The Impact of the New Energy Demonstration City Policy on Green Growth in Pilot Cities: Evidence from a Quasi-Experiment in Chinese Prefecture-Level Cities

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Abstract. This study employs the quasi-natural experiment of the New Energy Demonstration City policy, utilizing panel data from 217 prefecture-level cities between 2012 and 2021 and adopting a difference-in-differences (DID) model to investigate how the New Energy Demonstration City policy affects green growth in pilot cities. The results demonstrate that the New Energy Demonstration City policy significantly enhances the green total factor productivity of pilot cities, particularly achieving positive outcomes in promoting green industries and technological innovation. Mechanism analysis reveals that the policy drives green growth by facilitating the transformation of household energy consumption structure and the expansion of industrial scale, with a significant positive relationship between the increase in the number of industrial enterprises and green total factor productivity. Heterogeneity analysis further shows that different city types and fiscal conditions have significant differences in policy effects, with resource-based cities and cities under greater fiscal pressure experiencing more pronounced increases in green productivity after policy implementation. The study suggests that future policies should focus on the popularization of clean energy and industrial green transformation, and adjust policy strategies according to the resource endowments and fiscal capabilities of cities. This research provides theoretical support and policy recommendations for further optimizing the New Energy Demonstration City policy.

Keywords: New Energy Demonstration City Policy; Green Growth; Green Total Factor Productivity; Technological Innovation; Energy Consumption Structure; Heterogeneity Analysis.

1. Introduction

As global environmental issues become increasingly severe, promoting green development has emerged as a common goal for countries worldwide. China, as the largest developing country in the world, recognizes that the transformation and optimization of its energy structure are crucial for achieving sustainable development.[2] According to the National Bureau of Statistics, the proportion of coal consumption in the total energy consumption was 53.2% in 2024, a decrease of 1.6 percentage points from the previous year. However, this still falls short of the target to increase the share of non-fossil energy consumption to around 20% by 2025. For a long time, the dominance of traditional fossil fuels in China’s energy consumption has led to an irrational industrial structure and low energy efficiency, severely constraining environmental protection and sustainable resource utilization.[2] Therefore, driving green growth, particularly through the promotion of new energy sources, has become an important task facing China.

Since 2006, the Chinese government has actively introduced a series of policies to promote the development of renewable energy. In particular, the National Energy Administration initiated the application process for New Energy Demonstration Cities in 2012 and officially launched the program in 2014. The initiative aims to enhance the sustainable development capabilities of cities by promoting the application of clean energy sources such as solar and wind power through the construction of demonstration cities. These policies have not only spurred advancements in new energy technologies but also provided strong support for energy transition through the backing of local governments.[3]

The implementation of the New Energy Demonstration City policy is crucial for the green growth of pilot cities. This study aims to assess the impact of the New Energy Demonstration City policy on green total factor productivity, particularly through the mechanisms of household energy consumption structure transformation and industrial scale expansion. We also examine the heterogeneous effects of the policy across different city types and fiscal conditions. By analyzing panel data from 217 prefecture-level and above cities in China, this study seeks to provide theoretical support for policymakers to optimize the New Energy Demonstration City policy and further promote green development.

2. Literature Review

The New Energy Demonstration City policy, as a significant measure by the Chinese government to promote energy transition and green development, aims to guide cities in achieving green transformation in energy production and consumption, reduce carbon emissions, and foster a low-carbon economy and green growth. Since the implementation of the policy across China in 2014, many pilot cities have made substantial progress in green technological innovation, energy use efficiency, and environmental protection. The policy has not only spurred technological innovation and the development of green industries but also promoted the growth of green finance, providing crucial support for sustainable urban development. [4]

In academia, numerous studies have been dedicated to exploring the mechanisms through which the New Energy Demonstration City policy influences green growth. Research by Li et al. has demonstrated that the policy enhances the green total factor productivity (GTFP) of pilot cities by promoting green technological innovation and facilitating the low-carbon transformation of industrial structures, thereby achieving carbon emission reductions through strengthened environmental regulation and technological progress. [5] For instance, studies have shown that the New Energy Demonstration City policy has, to a certain extent, improved the carbon total factor productivity of pilot cities by increasing the intensity of environmental regulation and fostering technological progress. In addition to promoting green innovation, the policy has also bolstered support from green finance and policy, leading to the rapid development of green industries.

