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Original Research Article

Studying the nexus of green financing and sustainable development in China: Role of socioeconomic influences

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ABSTRACT: The paper explores the concept of "green finance" and its role in addressing environmental issues through diverse funding strategies in China. It analyzes the factors driving renewable energy development in China from 2005 to 2022 using a unique method called "christened plate cointegration" and connectedness modeling. The study highlights the significance of encouraging environmentally responsible financing and involving private sector businesses in regional and global growth for long-term sustainability. The paper emphasizes the importance of cross-country dependence (CD) as a metric for analyzing interconnectedness between studied countries and suggests isolating the pass dependence for an impartial CD analysis. The study demonstrates that an increase in renewable energy usage leads to a rise in trademark registrations and financial development applications, and private sector involvement corresponds to the rise in trademarks and patents. Overall, the study emphasizes the significance of green financing in mitigating climate change and advancing sustainable growth, as well as the role played by private enterprises in local, national, and global development.

KEYWORDS: green finance; renewable energy sources; sustainable development; China; cross-country dependence (CD)

1. Introduction

China's massive economic growth has necessitated the use of an enormous amount of energy, which has led to a tremendous amount of pollution. Unfortunately, China's growing economy is consuming more energy than can be provided by the current renewable energy infrastructure. To lessen the environmental impacts of economic activity and the electricity needed to power it, legislation must be enacted to encourage the extensive adoption of renewable bases. This study examines and evaluates various options to determine which renewable energy source is best at reducing carbon emissions. This study's results will pave the way for a novel approach to renewable Vigor production that is more well-organized at plummeting carbon production than existing approaches. Boffins is examining the potential of numerous renewable liveliness foundations to reduce overall carbon dioxide discharges in response to this phenomenon.

Due to our growing dependence on fossil fuels, GHG emissions have increased, which has hampered economic growth in recent years[1]. The Industrial Revolution required fossil fuels like coal and oil to achieve its goals. Commercial expansion is a cornerstone of economic growth, and the use of fossil fuels provides a considerable accelerator that may be applied to this process. Warnings concerning the dangers of climate change to human health, quality of life, and the environment have increased in the

scientific literature over the past few decades[2]. Emissions of carbon dioxide are also a significant contributor to global warming. Several scientists and countries have stressed the need to solve this issue to prevent it from having catastrophic repercussions on the global ecology. Sebestyén and Abonyi[3] suggest that emissions of greenhouse gases could treble from their pre-industrial level by 2035 if drastic measures are not implemented. Allowing this to happen is crucial to halting global warming. An increase in the global average temperature of more than 2 °C was forecasted during the 2015 Paris Climate Conference[4]. To a greater extent, the living standards of the citizens of countries that successfully attract FDI are raised due to the expansion of their economies. Researchers and public officials argue that FDI can significantly influence a country's development efforts[5]. Foreign direct investment in developed countries has increased dramatically due to trade liberalization. Research findings are summarized in "Environmental policies and energy efficiency investments. An industry-level analysis"[6], and they show that its importance as a source of fresh money has grown over time in various countries. To feed the biosphere's projected 9 billion people in 2040, traditional agriculture will need an additional 35% of the country. Increases in greenhouse gas emissions are inevitable, even though agricultural emissions currently comprise a small percentage of the total[6]. Greenhouse gas emissions account for half the total emissions needed by 2060 to maintain a temperature rise of fewer than 2 °C. This is necessary to prevent a temperature increase greater than 2 °C. Mitigating the consequences of global warming and safeguarding vital resources would be highly challenging if the environment were destroyed due to these factors.

Much writing has been done on energy policy and its bearing on economic expansion. Yet, there is a lack of data on how rules that favor renewable vigor bases affect commercial production. This finding comes as a bit of a surprise, assuming the crucial character that the growth of renewable liveliness sources dramas in vigor strategy and as a strategy to help ensure the long-term viability of the reduced remarked that if we want to see a change in global vigor ingesting and an increase in the middle quality of life in economies around the world, we should prioritize providing people with more access to renewable energy sources[7]. Somebody who thinks increasing people's access to renewable energy should be a government priority said this.

Regarding carbon dioxide emissions, China is second only to the United States. Many scientists, politicians, and nations believe China is primarily responsible for the greenhouse gas emissions that lead to global warming. In contrast to glass, the sheets are not as see-through[8]. It can be instructive to consider a matter from a different perspective to get to the root of a point. Several ecologists and environmentalists blame China for the world's present environmental crisis. There has been a tremendous outcry worldwide due to the frightening rate at which pollution spreads throughout the country.

