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ARTICLE

The Role of Green Credit in Promoting Sustainable Development in Vietnam: Evidence from Quantile-on-Quantile Regression

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ABSTRACT

Climate change is no longer a challenge for a single nation but a responsibility for the global community. With the looming threat of the "brown economy," sustainable development (SD) has become essential for economies worldwide. Green credit, which includes funding, lending, and other credit methods that account for environmental impact and conservation, plays a crucial role in promoting SD. By adopting green credit, banks can reduce risks associated with polluting industries while supporting sustainability goals. This study examines the relationship between green credit, including credit for agriculture, forestry, and fisheries, and international financial flows for renewable energy in Vietnam from 2012 to 2021. Using Quantile-on-Quantile Regression (QQR), we assess how green credit influences SD at various quantiles, providing a detailed understanding of its impact over time. The results show a positive relationship between international renewable energy support and SD at lower quantiles (0.05 to 0.55), which weakens at higher quantiles. Similarly, credit for agriculture is positively correlated with SD at quantiles 0.05 to 0.3, but this relationship diminishes at higher quantiles. Based on these findings, we recommend that Vietnamese authorities focus on improving capital efficiency and strengthening the oversight of renewable energy projects. Additionally, increasing CA in rural areas with lower SD levels will help promote sustainability in these regions.

Keywords: Sustainable Development; Green Finance; Quantile-on-Quantile

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1. Introduction

Climate change issues are no longer a challenge for individual nations but a shared responsibility of the global community [1]. Faced with the destructive threat of the "brown economy", sustainable development (SD) has become imperative for all economies worldwide [2]. To achieve this goal, financial intermediaries play a key role in providing capital to support projects and activities related to SD [2, 3]. However, banks have recently faced pressure to align with the United Nations' SD goals by divesting from activities and projects with high CO_2 emissions. Moreover, banks are being urged to shift their lending towards activities related to SD projects [4]. This shift could lead to changes in banks' loan portfolios, with an increasing emphasis on green credit playing a crucial role. Green credit refers to the financial support that banks provide to projects with minimal environmental risks or those aimed at environmental protection [5, 6]. Essentially, green credit includes a variety of financing approaches such as loans, funding, and other credit mechanisms that take into account environmental conservation and impacts. By adopting green credit practices, banks not only contribute to SD goals but also mitigate risks linked to industries with high environmental pollution. A notable example is Germany, which has effectively implemented green credit policies. The state-owned KfW Group, Germany's national development bank, plays a key role in supporting the country's development policy, international cooperation, and sustainability agenda. Sustainability is central to KfW's business operations, with a clear focus on promoting environmental and climate protection on a global scale. Additionally, KfW demonstrates social responsibility through active engagement with its stakeholders [7]. Similarly, China's Green Credit Policy leverages financial instruments and incentive mechanisms to encourage companies to adopt energy-efficient and emission-reduction projects, thereby enhancing environmental protection efforts and curbing pollution. As part of its commitment to reducing energy consumption by 20 percent per unit of GDP and cutting major pollutant emissions by 10 percent by 2010, China mandated that commercial banks refrain from issuing loans to enterprises with high energy consumption and pollution levels [8].

