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The impact of green innovation, renewable energy, industrialization and institutional quality on green growth in Vietnam

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Abstract

This study aims to assess the impact of green innovation, renewable energy, industrialization, and institutional quality on green growth in Vietnam during the period 1996-2022 using the ARDL model (Autoregressive Distributed Lag Model). The results show that green innovation and industrialization have negative impacts, while renewable energy and institutional quality have positive impacts on green growth in the short term. In the long term, green innovation, renewable energy, industrialization, and institutional quality have positive impacts on Vietnam's green growth. Based on the research results, the paper proposes some policy implications to promote green innovation, apply energy-saving technologies, utilize renewable energy sources, and improve institutional quality to achieve green growth, thereby promoting sustainable development for the Vietnamese economy.

Keywords: Green growth, green innovation, industrialization, renewable energy.

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1. Introduction

Green growth has become popular over the past decade as countries around the world pursue sustainable development goals with the desire to maintain high economic growth rates while reducing greenhouse gas emissions, improving energy efficiency, using renewable energy sources, and promoting green technology innovations. Green growth can be used as a viable solution to save energy and control environmental damage [1].

After nearly 40 years of renovation, Vietnam has become a bright spot in economic growth, but at the same time, greenhouse gas emissions have also increased significantly as the country has undergone rapid economic development, industrialization and urbanization. Therefore, the Vietnamese Government recognizes the need to balance economic development with environmental sustainability and has made green growth a top priority agenda with a commitment to achieve net zero emissions by 2050 at the 26th United Nations Climate Change Conference (COP26). Over the years, Vietnam has made significant progress in implementing its green growth strategy with positive environmental results such as low per capita greenhouse gas emissions compared to other countries in the region, increased forest cover (from 38.7% in 2008 to 42% in 2020), and improved air quality (average annual PM 2.5 concentration decreased from 32.9 to 27.2 (μg/m³) in the period 2018-2022). Along with the achievements, there are also challenges such as: natural resource intensity in Vietnam's current economic growth, the "brown economy" model with low resource efficiency, and outdated manufacturing technology which poses many challenges to the transition to green technology. In addition, there are still limitations in the exploitation and use of renewable energy sources, low institutional capacity, loose environmental regulations, and many obstacles in the implementation and monitoring of green growth actions and goals. Therefore, studying the impact of green innovation, renewable energy, industrialization and institutional quality on Vietnam's green growth is necessary and has profound practical significance.

The novel contribution of this study is to explore the impact of green innovation, renewable energy, industrialization, and institutional quality on green growth, contributing to enriching the empirical studies on green growth and filling the gap in the literature on green growth in Vietnam. In addition, this study uses the ARDL method to assess the impact of the factors considered on green growth in the short and long run. The results of this study suggest some important policy implications to promote green growth towards the goal of sustainable development for the Vietnamese economy.

The structure of this study includes the following contents: Section 1 introduces the research problem. Section 2 provides an overview of the research. Section 3 presents data sources, models and research methods. Section 4 analyzes the research results and discusses, and the final section is the conclusion and policy implications.

2. **Literature Review**

2.1. The impact of Green Innovation on Green Growth

In recent decades, green innovation and its impact on green growth have been widely debated among economists. A review of the literature regarding the impact of green innovation on green growth reveals two main views.

First, green technology and innovation play an important role in promoting sustainable economic development by reducing production waste and pollutant emissions [2]. Through the advancement of environmentally friendly technologies, enterprises can reduce energy use and pollutant emissions, thereby facilitating sustainable production activities to promote green growth. In addition, green innovation and technology help reuse and recycle production waste Zhang et al. [3]. Ulucak [4] demonstrates that green innovation plays an important role in promoting green growth in BRICS economies (Brazil, Russia, India, China, and South Africa) during the period from 1992 to 2016. Similarly, Chen et al. [5] also show that green innovation plays an important role in achieving green growth in BRICS economies.

Second, green innovation does not always promote green growth. Green technology is sometimes considered an obstacle to green growth when technological innovation creates rebound effects that increase energy consumption, contribute to pollution, and reduce green growth [6]. Another reason is that enterprises pursue green innovation only to maximize profits by saving capital and labor, but ignore environmental concerns, leading to increased environmental pollution and waste of resources, which is detrimental to green growth, Zhang and Vigne [7]. Ulucak [8] found that technological innovation reduces carbon emissions in the United States, while this effect is not statistically significant in China.

