.5674**
between = **0.9634**
overall = **0.9477**

Obs per group:
min = 12
avg = 14.4
max = 15

Wald chi2(10) = 2662.95
corr(u_i, X) = **0** (assumed) — Prob > chi2 = 0.0000

Renewableenergyconsumption	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
log_GDP	-37.04835	2.729958	-13.57	0.000	-42.39897	-31.69773
Log_Trade	28.35708	5.314837	5.34	0.000	17.94019	38.77397
Urbanpopulationgrowthannual	3.365341	.9907292	3.40	0.001	1.423548	5.307135
Foreigndirectinvestmentneti	-1.228708	.4468989	-2.75	0.006	-2.104613	-.352802
Alternativeandnuclearenergy	.3430121	.0628328	5.46	0.000	.219862	.4661621
int_GDP1	24.9576	6.63263	3.76	0.000	11.95788	37.95732
Int_Trade1	-71.94393	17.07841	-4.21	0.000	-105.417	-38.47087
Int_urban1	-4.268749	1.860894	-2.29	0.022	-7.916034	-.6214633
int_FDI1	2.668502	1.569338	1.70	0.089	-.4073445	5.744349
Int_nuc1	-2.747015	.392289	-7.00	0.000	-3.515888	-1.978143
_cons	133.703	7.977427	16.76	0.000	118.0676	149.3385
sigma_u	0					
sigma_e	1.3358862					
rho	0	(fraction of variance due to u_i)				

Figure 7: Panel Data Regression model (Random effect)

Numerous noteworthy implications are suggested by the fixed-effects model's findings. For within-group variation, the R-squared value is 0.8058. It shows that 80.58% of the variance in the use of renewable energy is explained by the independent variables included in each nation. Several variables, including log_GDP, Int_nuc1, Alternative and nuclear energy, have low p-values. It demonstrates that they are very important statistical predictors of renewable energy usage. For example, a significant decline in the utilization of renewable energy is correlated with an increase in log_GDP. The random-effects model offers various coefficient estimates for the independent variables, though. In particular, Log_Trade, AlternativeandNuclearenergy, int_GDP1, int_Trade1, and int_nuc1 are statistically significant predictors of the use of renewable energy. The random-effects model does not discover statistical significance for log_GDP, in contrast to the fixed-effects model. The analysis finds discrepancies between the two models in terms of the importance and direction of some coefficients. This emphasizes how critical model selection is when analyzing panel data. When we think that characteristics unique to a certain country are influencing the connection between variables, the fixed-effects model is more appropriate. The random-effects model, in contrast, posits that country-specific effects are arbitrary and unrelated to the independent variables. The study infers that there is a systematic difference between the coefficients obtained in the fixed-effects and random-effects models because the p-value is so modest. The relationship between independent variables and the utilization of clean energy appears to be better illuminated by the fixed-effects model.

	Coefficients			
	(b) fixed3	(B) random3	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
log_GDP	-41.32011	-37.04835	-4.271759	9.137117
Log_Trade	8.668907	28.35708	-19.68817	13.81909
Urbanpopul~l	1.564272	3.365341	-1.80107	1.215372
Foreigndir~i	-.3183706	-1.228708	.9103371	.2747119
Alternativ~y	.3439692	.3430121	.0009572	.295726
int_GDP1	-5.646079	24.9576	-30.60368	11.85283
Int_Trade1	-4.580978	-71.94393	67.36295	26.23334
Int_urban1	-4.895062	-4.268749	-.626313	3.65268
int_FDI1	.5635261	2.668502	-2.104976	.8524004
Int_nuc1	-2.085368	-2.747015	.6616475	1.201049

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 128.59
Prob>chi2 = 0.0000

Figure 7: HausmanTest

5. Discussion

The study's findings provide important light on the connection between a number of macroeconomic variables and CO2 emissions. It clarifies the possible moderating influence of green funding as well. The results highlight the importance of comprehending how economic expansion affects the environment. Additionally, it has the ability to lessen the impact of green finance. Among of the primary findings of the research is the significant and indirect impact of several macroeconomic variables on carbon dioxide emissions. Two important factors are the Gross Domestic Product (GDP) and Foreign Direct Investment (FDI). Trade transparency has been shown to have a major influence in increasing greenhouse gas emissions. Anser (2019) and Hanif found that FDI, GDP, and emissions of carbon dioxide were positively correlated. The present investigation is in conflict with earlier research that was conducted. In line with earlier research by Dong

et al. (2018), the study highlights the contribution of renewable energy use to CO2 emission reduction. This demonstrates how nuclear power might environmentally friendly replace conventional energy sources. It promotes the environment's preservation. The findings show that FDI, trade transparency, and GDP may all benefit greatly from green financing. This result is consistent with further research by Glomsrd and Wei (2018) and Gianfrate and Peri (2019). It implies that green money may improve environmental sustainability via lowering carbon dioxide emissions. Furthermore, the data reveals a troubling trend. The environment is still being positively impacted by urbanization. Even with the possible benefits of green funding, this is the case. It demonstrates that green finance suffered when CO2 emissions were present. This contradicts previous research by Anser (2019), It connected increased CO2 emissions with urbanization. The need of careful urban planning and sustainable urban development strategies is emphasized in this conclusion. Especially in poor countries with nuclear power.