Similar perspectives have also been supported by Jing and Wang, who argue that the New Energy Demonstration City policy exerts heterogeneous effects on different cities. The policy appears to be more effective in eastern cities and those with higher administrative levels, whereas its role in promoting green growth is relatively weaker in central and western cities. [6]

Apart from the analysis of policy heterogeneity, Deng Shicheng et al. have found that the policy also has spatial spillover effects. Specifically, the policy effects in pilot cities exhibit a “local-neighborhood” spatial spillover characteristic, which promotes green innovation and technological progress in surrounding cities. [7], This finding is consistent with the results of Yan Dan et al., who further emphasized the regional collaborative effect of the policy. [8]

Moreover, Liu et al. have pointed out that the effects of the policy are subject to a certain time lag, typically becoming gradually evident only after five or more years of implementation. [9] This finding serves as a reminder that in policy evaluation, it is imperative to take into account its long-term impacts rather than focusing solely on short-term changes. Additionally, although existing studies have analyzed the effects and mechanisms of the policy from multiple perspectives, in-depth exploration of its long-term impacts remains insufficient.

Overall, existing studies have provided robust theoretical support for the role of the New Energy Demonstration City policy in promoting green growth. However, several research gaps remain to be addressed. First, there is a scarcity of research on the long-term impacts of the policy. Future studies could further investigate the sustained effects of the policy on GTFP, green innovation capacity, and patterns of economic growth over extended time horizons. Second, the influence of institutional differences and regional characteristics across cities has not been fully explored. Future research should consider how to tailor policy content according to local features to achieve more precise green growth. Lastly, the New Energy Demonstration City policy often interacts with other policy measures, such as green finance policies and industrial support policies. Investigating the synergistic effects between different policies to enhance the overall benefits of green growth will be an important direction for future research.

3. Policy Background and Theoretical Analysis

3.1. Policy Background

As the largest developing country in the world, China's energy issues are closely intertwined with its national economic and social development. Since the reform and opening-up, China has experienced rapid economic growth. However, this growth has been heavily reliant on traditional fossil fuels, leading to irrational industrial structures and energy use patterns, which have caused environmental pollution and constrained energy efficiency.

To address these challenges, the Chinese government has introduced a series of policies to promote the transformation of the energy structure, with a particular focus on the development of new energy sources. Since the promulgation of the *Renewable Energy Law* in 2006 and the release of the *Medium- and Long-term Plan for Renewable Energy* in 2007, the direction for future energy structural adjustment has been clarified, and renewable energy has been incorporated into the national strategy. The country has continuously intensified its support for renewable energy, with both the "Eleventh Five-Year Plan" and the "Twelfth Five-Year Plan" reflecting this orientation.

To accelerate the application of new energy, the National Energy Administration initiated the application process for New Energy Demonstration Cities in 2012, encouraging the widespread use of clean energy sources such as solar and wind power to enhance urban sustainability. The application criteria encompassed both comprehensive capabilities and the foundation for new energy utilization, requiring specific standards to be met in energy conservation, emission reduction, and new energy use. By 2014, the National Energy Administration had announced the first batch of 81 New Energy Demonstration Cities and eight industrial parks, including Changping District in Beijing. These cities have promoted the development of distributed energy sources such as solar, wind, biomass, and geothermal energy through technological innovation and application, optimized their energy structures, and improved energy efficiency and environmental quality.

The construction of New Energy Demonstration Cities has not only spurred advancements in clean energy technologies but also created favorable conditions for the widespread application of new energy through policy support from local governments and the establishment of technological platforms. With continuous progress in new energy technologies and the improvement of the industrial chain, China will continue to take solid steps on the path to energy transition and green development.