2.2. The Impact of Renewable Energy on Green Growth

Transitioning to renewable energy sources is crucial to mitigating climate change and promoting sustainable development. Unlike fossil fuels, which contribute significantly to greenhouse gas emissions, renewable energy sources such as solar, wind, and geothermal provide clean and sustainable alternative energy sources. In addition to environmental benefits, renewable energy sources have the potential to stimulate economic growth as they are cost-effective, provide energy security, and help alleviate poverty [9]. Several empirical studies have assessed the impact of renewable energy on promoting green growth using different proxies of green growth. Meng et al. [10] found that higher consumption of renewable energy leads to less carbon-intensive (or higher carbon productivity) economic growth in Chinese provinces, which in turn promotes green growth in 30 Chinese provinces during the period 2011–2020. Du and Li [11] found that increasing the share of renewable energy in total final energy consumption is effective in promoting long-term green growth in 71 countries around the world.

While many studies show a positive impact of renewable energy on green growth, some studies provide evidence that renewable energy hinders green growth. Venkatraja [12] argues that renewable energy hinders economic growth due to high capital investment and limited technological progress, but this negative impact will gradually decrease as the economy develops at a higher level. Jebli and Youssef [13] found that the high use of combustible renewable energy leads to higher carbon emissions, which is likely to hinder green growth in five North African countries during the period 1980-2011. Mensah et al. [14] found that higher use of renewable energy promotes green growth in Asian OECD countries by reducing emissions, but it has a negative impact on green growth by increasing emissions in European and American OECD countries.

In addition, the use of renewable energy was found to have no effect on green growth in the Oceania OECD countries. Menegaki [15] found no relationship between renewable energy consumption and economic growth in 27 European countries during the period 1997-2007. Similarly, Murshed et al. [16] concluded that renewable energy consumption has no effect on green growth when exploring the link between renewable energy and green growth in seven emerging countries.

2.3. The Impact of Industrialization on Green Growth

Industrialization is considered the backbone of the economy, playing an important role in economic growth, but also a major factor in environmental degradation. Several studies have confirmed that industrialization affects green growth through its simultaneous impact on output and carbon emissions, Liao et al. [17] and Opoku and Yan [18]. Wang, et al. [19] argue that industrialization promotes green growth because the growth efficiency is greater than the loss due to environmental degradation in India and China. Raheem and Ogebe [20] argue that industrialization is the main driver of green growth. The impact of industrialization on green growth is through improving environmental quality and increasing per capita income. Naeem et al. [21] asserted that industrialization is not conducive to green growth in 19 African countries because it causes environmental degradation due to reduced efficiency in the use of natural resources in production processes. Shahab et al. [22] found that industrialization degrades environmental quality and negatively impacts green growth in Pakistan due to the high use of conventional energy sources in industrial activities during the study period from 1980 to 2011. Wen et al. [23] found that industrialization negatively impacts green growth in the short run but positively impacts green growth in the long run due to reduced CO_2 emissions due to technological advances.

2.4. The Impact of Institutional Quality on Green Growth

Several previous studies have demonstrated that good governance improves institutional quality, which in turn promotes green growth performance. Good institutional quality enables the establishment of comprehensive environmental regulations and promotes the widespread adoption of cleaner technologies, reduces pollution emissions, and protects natural resources [24]. Furthermore, institutions promote sustainable management by demarcating property rights and establishing governance frameworks that prevent overexploitation of resources [25]. In addition, institutions facilitate green technology transformation by providing finance, developing supportive policies, and promoting collaboration between research institutions and businesses Li and Li [26]. Tawiah et al. [27] argue that institutional aspects such as government effectiveness and the rule of law can play an important role in promoting environmental quality improvement and green growth in developing countries. Ahmad et al. [28] find that institutional quality plays an important role in reducing ecological footprint in emerging countries during the period 1984 - 2017. Qiu et al. [29] demonstrate that improving governance quality by improving institutional quality through reducing political and economic risks and properly protecting intellectual property rights can make technological innovation more effective in stimulating green growth in 46 countries participating in the Belt and Road Initiative (BRI). Song et al. [30] found that improving the quality of economic and political institutions can directly or indirectly promote long-term green growth in 88 economies globally.