China has been at the forefront of the global race since 2008 regarding greenhouse gas emissions. (GHGs). China ranks 48th globally for CO_2 emissions per capita, with 7.10 tons. It will take China a while to emit as much carbon dioxide per person as the United States. With 10.21 billion metric tons of CO_2 released into the atmosphere in 2019, China surpassed all other countries as the top emitter of carbon dioxide. It is estimated that 28% of worldwide CO_2 releases originate in China. Climate-altering gas emissions are highest in the United States.

In addition to increased population, technical development, and energy demands, China has also seen an increase in the country's carbon emissions[9]. There is a correlation between the amount and quality of carbon emissions and the state of many different natural resources, from humans and animals to the Earth itself. For this reason, they are a severe threat to the national economy and the standard of living enjoyed by its citizens. As stated in the literature, these features are vital to the smooth effect of the

aforementioned economic movement[10]. There are not enough references to back up the statements made in this paragraph. Examining the connection between carbon emissions and sustainable growth with the help of natural resources and other forms of renewable energy is an attempt to discover answers to this international challenge[11]. The study will focus on how renewable energy and other natural resources can contribute to this expansion.

- The following are a few valuable outcomes from this research. While previous studies have examined the causal link between environmentally friendly innovations like green finance and sustainability practices, our study is the first to use annual balanced panel data for 30 provinces in China to assess the cointegrating relationship between environmentally friendly innovations, ecological sustainability practices, and all three of these factors from 2005 to 2022.
- We examined how natural efficiency and green finance have affected green innovation. Additionally, we divided the entire sample into six sub-samples (high-GI and low-GI sub-samples, high-GF and low-GF sub-samples, and high-EPI and low-EPI sub-samples) to compare the levels of ambient achievement, green financing, and environmental protection in each region of China. Since a change in one factor might affect another, authorities should consider the environmental effect, green funding, and ecological inventiveness together.

1.1. Global scenario

The global scenario highlights the significance of green financing in mitigating climate change and advancing sustainable growth. There is a growing recognition of the importance of environmentally responsible funding and the involvement of private sector businesses in regional and global growth for long-term sustainability. The interconnectedness between countries and analyzing factors driving renewable energy development is crucial in understanding the nexus of green financing and sustainable development.

1.2. Objectives and previous research

The research aims to study the nexus of green financing and sustainable development in China, explicitly analyzing the factors driving renewable energy development from 2005 to 2022. Previous studies have examined the causal link between environmentally friendly innovations like green finance and sustainability practices. However, this study is the first to use annual balanced panel data for 30 provinces in China to assess the cointegrating relationship between environmentally friendly innovations, ecological sustainability practices, and all three of these factors.

1.3. Research gap and novelty

The research aims to fill the gap in understanding the factors driving China's renewable energy development and its relationship with green financing and sustainable development. The unique method of "christened plate cointegration" and connectedness modeling is implemented in this study to analyze the factors driving renewable energy development in China. This approach provides a novel perspective on the interconnectedness between countries and the role of green financing in advancing sustainable growth.

2. Literature review

A green economy relies on various factors, one of which is the availability of financial resources. Adaptation and mitigation strategies are another option[12]. Reduced or eliminated emissions of greenhouse gases will result in cash flows that can be invested in climate change mitigation efforts.

"Adaptation financial flow" refers to the amount of money invested in projects that mark merchandise in addition to individuals' new spirit to the belongings of weather alteration. Energy consumption and GDP growth were examined for the N11 nations using the distributed lag metric causality method[13].

They found that several countries already have conservation initiatives in place. Governments worldwide, especially those in the Eurozone, have been alerted to this issue. It has been speculated that, from a monetary standpoint, an increase in economic sources could have significant positive effects on energy and the environment. This is contentious theory.

New environmentally helpful resources, especially renewable energy, will significantly benefit the expanded efforts of the international banking sector to limit climate change. Those concerned about the belongings of weather change and trash in the world around them may want to consider expanding their sets to take account of environmentally friendly properties. Alternative solution finance, clean innovation venture capital, and negative and positive screening are all green trading tactics[14].

Green finance could gain from including monetary presence, secluded spending, and non-financial statistics if novel techniques for stressing and maintaining RE are developed to lessen the negative consequences of the current global environment. Incorporating non-financial information, private spending, and financial inclusion may all improve green finance[15]. This is because the novel approach actively works to lessen the impact of the current worldwide circumstance. The textual description calls it a "proven way to integrate exposed data with shareholder requests and deliver further specific data". There are not enough references to back up the statements made in this paragraph. Individuals make beneficial choices more readily, resulting in cost savings and consistent legal compliance. The evaluation of these comprehensive reports, which aid in developing "whole system structures" is also lacking. Organizational decision-makers can increase the value of integrated information by double-checking and assessing its accuracy.

