# A Study on the Impact of Green Finance on Renewable Energy

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**Abstract.** Green finance can significantly promote the development of renewable energy, and its impact exhibits marked regional variations. Based on panel data from 30 provinces (autonomous regions and municipalities) in China covering the period 2010–2021, this paper employs a two-way fixed-effects model to systematically examine the impact of green finance on the development of renewable energy. The findings reveal that green finance exerts a significant positive effect on the development of renewable energy, indicating that it can drive the green transition of the energy structure by optimising capital allocation and alleviating financing constraints. Further heterogeneity analysis suggests that the promotional effect of green finance is more pronounced in the eastern regions. The conclusions of this study provide empirical evidence for improving the green finance policy framework and promoting the development of renewable energy in a manner tailored to local conditions.

**Keywords:** green finance, renewable energy, green energy transition

## 1 Introduction and Literature Review

The green transition of the energy structure is a crucial task for China to achieve high-quality and green development, and the level of renewable energy development is directly linked to the optimisation of the energy system and the realisation of sustainable development goals. In recent years, the impact of green finance on renewable energy development has become a hot topic in academia, with related research primarily focusing on the relationship between the two, their mechanisms of action, and heterogeneity. Existing literature generally holds that green finance can significantly promote the development of renewable energy. Li Boyang[1] et al. found, from the perspectives of green credit and green venture capital, that the supply of green finance funds helps to drive the scaling-up and sustainable development of renewable energy; Chen Tingqiang et al. argued that financial development can promote regional renewable energy growth by expanding the scale of financing and fostering technological innovation, although a threshold effect exists; Wu Zhaoxia et al. further elucidated the trans-


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mission mechanisms through which green finance promotes the development of renewable energy. International and cross-national studies have also provided similar evidence. Sun et al.[4] , Tang et al., and Li et al.[2] all found that green finance has a sustained promotional effect on China's renewable energy development, with regional or spatiotemporal variations; Zhang Jixin et al. and Li Jintian verified its positive impact based on data from multiple countries and BRICS nations; Abbas et al.[5] point out that green finance and environmental taxes are conducive to increasing investment in renewable energy and electricity output in China, whilst geopolitical risks have a restraining effect. Due to space constraints, this paper does not list all references from the literature review section individually.

## 2 Theoretical Analysis and Research Hypotheses

Some scholars argue that green finance can promote the development of renewable energy through capital guidance and resource allocation mechanisms. Given that the renewable energy sector involves large-scale investment, long payback periods and high R&D expenditure, and is heavily reliant on external financing, green finance can provide stable financial support, alleviate financing constraints and drive the large-scale development of the industry. In the short term, its impact may be constrained by technological and supporting infrastructure limitations; however, in the long term, green finance can channel social capital, drive the green transition of the financial system, and encourage enterprises to enhance their technological innovation and grid integration capabilities. Existing research indicates that the impact of green finance on renewable energy development varies: in eastern regions, where financial markets are well-developed and marketisation is advanced, the promotional effect is more pronounced; whereas in central and western regions, constrained by financial development and supporting infrastructure, its impact is relatively limited. Based on this, this paper proposes the following hypotheses: Hypothesis 1: Green finance has a significant positive impact on the development of renewable energy. Green finance can channel capital into the renewable energy sector, alleviate financing constraints, and assist in the industry's quality improvement and upgrading; Hypothesis 2: The impact of green finance on renewable energy development exhibits significant heterogeneity. Differences in regional economic foundations, levels of marketisation, and energy conditions will lead to uneven outcomes in the empowerment effects of green finance.