While there is ample evidence of a link between institutional quality and green growth, some studies have also found that strong institutions do not always yield positive outcomes. Obobisa et al. [31] found that institutional quality can have a positive impact on carbon emissions, but that the absence of strict environmental regulations or failure to enforce existing regulations can increase carbon emissions in 25 African countries. Degbedji et al. [32] found a mixed effect of institutional quality on green growth in the West African Economic and Monetary Union countries. Institutional quality positively affects green growth in Maldives, Mali, Niger, Senegal and Togo but negatively affects green growth in Benin and Burkina Faso.

In general, there are many empirical studies on the impact of green innovation, renewable energy, industrialization, and institutional quality on green economic growth, but the research results are inconsistent, and there are differences in conclusions. Moreover, studies on green growth for Vietnam are very limited. On the other hand, green innovation, industrialization, and renewable energy have become decisive factors for growth and sustainable development in many economies around the world. Therefore, to fill this gap, the current study examines the impact of green innovation, renewable energy, industrialization, and institutional quality on green growth in Vietnam. This is the goal that this study aims to achieve.

3. Data and Methodology

3.1. Data Description

The objective of this study is to examine the impact of green innovation, renewable energy, industrial development, and institutional quality on green growth in Vietnam. The study uses time series data for the period 1996 - 2022, from the WB (World Bank), WDI (World Development Indicators), and WGI (Worldwide Governance Indicators).

Table 1.
Description and measurement of variables.

Acronym	Variable	Measurement unit	References	Source
Dependent variable				
LnGG	Green growth	Natural logarithm of green GDP Green GDP = Gross Domestic Product - Natural Resource Degradation - Pollution Damage.	Ulucak [4]; Zhang and Vigne [7] and Chen et al. [5]	WB
Independent variable				
LnGIN	Green innovation	Natural logarithm of total number of patents	Ulucak [4] and Zhang and Vigne [7]	WDI
REC	Renewable energy consumption	Renewable energy consumption (% of total energy consumption).	Shah, et al. [9]; Meng, et al. [10] and Chen, et al. [5]	WDI
IND	Industrialization	Industrial value added (including construction), % GDP	Naeem, et al. [21] and Degbedji, et al. [32]	WB
INS	Institutional quality	Using the PCA method to determine based on 6 global governance indicators (WGI).	Kaufmann, et al. [33] and Degbedji, et al. [32]	WGI/PCA

For the institutional quality (INS) variable, the study uses the global governance indicators (WGI) developed by Kaufmann et al. [33] which include six component indices: political stability (PS), voice and accountability (VA), government effectiveness (GE), regulatory quality (RQ), rule of law (RL), and control of corruption (CC). The above indices are calculated according to the normal distribution unit with values ranging from -2.5 to 2.5, which raises concerns about multicollinearity when included as separate variables in a model. Therefore, this study uses the Principal Component Analysis (PCA) method to construct a composite index by converting correlated variables into uncorrelated components to eliminate the problem of multicollinearity. The PCA technique for calculating the INS variable is described as follows:

$INS_i = W_{i1}X_1 + W_{i2}X_2 + W_{i3}X_3 + W_{i4}X_4 + W_{i5}X_5 + W_{i6}X_6$.

Where: INS is the institutional quality variable; W is the weight; X is the measurement variable consisting of six component indicators listed above.

3.2. Research Methodology

Based on the studies of Ulucak [4], Zhang and Vigne [7], Chen et al. [5], Naeem et al. [21], and Degbedji et al. [32], the proposed research model is as follows:

LnGG = f(LnGIN, REC, IND, INS)

For the above model, the dependent variable are the natural logarithms of green growth (LnGG), while the explanatory variables include natural logarithms of green innovation green (LnGIN), renewable energy (REC), industrialization (IND), and institutional quality (INS).

Since we seek to investigate the short run and long run effects on the explanatory variable on green growth, we construct an ARDL as follows:

$$\Delta LnGG_t = \alpha + \sum_{i=1}^{n}\beta_i \Delta LnGG_{t-i} + \sum_{i=0}^{n}\gamma_i \Delta LnGIN_{t-i} + \sum_{i=0}^{n}\delta_i \Delta REC_{t-i} + \sum_{i=0}^{n}\theta_i \Delta IND_{t-i} + \sum_{i=0}^{n}\mu_i \Delta INS_{t-i} + \omega LnGG_{t-1} + \rho LnGIN_{t-1} + \tau REC_{t-1} + \varphi IND_{t-1} + \psi INS_{t-1} + \varepsilon_t$$

Where: α is the intercept coefficient; β, γ, δ, θ, μ are short-run coefficients; ω, ρ, τ, φ, ψ are long-run coefficients; ε_t is the error term; Δ is the first difference operator.