The importance of green finance and financial inclusion in realizing the aims of an additional productive, protected, then low-carbon economy is emphasized in energy policy. To increase its worldwide competitiveness, the United Kingdom aims to invest in green finance[16]. Expanding the use of solar energy throughout the G-20 could help their economies grow. If we are successful, we may rest easy knowing that the Earth will be in good shape for future generations. Several nations have concluded that they may reduce their environmental impact by increasing their investment in RE. For most people, the benefits of producing power from renewable sources far outweigh the expenses. None of the nations surveyed[17], including those with low, moderate, and high income levels, found that using renewable energies was associated with long-term economic progress.

Reduced use of fossil fuels could help lessen the environmental toll of our power habits[18]. There are a variety of dangers associated with using this energy source; thus, it should be avoided at all costs. For the record, most renewable energy sources have not been subjected to rigorous scientific study. This is a significant reason they should be avoided because of their risk. The majority of the responsibility for the disaster will fall on corporations and other types of businesses. But losses might go into the millions if anything goes wrong with the "wind power generating gears" or a solar panel in multiple ongoing projects. Yet this is only part of the story; if you want to succeed, you'll have to overcome obstacles like "the weather" and others. The weather and sunshine are crucial to the success of many renewable energy projects now under development[19]. Weather conditions, such as cloud cover that prevents sunlight from reaching the generator or a lack of wind, can significantly negatively impact the amount of energy generated and the effectiveness of these schemes.

3. Specifications for the model and study design

3.1. Research strategy

To accelerate industrialization, it is necessary to increase access to finance. According to preliminary analyses, there is a link between the current economic systems and CO_2 emissions. Using renewable energy has helped cut down on pollution. Carbon emissions, environmentally responsible banking practices, and adopting renewable energy sources were all areas of inquiry that benefited from applying quantile regression. The addition of the "foreign" covariate bolstered our results.

3.1.1. The sustainable finance performance index

Understanding that green financing is a process in which multiple parties work together to embed sustainable value is crucial (with start-up corporations besides new-fangled entities ensuing blurs or purchases). It can be calculated by subtracting the market value of environmentally friendly companies from the total market value of all enterprises. Investing in green projects has the twin goals of reducing fuel consumption and protecting the natural world. This research demonstrates the significance of public spending. We can derive green financial statistics and an index by subtracting the sum spent on energy generation and environmental protection from the overall sum. **Table 1** displays the outcomes.

Table 1. An ecologically responsible indicator of the financial markets.

Component	**Eigenvalue**	**Variation**	**Percentage**	**Cumulative**
Comp 1	1.365	3.732	2.2489	4.4496
Comp 2	2.256	1.1495	2.2509	2.295
Comp 3	2.2028	-	3.302	2
Eigenvectors				
Variable	Comp 1	Comp 2	Comp 3	-
GI	1.1909	−2.2024	−2.2819	-
EPI	2.2698	2.2983	2.2208	-
GF	2.2795	−2.2709	2.2846	-
Correlation matrix				
Variable	GC	GS	GN	-
GI	2	-	-	-
EPI	2.277	2	-	-
GF	2.259	2.299	2	-

3.1.2. Descriptive statistics

The provided sources do not contain specific information about descriptive statistics. The first paper focuses on the relationship between green financing, renewable energy, and sustainable development in China rather than providing descriptive statistics. The second and third sources discuss the augmented Dickey-Fuller (ADF) test and its application in analyzing short-range features of sequences but do not mention descriptive statistics. The fourth source says the use of nonparametric models and the generation of outcomes from separate samples but does not provide descriptive statistics. The fifth source discusses the influence of indices on the system and the impact of shocks but does not mention descriptive statistics.

Privately owned and run businesses do not have a voice that compiles information linked to the amount of money spent on energy production and environmental protection[20]. Our choice to use this

ranking was heavily influenced by the fact that there was inadequate oversight in the data collection process. It's possible that removing a capital business from the equation will make it easier to understand how administration spending affects the Green Cheap score. Principal component analysis and information from primary statistics sources can be utilized to compute whole green finance (GF) indexes[21]. The fact that it has a value that is more than one makes it a potential option for the PCA's formulation of economic development indicators.

Table 2 contains data on carbon dioxide emissions, khaki financing, and the share of total energy drinking from renewable sources in eloquent numbers. **Table 2** presents the descriptive statistics. The mean value for the GI is 1.16 to 2.29, indicating a moderate level of these indices on average. The standard deviation values range from 1.16 to 2.29, suggesting a moderate level of spread or dispersion in the data. The maximum and minimum indicate less variability in the data. The summary statistics give insights into general trends and variability in green finance environmental performance.

Table 2. Descriptive statistics.