3.2. Theoretical Analysis

The central objective of the New Energy Demonstration City policy is to promote green development, optimize the energy structure, and facilitate economic transformation, particularly in enhancing GTFP. According to the theory of green growth, such growth relies not only on the gradual substitution of traditional energy sources but also on green technological innovation, improvements in energy use efficiency, and adjustments in industrial structure. Therefore, by promoting the application of clean energy and low-carbon technologies, the New Energy Demonstration City policy has significantly increased the GTFP of pilot cities, thereby fostering green growth in these urban areas.

According to the study by Wang et al., the New Energy Demonstration City policy can significantly enhance the GTFP of enterprises through technological innovation, optimization of resource allocation, and policy support, thereby demonstrating the positive role of such policies in promoting green growth. [10] The research indicates that the impetus provided by the policy has played a crucial role in improving energy use efficiency, reducing carbon emissions, and optimizing the industrial structure.

H1: The New Energy Demonstration City policy effectively promotes green growth in pilot cities.

The transformation of household energy consumption structure plays a vital role in driving urban green growth. Typically, this transformation involves a shift from traditional energy sources (such as coal gas and natural gas) to cleaner, low-carbon alternatives (such as electricity and renewable energy). According to the Environmental Kuznets Curve theory, in the early stages of economic development, the increase in energy consumption is often accompanied by a worsening of environmental pollution. However, with the advancement of technology and the implementation of environmental policies, pollution levels tend to decline in later stages. [11] Therefore, the transformation of household energy consumption structure, especially the increased use of clean energy sources like natural gas, helps to reduce urban pollution and carbon emissions, thereby promoting the increase in GTFP.

According to the empirical study by Zhang et al., the optimization of household energy consumption structure can significantly reduce carbon emissions and promote low-carbon development, especially when the proportion of clean energy use increases. This study indicates that the transformation of household energy consumption is conducive to achieving the goal of green growth. [12]

H2: The New Energy Demonstration City policy promotes green growth in pilot cities through the transformation of household energy consumption structure.

The impact of industrial scale expansion on green growth is typically realized through the promotion of green technological innovation, increased production efficiency, and the agglomeration effect of industries. According to the theory of economies of scale, as the number of industrial enterprises increases, the allocation of production factors becomes more efficient. Firms can share environmental technologies, reduce unit production costs, and enhance production efficiency, thereby driving up GTFP. [13] Moreover, theories of technological innovation and industrial agglomeration also suggest that a greater number of industrial enterprises can foster market competition, stimulate innovative vitality, and promote the application of green technologies and clean energy, which in turn raises GTFP.[14].

In the study by Li et al., the New Energy Demonstration City policy significantly enhanced the GTFP of industrial enterprises by supporting the expansion of industrial scale, particularly in green industries and clean energy sectors. [15] The research indicates that the increase in the number of industrial enterprises not only spurred technological innovation but also promoted the agglomeration of green industries, thereby further improving production efficiency and environmental performance. Thus, Hypothesis 3 is also theoretically supported, that is, the New Energy Demonstration City policy promotes green growth by facilitating industrial scale expansion

H3: The New Energy Demonstration City policy promotes green growth in pilot cities through industrial scale expansion.

4. Data and Methods

4.1. Data and Sources

4.1.1. Dependent Variable

GTFP. In the existing literature, the measurement of green development level is mainly divided into two categories: indicator system evaluation and efficiency measurement. The latter can further be categorized into Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). [16]

In this study, we employ Data Envelopment Analysis (DEA), which, compared to SFA, has the advantage of being able to evaluate multiple output or input factors simultaneously. In DEA, GTFP refers to the extent to which a production unit (DMU) reaches the optimal technological level of the data set. Technical efficiency can be measured from both input and output perspectives. Given a fixed set of inputs, technical efficiency is measured by the degree of output maximization.