## 3 Research Design

### 3.1 Sample and Data Sources

This study utilises panel data from 30 provinces in China (excluding Hong Kong, Macao, Taiwan and the Tibet Autonomous Region due to data gaps) covering the period 2010–2021 for empirical analysis. The dependent variable is the level of renewable energy development, represented by the logarithm of each province's renewable energy

generation (including hydropower, wind power and solar power) (Renew). The independent variable is the Green Finance Index (GF). Following the research by Mao Xiaomeng and Wang Renzeng (2024)[3], this study utilises panel data from 30 provinces, autonomous regions and municipalities covering the period 2010–2021 to measure the development of regional green finance across four dimensions: green credit, green equities, green insurance and green investment. The control variables in this paper cover the following five aspects: economic factors include provincial gross domestic product (lnGDP), provincial urbanisation rate (urban), and provincial foreign direct investment (FDI); energy factors include provincial coal consumption (lnCoal); and environ-mental factors include provincial $CO_2$ emissions ($lnCO_2$). In defining the meanings of the variables, logarithmic transformations were applied to certain variables. The primary objective was to eliminate heteroscedasticity and smooth out data fluctuations, thereby enhancing the robustness and interpretability of the empirical results. Specifically, the data on the dependent variable—the development of renewable energy—is sourced from the *China Electricity Yearbook*[1] and was manually compiled and verified by the author; data on green finance is primarily drawn from the Guotai-An database, the EPS database, the *China Industrial Statistics Yearbook*[2], and the *China Statistical Yearbook*[3]; data for other control variables is sourced from the *China Statistical Yearbook*[3], the *China Environmental Statistics Yearbook*[4], and the *China Science and Technology Statistics Yearbook*[5].

### 3.2 Variable Selection and Model Specification

In the baseline test, this paper uses the level of renewable energy development (Renew) as the dependent variable. In addition, this study faces potential endogeneity issues, primarily manifested as a reverse causal relationship between green finance and the development of renewable energy—specifically, the development of renewable energy projects may attract more green finance investment, rather than green finance driving the development of renewable energy. To address this issue, this study employs a lagged explanatory variable approach to mitigate endogeneity bias. Given the long construction cycles and slow return on investment associated with renewable energy projects, there is a significant time lag before the effects of green finance policies become apparent. Therefore, this study introduces a green finance index lagged by two periods as a core explanatory variable. This not only accurately captures the long-term impact of green finance on renewable energy development but also effectively mitigates the endogeneity bias caused by reverse causality. The following two-way fixed-effects model is constructed:

1 *China Electricity Yearbook* is published annually by the China Electricity Council, Beijing, China.

2 *China Industrial Statistics Yearbook* is published annually by the National Bureau of Statistics of China, Beijing, China.

3 *China Statistical Yearbook* is published annually by the National Bureau of Statistics of China, Beijing, China.

4 *China Environmental Statistics Yearbook* is published annually by the Ministry of Ecology and Environment and the National Bureau of Statistics of China, Beijing, China.

5 *China Science and Technology Statistics Yearbook* is published annually by the Ministry of Science and Technology and the National Bureau of Statistics of China, Beijing, China.

$$\text{Renew}_{it} = \alpha_0 + \beta_1 GF_{it-2} + \beta Control_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

Equation (1) represents the baseline two-way fixed-effects model in this study, where: `$\text{Renew}_{it}$ ` denotes the level of renewable energy development in province i in year t; `$GF_{it-2}$ ` denotes the green finance index lagged by two periods, used to identify its lagged effects on renewable energy development; `$\text{Control}_{it}$ ` denotes the control variables; `$\mu_i$ ` denotes the regional fixed effects; `$\lambda_t$ ` denotes the time fixed effects; and `$\varepsilon_{it}$ ` denotes the random disturbance term.

# 4 Empirical Results and Analysis

## 4.1 Descriptive Statistics

Following screening, a total of 360 valid observations were obtained. The descriptive statistics for each research variable are shown in the table 1. The standard deviation of the dependent variable 'Renew' is 1.53, with a relatively wide range, indicating significant differences in the level of renewable energy development across regions; the standard deviation of the core explanatory variable 'GF' is small, with limited overall fluctuation, suggesting that the degree of regional green finance development is relatively concentrated. Among the control variables, the ranges of the data for Gross Domestic Product (lnGDP) and coal consumption (lnCOAL) are moderate, reflecting significant divergence in the characteristics of economic development and traditional energy consumption across the sample regions; the levels of urbanisation (urban) and carbon emissions ($\ln CO_2$) exhibit low dispersion, with a generally stable distribution; there are some missing observations for FDI, and the data range is wide, indicating a clear stratification in the levels of foreign investment across different regions. Overall, the values of all variables fall within reasonable ranges, with no extreme outliers, providing reliable data support for subsequent empirical regression analysis.