This study uses the autoregressive distributed lag model (ARDL) proposed by Pesaran et al. [34]. This method has the following advantages: (i) ARDL is a more statistically significant approach to test cointegration in the case of small sample sizes; (ii) in the ARDL approach, regressors can have different optimal lags; (iii) the ARDL model can be applied to integrated series of order I(0) or I(1); (iv) the ARDL method can assess the short-term and long-term impacts of one variable on another. Due to the above advantages, the ARDL model is suitable for assessing the impacts of green innovation, renewable energy, industrialization and institutional quality on green growth in Vietnam.

4. Empirical Results and Discussion

4.1. Principal Component Analysis (PCA) Results

Table 2.
Results of PCA principal component analysis.

F1	PS	VA	GE	RQ	RL	CC
	0.3301	0.2740	0.4539	0.4521	0.4528	0.4468

The results of principal component analysis (PCA) to construct INS variables are presented in Table 2 according to six component indices, including variables PS, VA, GE, RQ, RL, CC as follows:

F1 = 0.3301PS + 0.2740VA + 0.4539GE + 0.4521RQ + 0.4528RL + 0.4468CC

Table 3.
Descriptive statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
LnGG	10.9864	0.4356	10.3693	11.5929
LnGIN	3.4530	0.3147	2.9849	3.9312
IND	36.1213	2.4587	29.7298	40.2087
REC	40.3518	13.3839	18.9	62.6
INS	0.3686	0.1174	0.1781	0.5879

4.2. Descriptive Statistics

Table 3 shows: The LnGG variable has an average value of 10.9864, the smallest is 10.3693, the largest is 11.5929, and the standard deviation is 0.4356. The LnGIN variable has an average value of 3.4530, the smallest is 2.9849, the largest is 3.9312, and the standard deviation is 0.3147. The IND variable has an average value of 36.1213, the smallest is 29.7298, the largest is 40.2087, and the standard deviation is 2.4587. The REC variable has an average value of 40.3518, the smallest is 18.9, the largest is 62.6, and the standard deviation is 13.3839. The INS variable has an average value of approximately 0.3686, the smallest is 0.1781, the largest is 0.5879, and the standard deviation is 0.1174.

4.3. Unit Root Test Results

With time series data, variables need to ensure stationarity.

Table 4.
Phillips-Perron and Dickey-Fuller unit root test statistics.

Variable	Dickey-Fuller		Phillips-Perron	
	Statistics	p-value	Statistics	p-value
LnGG	-0.280	0.9283	-0.324	0.9221
LnGIN	-0.337	0.9201	-0.308	0.9244
REC	-1.297	0.6306	-1.304	0.6273
IND	-2.859	0.5003	-2.843	0.5024
INS	-2.344	0.1580	-2.397	0.1425
First difference				
ΔLnGG	-3.252	0.0171	-3.263	0.0166
ΔLnGIN	-5.369	0.0000	-5.342	0.0000
ΔREC	-4.200	0.0007	-4.149	0.0008
ΔIND	-4.777	0.0001	-4.777	0.0001
ΔINS	-4.694	0.0001	-4.684	0.0001

The results of the Dickey-Fuller and Phillips-Perron unit root tests in Table 4 show that the variables are not stationary in the original series but are stationary at the first difference. The LnGG variable is stationary at the first difference I(1) with a significance level of 5%, the remaining variables are stationary at the significance level of 1%. Thus, the data is suitable for assessing short-term and long-term impacts using the ARDL model.

4.4. Choosing The Optimal Lag

Table 5.
Optimal lag order selection.

Lag	FPE	AIC	HQIC	SBIC
0	0.0519	6.6250	6.6871	6.8718
1	0.0813	0.0973	0.4698	1.5784
2	0.0060	-0.5649	0.1179	2,1503
3	0.0670	-3.9549*	-2.9616*	-0.0053*

Note: (*) Indicates lag order selected by the criterion.

Table 5 shows the optimal lag of the ARDL model with stationary variables at first difference I(1). Based on the AIC, HQIC, SBIC criteria, the optimal lag selected is 3.

4.5. Cointegration Test

To examine the long-run relationship between variables, the study conducted the ARDL Bound test.