$$\rho^* = \min \frac{1 - \frac{1}{s}\sum_{i=1}^{s} \frac{m_i^-}{x_{io}}}{1 + \frac{1}{m_1 + m_2}\left(\sum_{r=1}^{m_1} \frac{m_r^g}{y_{r0}^g} + \sum_{r=1}^{m_2} \frac{m_t^b}{y_{r0}^b}\right)}$$

$$\text{s.t.}$$

$$x_0^b - \sum_{j=1}^{n} \lambda_j x_j - m^- = 0$$

$$\sum_{j=1}^{n} \lambda_i y_j^g - y_0^g - m^g = 0$$

$$y_0^b - \sum_{j=1}^{n} \lambda_j y_0^b - m^b = 0$$

$$\lambda, m^-, m^g, m^b > 0, \sum_{j=1}^{N} \lambda_j = 1$$

4.1.2. Core Explanatory Variable

New Energy Demonstration City Pilot Policy ($Treat\_time_{it}$). The core explanatory variable is measured using a DID term. For cities that were selected as pilot cities for the reform in 2014, $Treat\_time_{it}$ = 1; otherwise, $Treat\_time_{it}$ = 0.

4.1.3. Control Variables

Drawing on existing research, the following control variables are included: ① Hukou Population (HRPT), represented by the proportion of hukou (registered) population to the total population; ② Gross Regional Product (GRPT), represented by per capita gross regional product; ③ Urban Land Use Area (ALUUC), represented by the area of urban construction land; ④ Education Expenditure (EED), represented by the proportion of regional education expenditure to GDP; ⑤ Highway Freight Traffic (HFT), represented by the total volume of highway freight transport.

4.1.4. Data Description

A balanced panel dataset of 217 prefecture-level and above cities in China from 2012 to 2021 is selected as the research sample to assess the impact of the New Energy Demonstration City policy on urban green innovation vitality. The relevant data are sourced from the China City Statistical Yearbook, Gross Regional Product Yearbook, China Energy Statistical Yearbook, China Urban Construction Statistical Yearbook, China Education Expenditure Statistical Yearbook, and China Transportation Yearbook. Descriptive statistics of the variables are presented in Table 1.

Table 1. Descriptive Statistics of Variables

Name	Symbol	N	Mean	Variance	Min	Max
Green Total Factor Productivity	GTFP	2,170	1.001	0.011	0.929	1.081
Technological Progress	TEC	2,170	1.001	0.01	0.954	1.052
Technical Efficiency	TC	2,170	1.001	0.01	0.95	1.081
Hukou Population	lnHRPT	2,170	5.914	0.697	3.4	8.136
Gross Regional Product	lnGRPT	2,170	16.672	0.903	14.276	19.459
Urban Land Use Area	lnALUUC	2,170	4.579	0.825	-0.994	7.536
Education Expenditure	lnEET	2,170	13.223	0.743	9.241	15.889
Highway Freight Traffic	lnHFT	2,170	9.096	0.883	5.361	13.225

4.2. Methodology

This study treats the New Energy Demonstration City policy as a “quasi-natural experiment” to construct a DID model, thereby addressing the endogeneity issues frequently encountered in the literature. The first-level variables control for city fixed effects, while the second-level variables control for time fixed effects. Considering that the new energy policy was proposed in January 2014, we designate 2014 as the year of policy shock. These correlations can be better reflected by comparing non-pilot cities to pilot cities in terms of green growth. Following the approach of Deschênes et al. [17], we establish the model:

$$GTFP_{it} = \alpha_1 + \beta_1 Treat\_time_{it} + \sum_{k=1}^{K} C_{1k} X_{kit} + \delta_i + \sigma_t + \varepsilon_{it}$$

Here, i and t represent city and year, respectively. GTFP denotes green total factor productivity, α_1 is the constant term, and β_1 represents the policy effect. δ_i and σ_t control for city fixed effects and time fixed effects, respectively. ε_{it} is the random error term. $\mathrm{Treat\_time}_{it}$ is the core explanatory variable, with the policy dummy variable set to 1 for pilot cities and 0 for non-pilot cities. Treat_t is the time dummy variable, set to 1 for years 2014 and after, and 0 for years before 2014.