However, the development of a green credit system faces challenges in most countries [9], including Vietnam. For a long time, Vietnam's economic growth model has relied primarily on the export of raw materials, with the extraction of natural resources being a prioritized development path. The economy has also depended on low-cost, low-skilled labor, resulting in low productivity. The use of natural resources remains wasteful and inefficient. Consequently, the country's natural resources are being depleted, the rate of environmental degradation is accelerating, and many natural environments are severely damaged and polluted. As a result, Vietnam's economic development has become unsustainable [1]. Furthermore, there is no comprehensive or consistent legal framework or policy related to green credit. Additionally, the lack of incentives for green credit activities, such as tax benefits or favorable credit terms, further limits its development. Therefore, the objective of this study is to examine the impact of green credit on SD in Vietnam. The reasons for selecting Vietnam are as follows: First, Vietnam remains dependent on a development model that relies heavily on natural resources, making it challenging to balance growth and environmental protection, particularly in sectors such as energy (coal-fired power, hydropower) and mining. Second, in the banking sector, the Vietnamese government has introduced several documents aimed at promoting green credit; however, these regulations mostly serve as guidelines and recommendations rather than enforceable mandates. Consequently, banks, driven by profit motives, continue to approve loans for investors without fully considering the potential negative social and environmental impacts. Third, the implementation and enforcement of environmental policies and regulations in Vietnam remain relatively weak. Many polluters continue to operate and are even granted permits to expand production, which diminishes the incentive for both banks and project owners to adopt stronger environmental protection measures. Lastly, although the State Bank of Vietnam has issued a directive on green credit, it has not yet provided detailed guidelines or financial mechanisms to support environmentally friendly projects. Agricultural, forestry, and fishery credit (CA) plays a crucial role in sustainable development, especially in protecting natural resources and improving community livelihoods. When farmers, foresters, fishers, and enterprises in these sectors gain access to credit, they can invest in advanced, environmentally friendly technologies, such as organic farming and sustainable aquaculture. With its long-standing rice-based civilization, Vietnam places a high priority on agricultural and fishery credit. Credit policies not only provide financial support but also encourage a shift toward sustainable production methods, contributing to environmental protection and sustainable economic growth. The government has actively promoted CA, with credit funding increasing from 148,401.3827 million USD in 2012 to 450,957.1758 million USD in 2021, demonstrating strong commitment to fostering sustainable growth in the agriculture sector. In addition, credit for the renewable energy sector is also part of Vietnam's green credit policy. Funding for renewable energy projects has accelerated over time. However, its impact on sustainable development remains unclear. Therefore, this study aims to address two questions: Does green credit steer Vietnam toward SD, and how does green credit impact SD across different stages? To answer these questions, we employ the QQR method proposed by Sim and Zhou [10] to examine the interactions among the variables. The QQR method combines quantile regression and non-parametric estimation, allowing for the investigation of how the quantiles of one variable affect the conditional quantiles of another variable [1]. The use of QQR enables us to gain a more detailed understanding of the relationship between green credit and SD at specific quantile levels, thereby enhancing our comprehension of the diverse impacts of green credit on SD over different stages. Compared to existing studies, this paper offers the following contributions. First, it provides evidence of the relationship between green credit and SD from the perspective of credit for agriculture, forestry, fisheries, and financing flows for renewable energy. Second, through the use of the non-parametric model (QQR), this study goes beyond merely assessing the impact of green credit; it clarifies the complex interactions between each quantile of green finance within the context of SD at various stages. These findings provide valuable insights for policymakers to develop green finance strategies aligned with the stages of SD. Finally, based on empirical results, we offer practical policy recommendations to enhance green credit, thereby supporting Vietnam and other developing countries in achieving SD goals.

2. Literature Review

There are mechanisms through which green credit influences SD. First, through loans, financial intermediaries indirectly affect the environment by providing loans to projects and activities that cause pollution [11]. Although these loans yield significant profits, they may come at the cost of environmental pollution. However, if banks refuse to lend to businesses, it may also result in temporary losses for the banks. This indicates that banks can influence the environment either negatively or positively through their business activities. The link between financial institutions and environmental impact was first emphasized in the early 1990s. Consequently, green credit plays a pivotal role in advancing SD. By incorporating social and environmental criteria into lending decisions, banks can reduce their exposure to credit, reputational, and legal risks. As a result, it is essential that "banks adhere to environmental standards in their lending activities" [12]. Additionally, there is increasing pressure from stakeholders regarding SD, driven by various documents, regulations, and conferences. This external pressure encourages financial institutions to align their practices with sustainable goals. Financial institutions must prioritize funding for projects that not only generate economic benefits but also meet environmental and social criteria [13, 14]. The implementation of these documents serves as a warning signal to high-polluting enterprises and an encouraging signal to environmentally friendly businesses. Vietnam has its roots in rice farming, and as a result, agricultural credit has always been a priority. Moreover, renewable energy has become an essential factor in sustainable development in recent years. Calls for the use of renewable energy are increasing, but the transition to renewable energy requires time and must be developed in stages. Additionally, agricultural credit issues fluctuate over time due to the shift towards industrial and service sectors.