Table 6.
ARDL Bound Cointegration Test.

		F-statistics		t-statistics	
Computed Statistic	**Test statistic**	**[I_0]**	**[I_1]**	**[I_0]**	**[I_1]**
F =7.642	At 1% significance	4.29	5.61	-3.43	-4.37
t =-4.803	At 2.5% significance	3.69	4.89	-3.13	-4.05
	At 5% significance	3.23	4.35	-2.86	-3.78
	At 10% significance	2.72	3.77	-2.57	-3.46

The ARDL bound test results in Table 6 show that the statistical value F = 7.642 is larger than all the critical values of the upper bound and the statistical value t = -4.803 is smaller than all the critical values of the upper bound at the significance levels of 1%; 2.5%; 5%; 10%, so the ARDL model has a long-run relationship.

4.6. The ARDL Results

The results of estimating the short-run and long-run relationships using the ARDL model are presented in the following table:

Table 7.
ARDL model estimation results

Variable	Long run		Short run	
	Coefficient	**Prob**	**Coefficient**	**Prob**
$LnGIN_{t-1}$	0.0719***	0.002		
REC_{t-1}	0.1148***	0.000		
IND_{t-1}	0.02294**	0.033		
INS_{t-1}	0.1231***	0.000		
Convergence coefficient	-1.0895***	0.000		
$\Delta LnGIN$			-0.0040***	0.008
$\Delta LnGIN_{t-1}$			-0.0032*	0.052
$\Delta LnGIN_{t-2}$			-0.0038**	0.020
ΔREC			0.0048*	0.066
ΔREC_{t-1}			0.0043*	0.056
ΔREC_{t-2}			0.0091***	0.007
ΔIND			-0.1302	0.109
ΔIND_{t-1}			-0.1521**	0.020
ΔIND_{t-2}			-0.1202*	0.051
ΔINS			0.0101**	0.020
ΔINS_{t-1}			0.0371***	0.005
ΔINS_{t-2}			0.0171**	0.034
Constant			0.3573***	0.000
R- Squred	0.998		0.998	

Note: *,**,***represent the significance level at 10%, 5% and 1% respectively.

4.7. Diagnostic And Stability Tests

To ensure the reliability of the above estimate, the study conducted an autocorrelation test, a heteroscedasticity test, a residual normal distribution test, and a model fit test. The test results showed that the ARDL model ensured reliability (Table 8).

Table 8.
Diagnostic tests for the ARDL

Test Hypothesis	**Tests**	**p-value**	**Decision**
Autocorrelation	Breusch-Godfrey	0.3146	No autocorrelation
Heteroscedasticity	Breusch-Pagan-Godfrey	0.1862	No heteroscedasticity
Normality	Jarque-Bera	0.2172	Normal residuals distribution.
Specification	Ramsey	0.3421	The model is appropriately specified

The results of the model stability test also show that the cumulative sum of residuals and the square of the cumulative sum of residuals are both within the standard range at the 5% level of significance. Thus, the ARDL model examining the impact of green innovation, renewable energy, industrialization, and institutional quality on green growth in Vietnam is stable.

4.8. Discussion of research results

Based on estimated results from the ARDL model, it shows:

Green innovation has a negative and statistically insignificant short-term impact on green growth but a positive and statistically significant long-term impact. In the short term, green innovation has an immediate impact and a lag 1 and lag 2 impact on green growth. This suggests that green innovation may not bring benefits in the short term but plays an important role in achieving environmental goals and promoting sustainable development in the long term. On the other hand, green innovation requires sufficient time for technological innovation activities to be adopted and integrated into the economy. Additionally, green technologies often require large initial investments for implementation, which may discourage some companies from investing. This study result is consistent with the study results of Zhang et al. [6], Zhang et al. [3], Ulucak [4], and Zhang and Vigne [7].

Renewable energy has a statistically significant positive impact on green growth in the long run, but the impact of renewable energy on green growth is statistically significant but insignificant in the short run. In the short run, renewable energy has an immediate impact and a lag 1 and lag 2 impact on green growth, so the transition to renewable energy sources has a strong positive impact on green growth. Initially, the exploitation and consumption of renewable energy cannot immediately bring significant results for green growth due to initial investments, infrastructure development, and the need for time to realize efficiency benefits. However, in the long run, the benefits of renewable energy will be promoted when production costs are reduced and environmental benefits are realized. The use of renewable energy as a viable alternative to conventional fossil fuels contributes to promoting green growth. This study result is consistent with the conclusion of Du and Li [11]; Mensah et al. [14]; Shah et al. [9] and Meng et al. [10] but different from the results of Menegaki [15] and Murshed et al. [16].