5. Empirical Analysis

5.1. Benchmark Regression

The article employs a DID approach for regression analysis, incorporating control variables while accounting for city fixed effects and time fixed effects. The regression results are presented in Table 2. In column (1) of Table 2, the coefficient for the $\mathrm{Treat\_time}_{it}$ term is positive and significant, controlling for city and time fixed effects. Columns (2), (3), and (4) of Table 2 display the regression results with the inclusion of control variables.

The regression results in column (2) of Table 2 indicate that the coefficient for the policy dummy variable (did) is 0.003 and significant at the 1% level. This suggests that the implementation of the New Energy Demonstration City policy has significantly increased the GTFP of pilot cities by 0.3 percentage points compared to non-pilot cities. This improvement is attributed to the policy's promotion of green industries and innovative green development models, such as the use of clean energy and the construction of environmentally friendly infrastructure. These measures effectively enhance resource utilization efficiency and productivity, thereby improving overall economic benefits.

Among the control variables, the impacts of hukou population (lnHRPT), urban land use area (lnALUUC), gross regional product (lnGRPT), education expenditure (lnEET), and highway freight traffic (lnHFT) on GTFP vary. First, an increase in hukou population leads to a rise in human resource costs, thereby exerting a negative influence on GTFP. This suggests that population expansion may intensify resource pressures and curb productivity improvements. Second, the expansion of urban land use area also shows a negative effect, likely due to irrational resource allocation in the urbanization process, which increases environmental pressures and affects green productivity. In contrast, an increase in gross regional product (lnGRPT) often provides more funding and resources for the research and development of green technologies and the construction of green infrastructure, thereby effectively promoting the improvement of GTFP. However, despite its crucial importance for long-term social development, education expenditure has not directly boosted green productivity in the short term, possibly due to the lagged effects of education. Lastly, while an increase in highway freight traffic can stimulate economic activities, it may also lead to more traffic and energy consumption, thereby exerting a negative impact on the environment and, in turn, suppressing the growth of GTFP. These control variables collectively influence the changes in GTFP, offering a multi-dimensional perspective for understanding the implementation effects of the New Energy Demonstration City policy.

Table 2. Benchmark Regression Results

	(1) GTFP	(2) GTFP	(3) TEC	(4) TC
green	0.003***	0.003***	0.001	0.003***
	(4.56)	(5.03)	(0.87)	(4.52)
lnHRPT		-0.004*	-0.001	-0.003
		(-1.78)	(-0.41)	(-1.26)
lnGRPT		0.014***	0.010***	0.005***
		(8.90)	(7.19)	(3.77)
lnALUUC		-0.003**	-0.002**	-0.001
		(-2.25)	(-2.07)	(-0.58)
lnEET		-0.013***	-0.009***	-0.004**
		(-4.45)	(-4.94)	(-2.14)
lnHFT		-0.001	-0.000	-0.001
		(-0.68)	(-0.16)	(-0.83)
Constant	1.001***	0.978***	0.981***	0.999***
	(14610.76)	(32.91)	(36.43)	(57.09)
City Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	2170	2170	2170	2170
r2	0.147	0.183	0.144	0.248

5.2. Parallel Trend Assumption

According to the study by Harris et al., the parallel trend assumption, which posits that the treatment and control groups should exhibit the same trend of change or lack significant systematic differences prior to policy implementation, is a fundamental prerequisite for the DID method to accurately identify causal effects.[18]

As illustrated in Figure 1, the figure displays the trends in GTFP for the treatment and control groups both before and after the policy implementation. It is evident from the chart that prior to the policy implementation (before time point 0), the trends in GTFP for both groups are nearly parallel, with point estimates close to zero and no significant fluctuations in the 95% confidence intervals. This indicates that the changes in GTFP for the treatment and control groups were consistent before the policy intervention, thus satisfying the parallel trend assumption. Following the policy implementation, the GTFP of the treatment group gradually increases, and the confidence intervals begin to significantly deviate from zero, demonstrating that the New Energy Demonstration City policy has a significant positive impact on GTFP. Based on this observation, the parallel trend assumption is deemed valid, thereby providing a rational basis for the DID estimation.