Therefore, it is necessary to monitor these two types of credit across smaller quantiles.

Previous studies have shown the relationship between green credit and SD. For instance, Bao and He [6] investigated the impact of green credit on SD in Chinese provinces and cities from 2012 to 2019. The results of this study indicated that green credit promotes green SD, with its impact gradually strengthening over time as the implementation of supplementary policies with significant constraints and incentives in green credit increases. Ding, Zhuang and Jiang [5] explored the relationship between green credit and high-quality SD of banks using unbalanced panel data from listed banks in China between 2007 and 2019. The findings revealed that green credit significantly boosts the high-quality SD of banks. Zheng, Zhang and Hu [15] studied the impact of green credit and carbon emissions on the green economy across 30 provinces in China from 2003 to 2019. Using the Spatial Durbin Model (SDM), the research found that improving green credit levels benefits the promotion of the green economy. Han and Liu [16] examined the impact of green credit on SD, and the results indicated that green credit not only promotes SD but also enhances the green innovation input of enterprises. He et al. [17] investigated the effects of green credit on green economic growth in 150 Chinese enterprises. The findings suggested that green credit can promote green SD, with its impact gradually strengthening over time as the implementation of supplementary policies with significant constraints and incentives increases. Volz [18] studied the effects of green credit on SD in Asian countries, and the results indicated that green credit can promote green SD in these countries. Schwerhoff and Sy [19] examined the financing costs associated with renewable energy and its connection to SD goals in Africa. The findings suggest that African governments have the potential to enhance their ability to finance critical projects essential for the future of their populations. Additionally, the study emphasizes the need for Africa to improve the quality of its local financial markets to increase domestic funding capacity. Zhang, Saydaliev and Ma [20] examined the impact of green finance on the demand for renewable energy in China from 1990 to 2020. The findings reveal that green finance positively contributes to global development and provides more detailed insights. The study's policy recommendations include decentralizing the energy sector to encourage greater private sector participation and offering financial incentives for businesses that adopt renewable energy solutions. These measures aim to enhance the adoption and sustainability of renewable energy in China.

A review of the research indicates that studies on the relationship between green credit and SD have the following limitations:

Firstly, regarding research, previous studies have not established a consistent variable for green credit, primarily focusing on the national context (such as China). In this study, we construct the green credit variable based on two components: credit for agriculture, forestry, and fisheries, and financial flows for renewable energy supported by the government. The reason for this choice is that both sectors are core to livelihoods, representing not only agriculture, forestry, and fisheries but also the renewable energy sector—two areas that contribute significantly to SD [9].

Secondly, concerning the scope of research, there has been no study that clearly explains the relationship between green credit and SD in Vietnam. Through this research, we hope to provide a new perspective on this relationship, not only in Vietnam but also in countries with nascent green financial systems.

Thirdly, previous studies have utilized traditional parametric methods (OLS, spatial regression). However, these methods may not fully capture the complexity of the relationship between green credit and SD. In this study, we will employ the QQR method to explore more detailed aspects of this relationship.