Variables	Definition	Data source	Mean	Standard deviation	Minimum	Maximum
GI	Green finance index	China Environmental Statistics Yearbook	1.16	2.24	2.29	4.45
EPI	MLN_{TONNE}	China Financial Statistical Yearbook	1.17	2.25	3.39	3.39
GF	MLN_{TOE}	China Environmental Statistics Yearbook	1.17	1.17	2.29	3.39
GI	% GDP	China Financial Statistical Yearbook	2.29	1.18	3.38	3.32
EPI	MLN_{TONNE}	China Environmental Statistics Yearbook	2.29	1.13	4.59	2.29
GF	% of total final energy consumption)	China Financial Statistical Yearbook	2.29	1.12	6.69	3.39
GI	% GDP	China Environmental Statistics Yearbook	2.24	2.27	1.12	4.48
EPI	GDP per capital	China Financial Statistical Yearbook	2.29	1.19	3.37	4.42
GF	Green credit	China Environmental Statistics Yearbook	2.256	1.14	3.347	5.502

3.2. Description of the model

Because of the interconnectedness of the studied countries, cross-country dependence (CD) is a valuable metric. By isolating the pass dependence, an independent and fair analysis of the CD working in this study is likely. It was suggested to take these steps. The equation stands for the *P* test (1).

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{j=i+1}^{N} \rho_{ji}\right) \tag{1}$$

$$y_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it} \tag{2}$$

i represent the bridge's size and t the time available to build it.

The augmented Dickey-Fuller (ADF) test looks at each sequence's short-range features. Because of this, the statistics behind defining a cord of literature shaped the general findings of the *t*-test (without a trend).

$$\Delta x_{i,t} = \omega j + \omega i x_{i,t-1} + \sum_{j=1}^{p_i} \emptyset_{i,j} \Delta x_{i,t-j} + \nu_{i,t} \tag{3}$$

The ADF examinations in each country vary significantly from one another. The IPS test has a

margin of error because its alternative hypothesis can accommodate some sway. Traditional series resistor analysis is a pointless and inefficient use of time and materials. The IPS unit root test estimation formula is illustrated below.

$$t_{NT} = \frac{I}{N}\sum_{i=1}^{N} t_{i,t}(P_i) \tag{4}$$

P_i denotes the ADF regression, and the *t*-statistic for the unit root in each country is characterized by t_i, t. The "American Distribution Function" is the abbreviation for this.

As a result, the singular board founder broadcast is predicted to have a more considerable impact than the standard board cointegration examination. We employ a long-term evaluation perspective[22]. Thus, the correct cointegration formula can be expressed as follows:

$$x_{i,t} = \alpha_i + p_i t + \beta_{1i} Z_{mi,t} + \mu_{it} \tag{5}$$

The linearity and seize relationships for each single plate component are detailed below. i, $1i$, $2i$,..., mi. Seven figures were identified to decide whether or not an organizer rapport exists in a multi-member panel. Characteristic manifold regression analysis could be carried out using these examines. Pedroni advises that assumed regression models to mitigate the impact of permit dependence play a role. Data from Pedroni tests that fit the criteria were put in one set, while those that didn't were put in another. To ensure that the predicted linear royalties the company's founders would get were statistically normal, Pedroni ran eight separate experiments.

Unlike the other stages, the first five are distinct because of their dimension. Shown below are the outcomes from eight separate samples. Nonparametric models like the Perron and Phillips Rh arithmetical replicas can benefit panel data models. The fact that the third statistic is nonparametric explains why it looks closely like the *t*-statistics. The last ordinariness examination is generated by a method recognized as the regular mean and impacts the eight distinct means cast off to schoolwork miniature inhabitants[23].

4. Results and discussion

Researchers need data to construct statistical payments to guarantee reliable information, and this practical research helps with summarizing document factors[24]. This is because the reliability of the checks was established using statistical methods. Large enterprises and government entities may feel the effects of the increased responsibility that the transition has brought. A representative from a large corporation said in **Table 3** that the legislation "does not affect anything but focuses on the need to examine how financial issues are regarded with small and midsize enterprises".

Companies with poor management may lose business from a wide range of potential customers. We need to adjust our methods immediately to be prepared for this shift. One participant in a listening session speculated that this effort to overhaul the GF system was the impetus for the subsequent "financial reform". A more comprehensive range of possibilities emerges when other facets of the answers are considered. An abundance of data revealing relationships between variables is seen in **Table 4**.

Table 3. Take a look at a sample from different angles.

Variables	CD coefficient	S scale LM coefficient	Pagan LM coefficient
GI	1.138***	62.24***	1136.68***
EPI	1.224***	92.26***	1636.65***
GF	1.339***	134.49***	2146.61***

Table 3. (*Continued*).

Variables	CD coefficient	S scale LM coefficient	Pagan LM coefficient
GI	7.738***	94.45***	1524.43***
EPI	7.776***	115.56***	1903.34***
GF	7.756***	165.52***	2722.28***
GI	5.977***	45.57***	822.22***
EPI	1.224***	116.66***	1852.29***
GF	2.719***	126.66***	2242.29***

Table 4. A unit root test using CIPS and CADF.