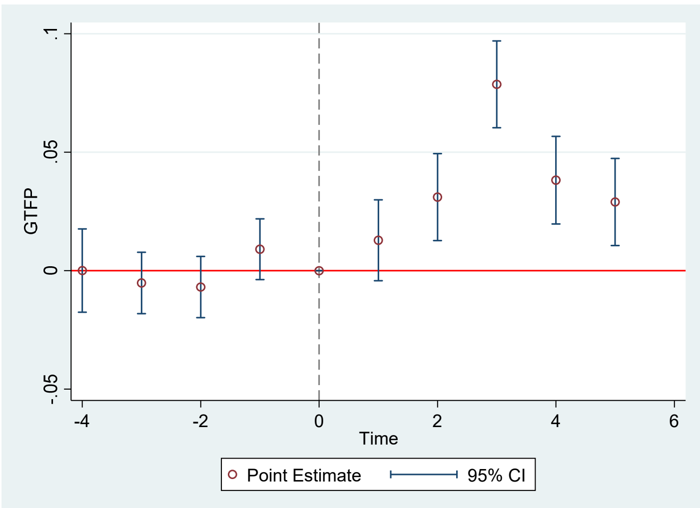

Figure 1. Illustration of the Parallel Trend Assumption

5.3. Robustness Tests

5.3.1. Placebo Test

To ensure the reliability of the impact of the New Energy Demonstration City pilot policy on GTFP and to avoid potential endogeneity issues, a placebo test was conducted. As shown in Figure 2, the distribution of the estimates is symmetric and highly concentrated around zero, with the red vertical line indicating the null hypothesis estimate. This suggests that in the absence of policy intervention, the estimates are close to zero. Therefore, the placebo test results show no significant bias, validating the robustness of the benchmark regression results and confirming the genuine existence of the policy effect, rather than the influence of model errors or external factors.

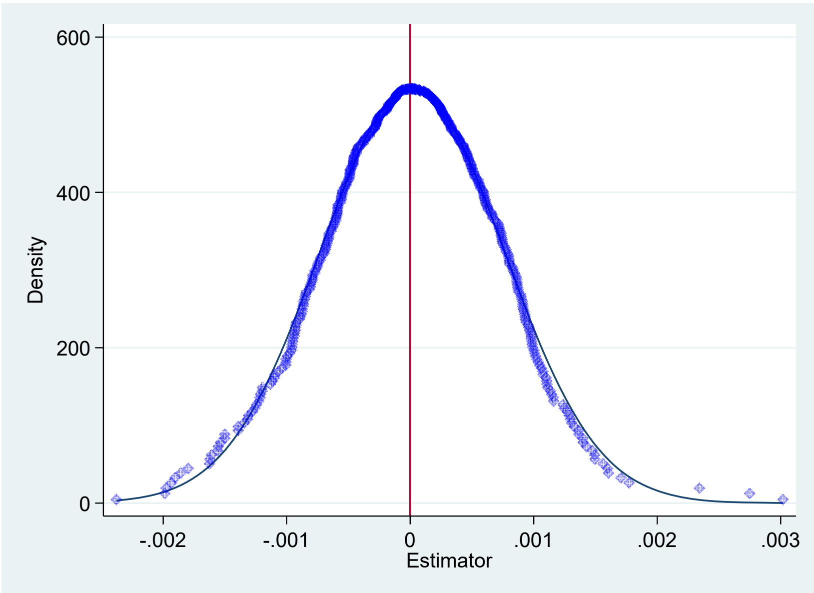

Figure 2. Illustration of the Placebo Test

5.3.2 Other Robustness Tests

(1) PSM-DID Estimation

In this study, a benchmark regression analysis was conducted using the DID method to assess the impact of the New Energy Demonstration City pilot policy on GTFP. Although the DID method can control for city fixed effects and time fixed effects, thereby addressing potential heterogeneity issues, it still has certain limitations, especially in dealing with selection bias. The DID method assumes that the treatment and control groups would have similar trends in the absence of policy intervention, an assumption that may not hold in practice and can lead to biased estimation results. Therefore, employing the propensity score matching (PSM) method can effectively address this issue. PSM matches samples with similar characteristics between the treatment and control groups, thereby reducing the impact of selection bias. Based on the matched samples, the DID method was further applied to control for time and city fixed effects, thereby enhancing the accuracy of the policy effect estimation. As shown in Table 3, in the PSM-DID model, the coefficient for GTFP remains at 0.003 and is significant (with a t-value of 3.79), and the significance test results are consistent, further validating the robustness of the benchmark regression.