3. Materials and Methods

3.1. Justification of Data and Variables

The research focuses on Vietnam, with sustainable development data sourced from the SDG Transformation Center (https://sdgindex.org/). Green credit data consists of two main components: credit for agriculture, forestry, and fisheries, sourced from the FAO, and credit for renewable energy, sourced from the OECD and the International Renewable Energy Agency. **Table 1** provides detailed information on variable symbols and measurement methods. The final dataset includes time series data from Vietnam spanning 2012–2021, a period chosen to minimize the impact of the global financial crisis. To enhance the reliability of estimates, annual data (2012–2021) is converted to quarterly frequency using the Quadratic Match-Sum method for the study's three variables. The Quadratic Match-Sum method, as previously applied in studies by Oanh and Dinh [1] and Dinh, Oanh and Ha [2], is chosen for its effectiveness in addressing potential mismatches between different time periods and smoothing out inconsistencies. This method allows for a more accurate representation of the relationship between variables by effectively aligning data at various quantiles. As a result, it ensures that the analysis captures the nuances of the data while minimizing potential biases from annual fluctuations. Green credit provided to agriculture could be higher during specific seasons (e.g., planting or harvest periods), while renewable energy credits might fluctuate depending on seasonal energy consumption patterns. Using the Quadratic Match-Sum method, the data is adjusted to a quarterly frequency, matching the seasonal trends more accurately. By smoothing out the mismatches between annual and quarterly data and aligning them across different quantiles, the method ensures that the relationship between the variables is better represented, allowing the study to capture seasonal patterns and avoid biases due to annual fluctuations. This approach improves the robustness of the analysis, providing a more reliable understanding of how green credit influences sustainable development over time [1, 2].

Table 1. Variable description and source.

Symbol	Indicator	Measurement	Source
SD	Sustainable development	Integrating the three criteria of economic, environmental, and social aspects, these comprise a total of 17 criteria detailed in **Table A1**.	Sdgindex.org
GC	Green credit		
CA	Credit to agriculture, Forestry and fishing	Credit to agriculture, forestry and fishing	FAO
IRES	International funding for the renewable energy sector.	International financing to Vietnam for clean energy research, development, and renewable energy production, expressed in inflation-adjusted US dollars.	OECD and International Renewable Energy Agency

Source: Compiled by the authors.

The SD variable in this study is measured using 17 specific SD indicators (detailed in **Table A1**), aligned with the three core pillars of sustainable economic, social, and environmental development as outlined by the SD goals. This approach, previously applied by Dinh, Oanh and Ha [2], Oanh and Dinh [21], and Hai and Dinh [22] serves as a comprehensive index to assess a country's SD level. The use of this metric ensures both completeness and relevance when addressing SD issues, providing a broad view of economic, social, and environmental dimensions. Green credit is assessed through two key indicators: credit provided to the agriculture, forestry, and fisheries sector (CA) and international funding for the renewable energy sector (IRES). Agricultural credit is instrumental in advancing green growth within agriculture, offering farmers access to financial resources that enable the adoption of more environmentally sustainable production methods. As noted by the Food and Agriculture Organization (FAO), access to agricultural credit can support farmers in transitioning to sustainable practices, such as the use of organic fertilizers, conservation agriculture, and water-efficient irrigation systems. These changes contribute to reducing greenhouse gas emissions, improving soil health, and preserving biodiversity [9, 23]. In Vietnam, agricultural issues are closely linked to forestry and fisheries. Therefore, in addition to agriculture, we consider credit for agriculture, forestry, and fisheries as one of the key components of green credit. Similarly, credit for renewable energy plays a vital role in Vietnam's green credit strategy. However, the development of renewable energy in Vietnam faces several challenges, necessitating support from international funding during the initial stages. Therefore, international funding for renewable energy is crucial for advancing green growth and encouraging the transition to sustainable energy solutions. International funding for renewable energy is essential for fostering green growth by promoting the development and utilization of renewable energy sources. These funds support research and implementation efforts that can significantly reduce greenhouse gas emissions.