In conclusion, this research contributes to our understanding of the intricate relationship between sustainability of the environment and economic growth. It also clarifies how green finance works in jurisdictions with nuclear power. It highlights how using nuclear energy and financial transparency may lower CO2 emissions. It draws attention to the detrimental consequences that economic indicators like GDP and FDI have on the environment. The importance of green funding as a tactic for environmental preservation is also emphasized in the paper. Even yet, it falls short in addressing the issues brought on by urbanization. All things considered, the results provide lawmakers and stakeholders with useful information.

5. Recommendation

The new analysis adds green financing as a moderator to the STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) model. In the context of nuclear power states, the main objective is to examine how key macroeconomic indicators, such as foreign direct investment (FDI), gross domestic product (GDP), trade openness, nuclear energy consumption, and urbanization, affect environmental outcomes, specifically CO2 emissions. A possible strategy to lessen the negative environmental consequences of these economic issues is presented: green funding. Several econometric methodologies are used to accomplish these research goals. Its purpose is to examine how the moderating, dependent, and explanatory factors relate to one another.The research draws attention to an important and urgent problem. Countries' unrelenting quest of economic expansion often has negative effects on the environment. Governments tend to undervalue and ignore these. For countries, achieving economic success is still the major objective. The associated environmental difficulties and disasters are often disregarded. The results highlight how urgent it is for nations to create and put into effect strict environmental laws. It complements their plans for economic expansion. It is essential that environmental sustainability and economic growth coexist. It can currently be disregarded. The use of energy is essential to economic development. The study's findings provide strong proof. It is claimed using nuclear energy has a good impact on the environment. Thus, it can be argued that increasing the number of nuclear power plants may both improve the economy and advance nuclear energy. It lessens its influence on the environment as well. This outcome emphasizes the probable benefits of developing infrastructure for nuclear energy. It is a means of achieving both financial and ecological objectives. The main result of the research is the link between development and contamination. The results highlight the need for stringent checks and balances. It is a policy measure to lessen the adverse effects of urbanization on the natural world. if there is no practical way to halt the urbanization trend. The paper also stresses how important it is to create and implement countermeasures. It's to keep the natural world safe. It is recommended that governments develop plans to lessen the negative environmental consequences of FDI. It included favoring labor-intensive manufacturing techniques over ones that required a lot of money. It encourages businesses to adopt eco-friendly procedures and technology. The report also emphasizes the possibilities of green finance. Thus yet, not much study has been done in this area. The results provide the basis for acknowledging green funding as an essential moderator. It lies between ecological results and macroeconomic prosperity metrics (FDI, GDP, trade openness). Prioritizing green activities and promoting green financing via

fiscal policies are advised for regulators and the government. To support sustainable economic development, there should be aggressive promotion of a variety of green finance alternatives. To sum up, the results of the research have important ramifications for theory and policy. the STIRPAT model's inclusion of green finance as a moderator. It creates new opportunities for this kind of study. This framework may be expanded upon in further research. It could use sophisticated econometric models and concentrate on various areas and nations. Additionally, researchers might investigate the mechanisms by which environmental elements are impacted by economic growth factors. It takes into account the influences of technique, composite, and scale individually. In the end, the research emphasizes how important it is to strike a balance between environmental preservation and economic success. It offers insightful advice to stakeholders and legislators attempting to tackle the difficult problems. It includes falsehoods about sustainable development in states with nuclear energy sources.

.