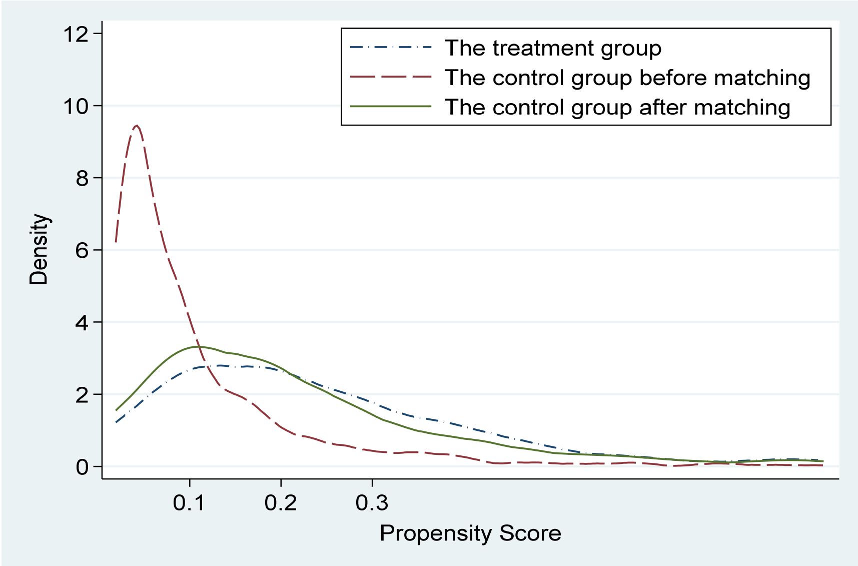

Figure 3. Illustration of Comparison Density Functions

Table 3. Robustness Test of PSM-DID

	(1) GTFP	(2) GTFP	(3) TEC	(4) TC
green	0.003***	0.003***	0.000	0.003***
	(3.79)	(4.23)	(0.16)	(3.92)
lnHRPT		-0.005*	-0.002	-0.003
		(-1.93)	(-0.78)	(-1.10)
lnGRPT		0.012***	0.008***	0.004**
		(7.21)	(4.60)	(2.29)
lnALUUC		-0.002	-0.002*	-0.000
		(-1.50)	(-1.85)	(-0.27)
lnEET		-0.009***	-0.006**	-0.003
		(-3.58)	(-2.23)	(-1.38)
lnHFT		-0.001	0.000	-0.001
		(-0.60)	(0.18)	(-1.07)
Constant	1.001***	0.965***	0.959***	1.007***
	(11653.06)	(31.66)	(29.66)	(44.09)
City Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	1883	1883	1883	1883
r2	0.168	0.186	0.142	

(2) SDID Estimation

In this study, the DID method assumes a parallel trend between the treatment and control groups, that is, the trends of the two groups should remain consistent in the absence of policy intervention. However, in some cases, the parallel trend assumption of DID may not hold, leading to biased estimation results. To overcome this limitation, this study further employs the Synthetic Difference-in-Differences (SDID) method. The SDID model addresses the issue of non-parallel trends by constructing a weighted average of the control group units. Through weighting, SDID adjusts the composition of the control group based on pre-intervention trend differences, thereby better simulating the counterfactual scenario without policy intervention and reducing the bias caused by the violation of the parallel trend assumption. As shown in Table 4, the policy's positive impact on GTFP remains significant in the SDID model, with estimated coefficients of 0.0017 and 0.0028, which are statistically significant across different regression specifications and consistent in direction with the benchmark DID model. This indicates that the SDID method effectively addresses the issue of non-parallel trends, thereby providing more robust estimates of the policy effect.