3.2. Methodology

The examination of how different quantiles of X affect various quantiles of Y was conducted through the utilization of a nonparametric quantile regression model. The model is articulated as follows:

$$Y_t = \beta^\theta (X_t) + \varepsilon_t^\theta \tag{1}$$

In this context, Y_t denotes the dependent indicator at time t, and X_t represents the independent indicators at time t. θ stands for the θth quantile on the distribution of X. Additionally, ε_t^θ signifies the quantile error term, where the estimated θth quantile is equal to zero. β^θ(.) represents an unknown parameter for which we lack historical information regarding the relationship between Y and X. Therefore, a first-order Taylor expansion of β^θ(.) around a quantile of X^θ to linearize the function β^θ(.) and this can be expressed as follows:

$$\beta^\theta (X) \approx \beta^\theta (X^\tau) + \beta^{\theta'} (X^\tau) (X_t - X^\tau) \tag{2}$$

Where $\beta^{\theta'}$ is the partial derivative of $\beta^\theta (X^\tau)$. Moreover, as highlighted by Sim and Zhou [10], Equation (1) can be reformulated as:

$$Y_t = \beta_0 (\theta, \tau) + \beta_1 (\theta, \tau) (X_t - X^\tau) + \varepsilon_t^\theta \tag{3}$$

In nonparametric analysis, the choice of bandwidth is crucial as it refines the target point and controls the speed of the results. We utilized 19 quantiles, starting from 0.05 and ending at 0.95, with a bandwidth value of 0.05 for this study. This choice is based on the rationale that increasing the bandwidth reduces variance but increases estimation deviation, and vice versa [10].

4. Results

4.1. Descriptive Statistical Results

Table 2: The results of the descriptive statistics for the variables show that the means of SD, IRES, and CA (in Ln form) are 4.2601, 18.0682, and 12.4725, respectively, with standard deviations of 0.0165, 1.8586, and 0.3789. This indicates that the volatility of the three variables is relatively small compared to the mean. **Table 3** presents the correlation results among the variables, revealing a relatively high positive correlation between them, which indicates that the three variables are closely related.

Table 2. Descriptive statistics.

Variable	Mean	Std. Dev	Min	Max
LnSD	4.2601	0.0165	4.2321	4.2810
LnIRES	18.0682	1.8586	14.1732	19.7084
LnCA	12.4725	0.3789	11.9077	13.0191

Source: Calculated by the authors.

Table 3. Correlation results of variables.

	LnSD	LnIRES	LnCA
LnSD	1.0000		
LnIRES	0.5833	1.0000	
LnCA	0.9668	0.5826	1.0000

Source: Calculated by the authors.

4.2. QQR Results

Before applying the QQR technique, we conducted a panel unit root test to eliminate potentially biased results and to establish stronger inferences regarding the stationarity characteristics of the mentioned indicators. The results presented in **Table 4** show that IRES is stationary at I(0), while the other two variables, SD and CA, are stationary at first difference I(1). Therefore, to ensure the accuracy and stability of the data, we incorporated the two variables, SD and CA, into the model in first-differenced form.

Next, we conducted an empirical study on the asymmetric interaction between SD, IRES, and CA using data from 2012 to 2021. The X-axis represents the quantiles of the independent variables, specifically IRES and CA, while the Y-axis displays the quantiles of SD, ranging from the 0.05th to the 0.95th percentile. Lower percentiles indicate two key aspects: first, the early stages of sustainable development, and second, rural regions or provinces with weak infrastructure, where agriculture, forestry, and fisheries make up a large proportion of the economy. The Z-axis represents the regression coefficients of the estimates. Additionally, the color axis illustrates the intensity of the impact, with dark blue indicating a weak correlation and red indicating a strong correlation. Specifically:

Figure 1: The relationship between IRES and SD at different quantiles in Vietnam. The results show that at lower quantiles (0.05–0.5), IRES has a fairly strong positive correlation with SD. However, at higher quantiles (0.55– 0.95), this relationship remains positive but at a significantly weaker level. This result indicates that when Vietnam receives international funding for the renewable energy sector, this funding will stimulate growth and exploitation in the renewable energy field, steering the country towards SD. Nevertheless, this funding only promotes Vietnam's development to a medium level of sustainability. At higher levels of SD, this funding seems to lack strong interaction, leading to diminishing effectiveness. This may stem from various factors, such as constraints on the effective use of funds, saturation in investment in renewable energy projects, or issues related to the management and operation of the funding. The results suggest that to achieve higher levels of SD, Vietnam may require supplementary solutions such as more effective management policies, technological innovation, and attracting various investment sources. Unlike previous studies that used parametric methods, such as Bao and He [6], Zheng, Zhang and Hu [15], and He et al. [17], this result enriches the academic literature on how financing for renewable energy affects SD at specific quantile levels.