Variables	CHIPS		CADF	
	Level	First-different	Level	First-different
GI	−1.115	−2.227***	−1.420	1.138***
EPI	1.95	−2.273***	−2.102	−1.224***
GF	−1.003	−2.226***	−33.45	−1.339***
GI	1.107	−3.326***	−2.622	−7.738***
EPI	−1.119	−3.366***	−2.269	−7.776***
GF	−1.114	−9.939***	−2.239	−7.756***
GI	2.253	−2.227***	−1.219	−5.977***
EPI	−2.45	−4.479***	−2.928	−1.224***
GF	2.202	−6.626***	−2.579	−2.719***

Items on the diagonal portions represent the influence of a single index on the entire system. In contrast, other series represent the influence of a single index on each of the other indices individually[25]. Thus, the impact of a single index is shown in each column. Shocks can have widely varying absolute magnitudes, but they often communicate the same amount of force regardless of index. Compared to the other directories, Green Money was exposed to most of the lowermost tremor broadcast to the others (7.87%). If we compare this rise to the one created by only looking at carbon-valuing catalogs, sunlight, breeze, and other liveliness causes, we find that it is larger by 0.04 percentage points. In perspective, solar biofuels produce the most overall stress (12.14%), whereas solar fuel cells produce the second-most stress (3.56%).

A Hausman test was conducted to see if the covariate-variables relationship was an immobile personal property archetypal. As a result, the CADF prediction model was used as the significant regression strategy for this inquiry. However, this study aims to examine the link between green finance and financial inclusion, focusing on the roles played by green financing, EPI, GI laws, and source reliance. Separating the nation into segments with varied degrees of data dependence and compliance with financial inclusion rules allows us to demonstrate a panel threshold model. Our next step is investigating how these two factors are linked to developing an eco-friendly economy. Early in the investigation, we focus on people's potential monetary contributions.

Our data supports previous results that show a strong correlation between financial presence and the adoption of green economics. Our modeling efforts have yielded a dependent variable (Column 4) that enables us to examine the effect of green money and renewable energy (RE) on economic and social mobility (6). The RE variable is 0.320 if the two international skill and asset variables remain constant at 5% during the inquiry. This is in Column 5. The results after several additional factors have been

considered are shown in lines (5) and (6), which lend more credence to this assertion. This result is the result of a combination of factors. Research and education (RE) are a powerful tool for a country's economic growth, social capital development, arts funding stability, and worldwide competitiveness. Joint estimation of random and fixed components may identify the appropriate econometric technique[26,27]. **Table 5** displays the outcomes of the fixed effects and random effects models.

Table 5. Analysis of the integration of coefficient.

Model	Zero shift		Average shift		Regime shift	
	Coefficient	Sign	Coefficient	Sign	Coefficient	Sign
LMτ	−1.4209	2.2129	−5.5529	5.5002	−6.6407	6.6002
LMϕ	−2.1027	2.2129	−5.5321	5.5002	−6.6529	6.6002

Results from the Hausman test indicate that, when applied to this data set, the model with fixed effects is superior to that with random effects. More than that, we use both models to study GF's consequences. When GF is increased by one percentage point, CO_2 emissions drop between 0.775 and 0.081 percent across all models. The fixed and random impact models provide these percentages. We find that the conclusions hold up under scrutiny. I found an analogous pattern in Argentina. Founded on these numbers, **Table 6** proves how switching to renewable energy causes a dramatic rise in pollution. Increases in the utilization of renewable energy are expected to result in a reduction of carbon dioxide emissions by between 5.11 and 5.04% for every one percent of increased usage. All control parameters have a statistically substantial negative outcome on CO_2 discharges except R&D, where a 1% increase in EPI leads to a 3.21% and 2.69% dewdrop in radiation, respectively. Every part, except R&D, fits this description. This study decides with the preceding research.

Table 6. The output of a quantile regression model with constant effects.