**Table 1.** Descriptive Statistics

| Variable Name | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| Renew | 360 | 5.34 | 1.53 | -1.61 | 8.26 |
| GF | 360 | 0 .19 | 0.07 | .071 | 0 .54 |
| lnGDP | 360 | 9.82 | 0.88 | 7.21 | 11.73 |
| lnCOAL | 360 | 9.23 | 1.00 | 4.87 | 11.64 |
| urban | 360 | 0.58 | 0 .13 | 0 .34 | 0.94 |
| FDI | 340 | 12.70 | 1.76 | 5.77 | 15.09 |
| $CO_2$ | 360 | 19.41 | 0 .74 | 17.56 | 20.88 |

### 4.2 Correlation Analysis


**Fig. 1.** Correlation Analysis

Figure 1 shows the correlation coefficient matrix between the main variables. As shown in Figure 1, the core explanatory variable, green finance (GF), is significantly positively correlated with the dependent variable, the level of renewable energy development (Renew), suggesting that the development of green finance may promote the development of renewable energy; simultaneously, the level of urbanisation (Urban) is significantly negatively correlated with the level of renewable energy development, whilst coal consumption (lnCOAL) exhibits a strong negative correlation with the level of renewable energy development, indicating that regions with a higher reliance on traditional energy sources generally have a lower level of renewable energy development.

### 4.3 Benchmark Regression Analysis

Table 2 reports the impact of green finance lagged by two periods on the level of renewable energy, with the regression results presented sequentially through the stepwise addition of fixed effects and control variables. The empirical results indicate that the coefficient of the two-period lagged green finance level (GF_12) is significantly positive across all columns. In Column (4), the coefficient of GF_12 is 0.92 and is significant at the 10% level, suggesting that, after controlling for time fixed effects, provincial fixed effects and other influencing factors, the development of green finance can, on the whole, significantly promote the development of renewable energy, thereby providing preliminary validation of the core hypothesis of this paper. With regard to the control variables, the coefficient for foreign direct investment (FDI) is 0.14 and passes the significance test at the 1% level, indicating that foreign direct investment drives the development of renewable energy in the region through technological spillover effects. The coefficients for the remaining control variables—such as economic development

level (GDP), coal consumption (lnCOAL), urbanisation level (Urban) and carbon emissions (lnCO2)—did not all pass the significance test, but their overall sign directions were generally consistent with theoretical expectations. Overall, with the inclusion of control variables and two-way fixed effects, the model's goodness of fit (Adj. $R^2$) improved from 0.03 to 0.70, significantly enhancing the model's explanatory power, and the regression results demonstrate good stability and reliability.

**Table 2.** Benchmark Regression

| | (1) Renew | (2) Renew | (3) Renew | (4) Renew |
|---|---|---|---|---|
| GF_l2 | 3.93*** | 0.92* | 1.59* | 0.92* |
| | (0.99) | (0.49) | (0.85) | (0.45) |
| GDP | | | 0.47 | -0.73* |
| | | | (0.56) | (0.41) |
| lnCOAL | | | -0.14 | 0.14 |
| | | | (0.18) | (0.13) |
| Urban | | | 3.69 | -2.44 |
| | | | (2.58) | (2.28) |
| FDI | | | -0.04 | 0.14*** |
| | | | (0.08) | (0.05) |
| $lnCO_2$ | | | 1.65** | 0.31 |
| | | | (0.73) | (0.54) |
| Cons | 4.76*** | 4.75*** | -31.94*** | 3.97 |
| | (0.24) | (0.13) | (11.49) | (9.92) |
| *N* | 300 | 300 | 282 | 282 |
| Fixed time | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Fixed by province | Uncontrolled | Controlled | Controlled | Controlled |
| Adj. $R^2$ | 0.03 | 0.64 | 0.54 | 0.70 |