Figure 2: The results of the relationship between CA and SD at different quantiles in Vietnam show that CA has a close relationship, indicating a positive correlation with SD at lower quantiles (0.05–0.25). At the next range of quantiles (0.30–0.45), the relationship between SD and CA gradually weakens. Similarly, at higher quantiles (0.50–0.95), while the relationship between SD and CA remains positive, the impact level is negligible. The findings suggest that, as a financial intermediary fostering economic progress, the banking system significantly influences the allocation of investment capital for socioeconomic advancement, serving a vital role in guiding economic sectors toward sustainable growth. As a result, green credit policies emerge as a pivotal strategy for driving the economy toward green growth. Green credit not only provides advantages to individuals and businesses involved in green initiatives but also aids in economic development, enhances living standards, and safeguards the environment [5]. The results align with the situation in Vietnam, where international funding for the renewable energy sector stimulates growth and development, guiding the country toward sustainable development in its early stages. However, limitations in infrastructure, such as outdated grid systems and insufficient energy storage facilities, can hinder the effective utilization of this funding. These infrastructural challenges prevent the country from maximizing the long-term benefits of renewable energy investments and achieving higher levels of sustainability.

Table 4. Results of stationarity tests.

Variables	ADF Test Stationarity Level	First Differencing	Stationarity Order
SD	−0.6126	−3.389***	I(1)
IRES	−11.588****	x	I(0)
CA	−1.8349	−12.483***	I(1)

Source: Calculated by the authors.

To test the robustness of the results, we use the Granger causality test across different quantiles. This method, proposed by Troster [24], allows us to assess the causal relationships between variables at different levels of the distribution, helping to clarify the differences in impact at various stages of SD. This method was previously employed in the studies by Thai Hung [25] and Hung [26] to assess robustness after using a non- parametric approach to evaluate the relationships between variables. The results are presented in **Figure 3**. At lower quantiles, the Granger test statistic is quite high, exceeding the critical value threshold (red line), indicating that CA has a strong causal relationship with SD. This means that credit in the agriculture, forestry, and fisheries sectors significantly affects SD at low levels. Similarly, the Granger test statistic for the relationship between IRES and SD remains robust, exceeding the critical value threshold at quantiles from 0.05 to 0.55. These results are consistent with the QQR findings, further confirming the relationship between CA, IRES, and SD.

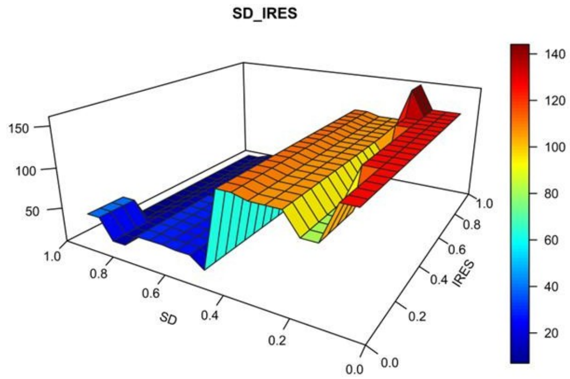

Figure 1. The relationship between IRES and SD.