Variables	Q(10)	Q(20)	Q(30)	Q(40)	Q(50)	Q(60)	Q(70)	Q(80)	Q(90)	95th
GI	−1.21**	−1.112***	−3.32	1.125*	1.129**	−1.1126	2.894***	2.824***	4.494***	−1.131***
	−1.109	−1.106	1.184**	−1.105	−1.104	−1.165	−2.218	−2.213	−4.14	−2.203
EP	1.145***	−1.172**	−1.137	1.182***	−1.168***	−1.149	4.475***	2.25***	2.276***	−2.808***
	1.139	−1.133	2.285***	−1.123	−1.118	−1.138	−2.585	−2.983	−2.36	−2.213
GF	1.142***	2.728***	2.249	1.109***	1.805***	4.498**	−1.533***	−2.05***	−3.5***	2.915***
	1.146	−1.182	4.475***	−1.123	−1.119	−1.879	−1.116	−1.113	−3.318	−2.208
GI	2.223***	1.177**	−2.266	2.262***	2.207***	1.173**	−1.129***	−1.939***	−3.30***	2.290***
	2.266	−1.134	−2.295***	−2.258	−2.286	−1.137	−1.121	−1.116	−3.332	−2.288
EPI	2.272**	2.647***	−2.2298	2.244***	1.118***	2.475***	−1.527***	−1.951***	−1.248***	2.204***
	2.236	−1.153	−2.694***	−2.222	−2.222	−1.169	−2.217	−1.114	−1.116	−2.208
GF	2.222***	5.509***	4.442*	3.635***	2.211***	4.442*	4.494***			2.275***
	2.938	−1.495	−1.822	−1.166	−2.208	−1.822	−4.14	2.283***	−2.21	−2.283
GI	2.716***	−1.689***	−1.902***	2.238***	2.217***	−1.902***	2.276***	−2.222	1.156***	3.300***
	2.260	−1.142	−1.145	−2.228	−2.223	−1.145	−2.36	7.875***	−0.228	−1.134
EPI	2.222***	−1.649***	−1.804***	3.340***	2.267***	−1.804***	−3.5***	−2.289	−2.225***	
	2.258	−1.151	−1.139	−3.338	−1.133	−1.139	−3.318	−2.235***	−2.15	
GF	2.221***	−1.739***	−2.210***	3.378***	2.221***	−1.703***	−3.30***	−2.218	−2.215***	
	2.259	−1.138	−2.229	−3.331	−2.219	−1.114	−3.332	−2.205***	−2.222	
Constant	12.626***	10.062***	8.396***	3.386***	3.399***	2.283***	−1.248***	−2.22	−2.231***	2.272***
	3.289	2.719	2.429	−4.461	−3.378	−2.292	−1.116	−2.941***	1	

This conclusion shows that in countries that invest more money into EPI, CO_2 emissions technology is more advanced. **Table 7** further proves that the correlation between China's CO_2 emissions and renewable energy is not static, just like the correlation between technology and its eventual impact on society.

Table 7. Evaluation of resilience (green credit).

Variable	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)
Panel: 1									
GI	−1.112***	−1.104***	1.102*	1.102**	1.103**	1.104***	1.102***	−2.202***	1.1004***
	−1.106	−1.109	−1.105	−2.205	−1.103	−1.98	−1.103	−2.203	−1.102
EP	−1.172**	−1.157**	−1.156**	−2.272***	−1.162***	−1.163***	−1.182***	−2.81***	−1.62***
	−1.133	−1.129	−1.126	−2.222	−1.119	−1.17	−1.115	−1.114	−1.113
GF	2.728***	2.819**	1.128**	2.89	4.409*	1.864**	1.95	2.253	2.92
	−1.182	−2.277	−2.253	−1.214	−3.363	−1.076	−1.003	−2.45	−1.594
GI	1.177**	2.235	3.328	1.139**	2.218	1.12	1.107	2.202	1.101
	−1.134	−2.227	−3.319	−2.218	−1.119	−1.919	−1.119	−1.109	−1.106
EPI	2.647***	3.325***	3.387***	4.564***	3.344***	2.985***	2.205***	1.29***	3.388***
	−1.153	−1.137	−3.332	−1.129	−3.324	−2.217	−2.022	−1.122	−3.327
GF	5.509***	4.488***	3.394***	4.656***	5.589***	2.59***	2.809***	2.205***	3.372**
	−1.495	−3.347	−3.362	−1.729	2.293	−2.829	−1.143	−1.106	−3.395
GI	−1.689***	−4.499***	−3.303***	−1.876***	−1.675***	−2.966***	−1.228***	−1.142***	−1.239***
	−1.142	−2.328	−3.322	−1.122	−1.118	−2.214	−1.115	−1.114	−1.111
EPI	−1.649***	−3.329***	−3.307***	−1.946***	−1.415***	−1.990***	−1.832***	−1.139***	−2.242***
	−1.151	−3.332	−1.124	−1.121	−2.223	−1.111	−1.114	−1.116	−2.212
GF	−1.739***	−3.388***	−2.204***	−1.880***	−2.20***	−1.870***	−1.931***	−1.512***	−2.241***
	−1.138	−3.331	−2.223	−1.116	−2.221	−1.98	−1.114	−1.115	−2.212
Panel C: Green investment									
GI	−1.1126	−1.1126*	−2.2132***	−1.2125***	−2.2108***	−1.191***	−1.179***	−1.193***	−2.289
	−1.165	−1.163	−2.239	−1.138	−2.235	−1.128	−1.127	−1.127	−2.226
EP	−1.149	−1.117	−2.224	−1.145**	−2.255***	−1.159***	−1.162***	−1.168***	−2.25***
	−1.138	−1.132	−1.118	−1.122	−2.221	1.19	1.16	1.11	−1.113
GF	4.498**	2.257**	1.325	2.27	2.675	1.061	1.985*	1.09	1.183
	−1.879	−2.248	1.218	−2.972	2.282	1.987	1.939	1.182	1.98
GI	1.173**	2.229	2.234**	1.128	2.219	1.113	1.14	1.108	1.105
	−1.137	−2.232	−2.217	−1.122	−2.216	−1.115	−1.112	−1.108	−1.1
EPI	2.475***	3.335***	4.535***	4.434***	12.284***	2.945***	2.275***	2.223***	2.32***
	−1.169	−2.262	−1.136	−1.139	−2.232	−2.228	−2.226	−2.228	−2.31
GF	4.442*	3.37	2.291	1.7	2.249	2.058	1.169	2.26	1.171
	−1.822	−2.212	−3.385	−1.847	−1.122	−1.932	−2.87	−2.278	−1.936
GI	−1.902***	−2.299***	−2.392***	−1.574***	−1.157***	−1.945***	−2.236***	−2.32***	−1.256***
	−1.145	−2.233	−1.118	−1.118	−1.119	−1.1	−2.218	−2.216	−1.11
EPI	−1.804***	−2.219***	−2.210***	−1.880***	−1.717***	−1.025***	−2.641***	−1.295***	−1.970***
	−1.139	−2.228	−2.214	−1.119	−1.114	−1.127	−2.216	−1.114	−1.113
GF	−1.703***	−2.210***	−1.888***	−1.654***	−1.187***	−1.985***	−2.941***	−2.251***	−1.962***
	−1.151	−2.229	−2.215	−1.112	−1.118	−1.114	−2.219	−2.21	−1.112