Reference

1. Apergis, N., Payne, J. E., Menyah, K., & Wolde-Rufael, Y. (2010). On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecological Economics, 69(11), 2255–2260. https://doi.org/10.1016/j.ecolecon.2010.06.014
2. Appiah-Konadu, P. A. U. L. (2013). The effect of trade liberalization on the environment: A case study of Ghana. [Doctoral dissertation]. University of Ghana.
3. Allevi, E., Basso, A., Bonenti, F., Oggioni, G., & Riccardi, R. (2019). Measuring the environmental performance of green SRI funds: A DEA approach. Energy Economics, 79, 32–44. https://doi.org/10.1016/j.eneco.2018.07. 023
4. Al-Mulali, U. (2014). Investigating the impact of nuclear energy consumption on GDP growth and CO2 emission: A panel data analysis. Progress in Nuclear Energy, 73, 172–178. https://doi.org/10.1016/j.pnucene.2014.02.002
5. Anser, M. K. (2019). Impact of energy consumption and human activities on carbon emissions in Pakistan: Application of STIRPAT model. Environmental Science and Pollution Research, 26(13) , 13453–13463. https:// doi.org/10.1007/s11356-019-04859-y
6. Atici, C. (2012). Carbon emissions, trade liberalisation, and the Japan–ASEAN interaction: A group-wise examination. Journal of the Japanese and International Economies, 26(1), 167–178. https://doi.org/10.1016/j.jjie.2011.07.006
7. Chikaraishi, M., Fujiwara, A., Kaneko, S., Poumanyvong, P., Komatsu, S., & Kalugin, A. (2015). The moderating effects of urbanisation on carbon dioxide emissions: A latent class modeling approach. Technological Forecasting and Social Change, 90, 302–317. https:// doi.org/10.1016/j.techfore.2013.12.025
8. Dietz, T., & Rosa, E. A. (1997). Effects of population and affluence on CO2 emissions. Proceedings of the National Academy of Sciences, 94(1), 175–179. https://doi.org/10.1073/pnas.94.1.175
9. Dong, K., Sun, R., Jiang, H., & Zeng, X. (2018). CO2 emissions, economic growth, and the environmental Kuznets curve in China: What roles can nuclear energy and renewable energy play? Journal of Cleaner Production, 196, 51–63. https://doi.org/10.1016/j.jclepro.2018.05.271
10. Gill, A. R., Viswanathan, K. K., & Hassan, S. (2018). A test of environmental Kuznets curve (EKC) for carbon emission and potential of renewable energy to reduce greenhouse gases (GHG) in Malaysia. Environment, Development and Sustainability, 20(3), 1103–1114. doi:10.1007/ s10668-017-9929-5
11. Gianfrate, G., & Peri, M. (2019). The green advantage: Exploring the convenience of issuing green bonds. Journal of Cleaner Production, 219, 127–135. https:// doi.org/10.1016/j.jclepro.2019.02.022
12. Glomsrød, S., & Wei, T. (2018). Business as unusual: The implications of fossil divestment and green bonds for financial flows, economic growth and energy market. Energy for Sustainable Development, 44, 1–10. https://doi.org/10.1016/j.esd.2018.02.005
13. Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. The Quarterly Journal of Economics, 110(2), 353–377. https://doi.org/10. 2307/2118443

14. Hamid, I., Alam, M. S., Murshed, M., Jena, P. K., Sha, N., & Alam, M. N. (2022). The roles of foreign direct investments, economic growth, and capital investments in decarbonising the economy of Oman. Environmental Science and Pollution Research International, 29(15), 22122–22138. doi:10.1007/ s11356-021-17246-3
15. Hanif, I. (2018). Impact of economic growth, non-renewable and renewable energy consumption, and urbanisation on carbon emissions in Sub-Saharan Africa. Environmental Science and Pollution Research, 25(15), 15057–15067. https://doi.org/10.1007/s11356-018-1753-4
16. Höhne, K., & Fekete, G. (2012). Mapping of green finance delivered by IDFC members in 2011. Ecofys.
17. Jiang, L., Zhou, H. F., Bai, L., Zhou, P., Gill, A. R., Viswanathan, K. K., & Hassan, S. (2018). Does foreign direct investment drive environmental degradation in China? An empirical study based on air quality index from a spatial perspective. Journal of Cleaner Production, 176, 864–872. https://doi.org/10.1016/j. jclepro.2017.12.048
18. Khan, A. Q., Saleem, N., & Fatima, S. T. (2018). Financial development, income inequality, and CO2 emissions in Asian countries using STIRPAT model. Environmental Science and Pollution Research, 25(7), 6308–6319. doi:10.1007/s11356-017-0719-2
19. Lin, W., Chen, B., Luo, S., & Liang, L. (2014). Factor analysis of residential energy consumption at the provincial level in China. Sustainability, 6(11), 7710–7724. doi:10.3390/su6117710
20. Merican, Y., Yusop, Z., Noor, Z. M., & Hook, L. S. (2007). Foreign direct investment and the pollution in five ASEAN nations. International Journal of Economics and Management, 1(2), 245–261
21. Mujtaba, A., Jena, P. K., & Joshi, D. P. P. (2021). Growth and determinants of CO2 emissions: Evidence from selected Asian emerging economies. Environmental Science and Pollution Research, 28(29), 39357–39369. doi:10.1007/s11356-021-13078-3
22. Mujtaba, A., Jena, P. K., Bekun, F. V., & Sahu, P. K. (2022). Symmetric and asymmetric impact of economic growth, capital formation, renewable and non-renewable energy consumption on environment in OECD countries. Renewable and Sustainable Energy Reviews, 160, 112300. doi:10.1016/j.rser.2022. 112300
23. Onder, H. (2012). Trade and climate change: An analytical review of key issues. World Bank Economic Premise, 56, 1–8.
24. Phillips, P. C., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I (1) processes. The Review of Economic Studies, 57(1), 99–125. doi:10.2307/2297545
25. Poberezhna, A. (2018). Addressing water sustainability with blockchain technology and green finance. In Transforming climate finance and green investment with blockchains (pp. 189–196). Academic Press. doi:10.1016/B978-0-12-814447-3.00014-8
26. Stretesky, P. B., & Lynch, M. J. (2009). A cross-national study of the association between per capita carbon dioxide emissions and exports to the United States. Social Science Research, 38(1), 239–250. doi:10.1016/ j.ssresearch.2008.08.004
27. Xing, Y., & Kolstad, C. D. (2002). Do lax environmental regulations attract foreign investment? Environmental and Resource Economics, 21(1), 1–22. doi:10.1023/A:1014537013353