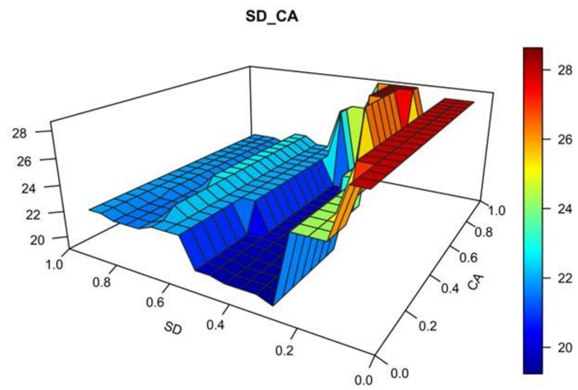

Figure 2. The relationship between CA and SD.

Source: Calculated by the authors.

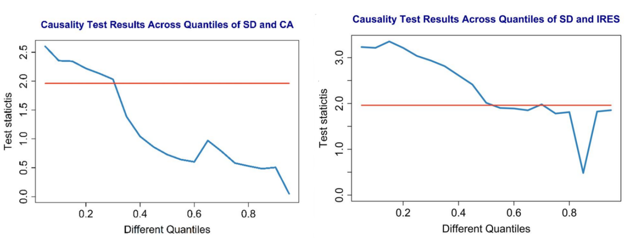

Figure 3. Causality test results across quantiles of IRES, CA, and SD.

Source: Calculated by the authors.

5. Discussion

The observed pattern aligns with the reality in Vietnam, where CA has played a pivotal role in the early stages of promoting SD. Access to credit has empowered farmers and rural enterprises to invest in environmentally friendly technologies, adopt more efficient resource management practices, and strengthen community resilience—all of which are essential for advancing sustainability. This financial support has been particularly impactful in regions heavily reliant on agriculture, enabling local producers to transition toward sustainable practices. In fact, Vietnam's areas with low levels of SD are predominantly rural. Therefore, it is reasonable for CA to enhance credit availability in these regions. However, as Vietnam progresses toward higher levels of SD, the diminishing impact of CA suggests that the initial benefits from credit have reached a point of saturation. In urban centers characterized by advanced technology and high rates of urbanization, where the proportion of agricultural activities is gradually decreasing, CA alone will not suffice to drive SD. In these contexts, newer factors and innovative approaches will be necessary to foster SD. This research has addressed the initial question, showing that CA—a part of green credit—has the potential to steer Vietnam toward sustainable development, though primarily only at the early stages of sustainable development (quantiles 0.05–0.25). At higher levels of SD (quantiles 0.30–0.95), CA seems to have no significant impact. This indicates a need for additional factors to sustain growth in the later stages of development, particularly in urbanized and industrialized areas where different dynamics are at play. As regions transition toward higher levels of SD, it becomes crucial to explore and integrate innovative strategies and policies that can effectively address the unique challenges and opportunities presented by urban and industrial contexts.

IRES has a strong positive correlation with SD at low to medium quantiles (0.05–0.4). However, at higher quantiles (0.55–0.95), this relationship remains positive but is significantly weaker. These results suggest that when Vietnam receives international funding for renewable energy, such funding will stimulate growth and development in the renewable energy sector, propelling the country toward sustainable development. At high levels of sustainable development, IRES fails to promote further progress. This limitation may be primarily due to the underdeveloped technical infrastructure for renewable energy, which forces investors to commit significant capital to establish essential initial infrastructure, such as transportation, electricity, and water supply. Moreover, the investment process is complicated by the government's failure to issue a comprehensive plan for renewable energy development and the absence of a roadmap for establishing retail electricity prices derived from renewable sources. Additionally, transparency in the production, distribution, and transmission of electricity has not been sufficiently prioritized. Therefore, to effectively harness the potential of IRES in advancing sustainable development, it is crucial for the government to prioritize the development of technical infrastructure. This includes not only investing in the necessary transportation, electricity, and water supply systems but also creating a clear and comprehensive regulatory framework that encourages private investment in renewable energy.... This research results address the initial question, demonstrating that IRES—a component of green credit—has a positive impact on promoting SD in Vietnam. However, this impact cannot drive Vietnam toward higher levels of SD due to the underdeveloped infrastructure for renewable energy.