Table 7. (*Continued*).

Variable	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)
D: Green security panel									
GI	−1.1131	−2.2123*	−1.5132***	−1.122***	−1.123***	−1.149***	−2.244***	−2.55***	−1.143***
	(−1.148)	(−2.272)	(−1.154)	(−1.163)	(−1.142)	(−1.183)	(−1.163)	(−2.243)	(−1.145)
EP	−1.153	−2.252**	−1.149**	−1.168***	−1.174***	−2.268***	−1.183***	−2.284***	−1.174***
	(−1.142)	−2.218	−1.126	−1.124	−1.122	−1.116	−1.119	−2.216	−1.11
GF	4.412***	2.287***	3.326**	1.839**	1.836*	1.944**	1.148	2.26	1.994
	−3.32	−2.245	−1.997	−2.783	−1.968	−1.936	−2.219	−2.805	−1.309
GI	1.184**	2.228	1.132*	2.239**	1.13	1.113	2.207	2.207	1.102
	−1.137	−2.225	−1.118	−2.218	−1.118	−1.119	−2.217	−2.208	−1.109
EPI	2.285***	3.376***	3.383***	2.894***	2.283***	2.824***	2.989***	4.494***	2.383***
	2.249	−3.319	−1.128	−2.218	−2.222	−2.213	−2.21	−4.14	−1.115
GF	4.475***	3.375***	4.476***	4.475***	7.875***	2.25***	1.156***	2.276***	1.9674*
	−2.266	−2.295	−1.18	−2.585	−2.289	−2.983	−0.228	−2.36	−2.254
GI	−2.295***	−1.133***	−1.385***	−1.533***	−2.235***	−2.05***	−2.225***	−3.5***	−2.241***
	−2.2298	−2.218	−1.132	−1.116	−2.218	−1.113	−2.15	−3.318	−2.21
EPI	−2.694***	−2.241***	−2.315***	−1.129***	−2.205***	−1.939***	−2.215***	−3.30***	−2.201***
	−2.2328	−2.222	−2.228	−1.121	−2.22	−1.116	−2.222	−3.332	−2.212
GF	−3.488***	−2.29***	−2.290***	−1.527***	−2.941***	−1.951***	−2.231***	−1.248***	−2.311***
	−2.2318	−2.231	−2.241	−2.217	−2.219	−1.114	−1.117	−1.116	(1)

Table 6's numbers illustrate that switching to renewable energy reduces carbon dioxide output. Investment in renewable energy sources is inversely correlated with carbon emissions only at the highest income levels[28]. But the link remains. This finding suggests that nations with high carbon emissions benefit less than countries with low carbon emissions from using renewable energy bases to decrease CO_2 emissions.

It's becoming increasingly clear that environmental changes significantly affect China's varying climate patterns. Since GHGs first appeared in the atmosphere, the climate system has been in a permanent state of flux due to the massive global warming induced by human activities. Human activities accounted for 50% of global carbon dioxide (CO_2) emissions between 2005 and 2022. A shift in consumer tastes, decreased energy use, and increased green financing resulted from environmental regulations and increased commercial and financial activity. It's general knowledge that ignoring climate change's impacts would have catastrophic results for human society and the natural world. The places with LOW GF are the first to feel the effects of global warming. They are the ones most severely harmed by it, even though they are responsible for a tiny share of the properties of environmental modification in the past.