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

## 4.4 Heterogeneity Analysis

This paper divides the sample into the eastern region and the central and western regions; the results of the group-specific regression are shown in Table 3. The regression coefficient for green finance in the eastern region is 3.19, which is significantly positive at the 10% level; the coefficient for green finance in the western region is 0.66, which does not pass the significance test. This indicates that the promotional effect of green finance on the development of renewable energy exhibits significant regional heterogeneity, being effective only in the eastern region. The central and western regions have not played a significant role, primarily due to underdeveloped financial markets, a lack

of suitable green financial products, an industrial structure dominated by energy-intensive traditional industries, weak policy enforcement, and a shortage of supporting infrastructure for green industries. Accordingly, targeted intervention measures are proposed: improving green financial markets in central and western China by introducing credit and bond products tailored to local conditions; optimizing the industrial structure to promote the low-carbon transformation of traditional industries; and strengthening policy implementation while increasing investment in green infrastructure to help channel green financial resources into driving the development of renewable energy.

**Table 3.** Heterogeneity Analysis

| Variable Name | (1) Eastern Region | (2) Midwest |
|---|---|---|
| | renew | renew |
| GF_l2 | 3.19* | 0.66 |
| | -1.60 | -0.41 |
| Cons | 20.29 | 4.80 |
| | -61.87 | -6.86 |
| Observations | 96 | 186 |
| *N* | 10 | 20 |
| Adj. $R^2$ | 0.74 | 0.77 |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This paper further conducts heterogeneity tests based on the degree of marketisation. The results of the grouped regression analysis indicate that the effects of green finance do not show significant differences across groups at different levels of marketisation, and the regression coefficients for all groups failed to pass the significance test. Consequently, this paper will not elaborate further or conduct in-depth analysis on the heterogeneity characteristics of the marketisation dimension.

### 4.5 Robustness Tests

**Replacement of the Dependent Variable.** From the perspective of renewable energy construction scale, renewable energy installed capacity was selected to re-measure the level of renewable energy development table 4. The regression results in Column (1) show that the coefficient for green finance lagged by two periods is 1.56, which remains significantly positive at the 1% level. This indicates that after replacing the dependent variable measurement indicator, the promotional effect of green finance on renewable energy development still holds, and the core conclusion remains stable.

**Reducing the Influence of Outliers.** Considering that municipalities directly under the central government have distinct particularities in terms of economic foundation, policy environment and resource endowment, which may bias the empirical estimation results, this paper further excludes these municipal samples and re-conducts the regression test. As shown in column (2) of Table 4, the coefficient of the two-period lagged core green finance variable (GF_l2) is 1.09, which is significantly positive at the 5%

significance level. It is consistent in sign with the full-sample baseline regression results and remains statistically significant, indicating that the positive promoting effect of green finance on renewable energy development has not undergone substantive changes, and the core research conclusions remain robust.

**Table 4.** Robustness Test

| Variable Name | (1) Renewable Energy Installed Capacity | (2) Excluding municipalities |
|---|---|---|
| GF_l2 | 1.56*** | 1.09** |
| | (0.54) | (0.43) |
| Cons | 2.22 | 2.41 |
| | (11.03) | (10.12) |
| Fixed time | Control | Control |
| Fixed by province | Control | Control |
| *N* | 282 | 242 |
| adj. $R^2$ | 0.58 | 0.70 |

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

## 5 Conclusions

Based on panel data from 30 provinces in China covering the period 2010–2021, this paper systematically analyses the impact of green finance on the development of renewable energy and further examines whether there is heterogeneity in this relationship. The following conclusions are drawn: Firstly, green finance has a significant positive impact on the development of renewable energy, with coefficients that are statistically significant at the 10% level, effectively driving the development of the regional renewable energy industry. Second, the impact of green finance on renewable energy development exhibits clear heterogeneity: the enabling effect of green finance is significant in the eastern regions, whereas no obvious driving effect has yet been observed in the central and western regions. Based on these findings, it is recommended that green finance support policies be refined, with increased investment in green finance directed towards regions with high levels of marketisation and financial development to optimise the efficiency of capital allocation. Concurrently, targeted support should be provided for the development of the green industry in the central and western regions, relevant supporting policies should be improved to alleviate regional development disparities, the effectiveness of policy implementation should be strengthened, and the high-quality development of the renewable energy industry should be promoted.

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