6. Conclusions

The issues of climate change today are no longer challenges faced by a single nation but are the responsibility of the entire international community. In the face of the destructive threat posed by "brown economies", SD has become an imperative for all economies worldwide. Green credit refers to financing forms such as funding, loans, and other credit granting methods that consider environmental impact and conservation. By shifting towards green credit, banks not only support the goals of SD but also reduce risks associated with environmentally polluting industries. Therefore, this study aims to examine the relationship between green credit, which includes credit for agriculture, forestry, and fisheries, and international financial flows supporting the renewable energy sector in Vietnam from 2012 to 2021. The use of QQR allows us to assess the relationship between green credit and SD at specific quantile levels, thereby providing deeper insights into the diversity of green credit's impact on SD across different stages. The research findings indicate that IRES has a positive relationship with SD at lower quantiles from 0.05 to 0.55, while this relationship diminishes at higher quantiles. This may stem from various factors, such as limitations in capital efficiency, saturation in investments in renewable energy projects, or issues related to the management and administration of funds. Consequently, we recommend that authorities in Vietnam focus on enhancing capital efficiency as well as strengthening the monitoring and evaluation of the feasibility of renewable energy projects. This approach will help ensure that international funds are utilized optimally and can continue to promote SD in the future. Furthermore, the government should increase investments in technical infrastructure for renewable energy, particularly in provinces and cities where SD remains at a relatively low level. By addressing these infrastructure needs, Vietnam can create a more conducive environment for renewable energy development, thereby enhancing its overall sustainable development efforts. Similarly, CA has a positive correlation at quantiles from 0.05 to 0.30, but this relationship also weakens at higher quantiles. This may be attributed to saturation in investments or the misalignment of credit allocation with the development needs of these sectors. Therefore, we recommend that relevant authorities reassess their credit allocation strategies to ensure that funds are distributed flexibly and in accordance with the actual development requirements of each sector. Additionally, efforts should be made to promote restructuring and innovation within these industries to optimize capital utilization and continue supporting Vietnam's SD goals. For provinces and cities in Vietnam with low SD quantiles, which are primarily rural areas, we recommend strengthening credit support for these regions.

In addition, rural areas are characterized by a significant portion of the population that has not yet had the opportunity to access formal financial services. When residents seek to expand agricultural activities through credit, they face considerable difficulties. Therefore, we recommend promoting financial inclusion in rural areas as a foundation for enabling households to access financial services. Through the expansion of financial inclusion, the implementation of green credit will yield substantial benefits, while also contributing to reducing income inequality and promoting gender equality in these regions [27, 28].

The limitations of this study pertain to the selection of indicators representing SD objectives. This research employs a single composite SD indicator, and the individual indicators from SD1 to SD17 have not been specifically examined. As a result, this approach may not provide a comprehensive understanding of how green finance influences individual SD objectives. Future research will aim to address this limitation. Additionally, credit for renewable energy is an essential component of green credit; however, due to data accessibility constraints, it has not been included in this study. We plan to explore this aspect in future research.

Author Contributions

The research is the joint contribution of H.N.V., H.N.Q., D.L.Q., with equal participation in the study.

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Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors do not have any competing financial, professional, or personal interests from other parties.

Appendix A

Table A1. 17 indicators for calculating the SDGI.

Sustainable Development Index (SDGI)		
Target 1	No poverty	
Target 2	No hunger	
Target 3	Good health and well-being	
Target 4	Quality education	
Target 5	Gender equality	
Target 6	Clean water and sanitation	
Target 7	Affordable and clean energy	
Target 8	Decent work and economic growth	
Target 9	Industry, innovation and infrastructure	SDGINDEX.ORG
Target 10	Reduced inequalities	
Target 11	Sustainable cities and communities	
Target 12	Responsible consumption and production	
Target 13	Climate action	
Target 14	Life below water	
Target 15	Life on land	
Target 16	Peace, justice and strong institutions	
Target 17	Partnerships for the goals	

Source: Compiled by authors.

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