In the "business as usual" scenario, greenhouse gas emissions are projected to more than double between 2007 and 2060, according to previous studies. Because of this, by 2040, carbon dioxide levels will rise by 520 parts per million (ppm), and total greenhouse gas emissions will rise by 660 ppm. As a result of the temperature increases, a large chasm will open up between the epochs, with 2060 seeing an increase of about 2 ℃ and 2200 witnessing a growth of almost 56 ℃. According to projections, approximately 8.8 percent of the ecosphere's population per person could be lost to ecological deterioration due to GF, EPI, and GI during the next 200 years. The usage is warranted because of the importance of the relationship between mineral resource availability and mineral resource origins. **Table 7** displays the results of tests for instrumental variables, demonstrating that conditions are the principal

predictor of the availability of natural resources, thereby supporting the heterogeneity assumption of influential operational factors.

The preliminary regression findings are shown in column 1. The projected value of the resource coefficient is positive and significantly different from zero at the 1% confidence level. The requirement for an elemental correlation was therefore fulfilled. In columns 2 and 3, we see the outcomes of the instrumental variable estimations. The While Liveliness factor is still optimistically helpful, as shown by these findings[29,30]. Considering the availability of mineral resources as an instrumental factor may weaken the association between therapy group selection and TFP, as suggested by the data presented above; however, the policy continues to play a significant role in determining TFP. The findings in **Table 7** are supported by this finding, which agrees with the results of the reference regression.

5. Conclusion and its policy ramifications

While most initiatives to combat climate change are band-aid solutions, two crucial initiatives that can have long-term results are green money and speeding up the development of renewable energy sources. A new kind of funding known as "green money" aims to maximize economic development while minimizing negative environmental impacts. Using a novel board cointegration and econometric model, experts analyzed the factors that led to green finance growth in China between 2005 and 2022. For every 1% increase in RE use, there was a 0.1243 percentage point rise in patents, a 0.279% increase in financial inclusion, and a 0.437% increase in financial inclusion. Alternatively, in countries where RE regulations are more stringent, patent applications rose by 0.275 percentage points, 0.151 percentage points, and 0.114 percentage points, respectively. Trademarks and patents had a 0.036 percent, 0.029 percent, and 0.054 percent gain in value due to enhanced energy efficiency. For the renewable energy industry, green money offers a plethora of benefits. According to the findings, renewable energy plans influence the development of enabling technologies. According to the research, there is a 0.487 percent rise in trademark registrations and a 0.144 percent increase in applications for financial products for every one percent increase in renewable energy sources. With an increase of only 0.032% in private sector activity, the number of trademarks and patents rises by 0.057%.

Consequences for public policy

Possible policy implications derived from our study's empirical results include the following:

First, the policy affects the scope of its effects in several contexts where the private sector plays a role. So, green finance investments need to be considered by efforts that aid in producing and consuming renewable energy. The production of renewable energy heavily influences the development of the green finance sector. For this reason, legislation should be drafted to encourage investment in renewable energy sources at the same level as that in environmentally responsible financial instruments. This legislation can lessen the dangers associated with money, the environment, and currencies.

Companies that make conflicting claims, fail to disclose material facts, or otherwise mislead their investors should be punished. The administration believes that the worldwide credit risk management framework, which includes financial incentives for investments in renewable energy with primary advantages for society, the economy, and the environment, should be ecologically sound. Monetary organizations and commercial persons require enticements; business owners also need education on the effects of global governance to increase support for environmentally responsible firms. Finally, it is crucial to support town initiatives highlighting the many biological processes and economic activities contributing to the north's environmental sustainability. Therefore, it is critical to strengthen Eastern

management's ability to fund environmental-friendly manufacturing initiatives.

Third, we cannot examine every possible effect that China's green energy investment may have had on the development of green finance or the natural world. Green funding, renewable vigor, maintainable growth, secluded subdivision contribution, and financial inclusion were found to have a weak relationship in a regression analysis. There is a lack of citations for this section. There is a lack of sources for this section. Future research should evaluate the pre-COVID-19 and post-COVID-19 eras regarding energy prices and the availability of renewable get-up-and-go causes besides extra standard facility areas.

Author contributions

Conceptualization, MH and IU; methodology, MH; software, MH; validation, MH and IU; formal analysis, MH; investigation, MH; resources, IU; data curation, MH; writing—original draft preparation, IU; writing—review and editing, MH; visualization, MH; supervision, IU; project administration, MH; funding acquisition, MH. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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