Industrialization has a statistically significant negative impact on green growth in the short run but a statistically significant positive impact on green growth in the long run. In the short run, industrialization affects green growth at lag 1 and lag 2. Industrialization degrades environmental quality and negatively impacts green growth in the short run due to the increased use of conventional energy sources in industrial activities. In the long run, industrialization positively impacts green growth due to the reduction of CO_2 emissions due to the application of technological advances. This research result is consistent with the research result of Wen et al. [23] but different from the research result of Shahab et al. [22] and Naeem et al. [21].

Institutional quality has a statistically significant positive impact on green growth in the short and long term. In the short term, institutional quality has an immediate impact and a lag 1 and lag 2 impact on green growth. Good institutional quality provides a stable and predictable business environment and encourages investment in environmentally friendly technologies that enhance economic efficiency, thereby promoting green growth. Furthermore, good institutional quality ensures the ability to enforce and comply with environmental regulations, minimizing negative externalities related to economic activities. On the other hand, institutional quality is also important in implementing and monitoring carbon emission reduction policies, developing climate change adaptation policies, and promoting sustainable development. The results of this study are consistent with the conclusions of studies by Acemoglu and Robinson [24]; Li and Li [26]; Tawiah et al. [27]; Ahmad et al. [28] and Song et al. [30].

5. Conclusion, Policy Implications and Limitations

5.1. Conclusion

The study assesses the impacts of green innovation, renewable energy, industrialization, and institutional quality on green growth in Vietnam during the period 1996-2022 using the ARDL model. The results show that green innovation and industrialization have negative impacts, while renewable energy and institutional quality have positive impacts on green growth in the short term. In the long term, green innovation, renewable energy, industrialization, and institutional quality have positive impacts on green growth in Vietnam.

5.2. Policy Implications

Based on the findings from the research results, the article suggests some of the following policy implications:

It is necessary to strengthen the provision and support for green innovation to strike a balance between environmental conservation and economic prosperity. The government should use the market competition mechanism to encourage the development of green innovation and improve the efficiency of green technology transfer and transformation, but at the same time, create conditions to promote green innovation through financial support policies. On the other hand, it is necessary to increase investment in green innovation, especially long-term investment in green innovation, and promote appropriate incentives such as tax breaks, subsidies, and public-private partnerships in the transition to green technology.

Institutions to encourage the use of renewable energy sources to replace traditional energy sources need to be developed and implemented to protect the environment, ensure energy security, contribute to economic development, and respond to climate change. In the context of green consumption becoming the mainstream trend in many economies around the world, Vietnam needs to promote the expansion of the renewable energy market, increase investment in renewable energy infrastructure, promote and deploy new technologies, and encourage the use of renewable energy in all sectors of the economy.

It is necessary to accelerate the industrialization process associated with the shift in production structure towards the use of modern technology to create highly competitive products with low costs and environmental friendliness. At the same time, it is essential to develop industries associated with the use of recycled materials, focusing on the use of clean energy and renewable energy. We must exploit and use natural resources economically and effectively, and encourage the use of renewable energy sources to replace traditional energy sources to protect the environment and ensure energy security.

Environmental protection laws should be developed in a synchronous, strict, and complete manner, ensuring effectiveness and efficiency. Public sector governance needs to be improved to enhance the capacity to enforce, monitor and supervise compliance with environmental regulations, and to minimize negative externalities related to the environment from economic activities. In addition, regulations on carbon emission reduction need to be closely examined and monitored, and climate change adaptation policies need to be effectively developed and implemented to promote sustainable development.

5.3. Study limitations and future directions

The current study assesses the dynamic impact of green innovation, renewable energy, industrialization, and institutional quality on green growth in the context of the Vietnamese economy. However, this study also has some limitations that future studies can address. Firstly, the current study was conducted in the context of the Vietnamese economy, but green growth varies across countries. Future studies can conduct research in other developing countries and can compare the results of this study to obtain more authentic results. Secondly, the current study only examines the impact of green innovation, renewable energy, industrialization, and institutional quality on green growth. Future studies can include other variables that affect green growth, such as foreign direct investment, trade openness, human capital, etc., when continuing to research this topic.

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