Table 4. Robustness Test of SDID

	(1) GTFP	(2) GTFP	(3) TEC	(4) TC
green	0.0017***	0.0028***	0.0010	0.0024***
	(3.15)	(3.35)	(1.30)	(3.21)
Control Variables	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	2170	2170	2170	2170

5.4. Heterogeneity Analysis

5.4.1. Urban Resource Endowment Characteristics

To further explore the impact of new energy policies on GTFP, this study conducts a heterogeneity analysis based on differences in urban resource endowments. According to the classification in relevant State Council documents (Guofa [2013] No. 45), the sample cities are divided into 129 resource-based cities and 88 non-resource-based cities, and a heterogeneity analysis of the effects of new energy policies in these two types of cities is carried out. The analysis reveals significant differences in the effects of new energy policies on GTFP, technical efficiency (TEC), and technological change (TC) between resource-based and non-resource-based cities. Specifically, the effect of new energy policies on GTFP is more pronounced in resource-based cities (with coefficients of 0.003 and 0.004, $p < 0.01$). This finding suggests that resource-based cities are more effective in achieving green technological innovation and application under the impetus of new energy policies, especially in regions with a heavy dependence on traditional energy sources, where policy implementation helps promote industrial transformation and green development. [19] In contrast, the impact of new energy policies in non-resource-based cities is relatively weaker, with limited improvement in GTFP. This may be related to the economic structure and industrial characteristics of these cities, that is, they have already made certain progress in the application of green technologies in non-resource-based industries, and the role of new energy policies has not been fully translated into an increase in production efficiency.

Based on these results, we can conclude that the differences in resource endowments and economic structures across different types of cities lead to heterogeneous effects of new energy policies. Therefore, when formulating and implementing new energy policies, it is essential to tailor measures according to the characteristics of different types of cities, adopting more precise and targeted policy measures to maximize policy benefits.

5.4.2. Urban Fiscal Pressure Characteristics

The heterogeneous analysis based on differences in urban fiscal pressure reveals significant disparities in the impact of new energy policies on GTFP, technical efficiency (TEC), and technological change (TC) between cities with strong and weak fiscal conditions. Specifically, the positive effect of new energy policies on GTFP is more pronounced in cities with greater fiscal pressure, with coefficients of 0.003 and 0.005 ($p < 0.01$). This indicates that these regions possess stronger capabilities for resource allocation and policy implementation, which effectively promote the application and innovation of green technologies and enhance green production efficiency. [20] In contrast, in cities with less fiscal pressure, the effect of new energy policies is more moderate, with a smaller increase in GTFP (coefficient of 0.002, $p < 0.05$). Moreover, the regression results of the control variables show that the positive impact of gross regional product (lnGRPT) on GTFP is significant across all types of cities and is more pronounced in regions with greater fiscal pressure. The negative impact of education expenditure (lnEET) is significant in all models, suggesting that although education expenditure enhances technical skills, its role in boosting GTFP is limited, especially in cities with less fiscal pressure. Additionally, the effects of urban land use area (lnALUUC) and highway freight traffic (lnHFT) are more complex. The former has a weaker negative impact in regions with less fiscal pressure, while the latter has almost no significant effect on GTFP.

Overall, fiscal conditions play a crucial role in the effectiveness of new energy policies. Policymakers should adjust policy strategies according to the fiscal pressure of different cities to maximize the benefits of new energy policies across various urban contexts. [21]

Table 5. Heterogeneity Regression Results—Urban Resource Endowment

	(1) GTFP	(2) TEC	(3) TC	(4) GTFP	(5) TEC	(6) TC
green	0.003***	0.000	0.002***	0.004***	0.001	0.003***
	(3.02)	(0.57)	(3.45)	(4.00)	(0.76)	(3.05)
lnHRPT	-0.006*	-0.002	-0.003	0.002	0.001	0.001
	(-1.94)	(-0.86)	(-1.22)	(0.62)	(0.30)	(0.13)
lnGRPT	0.014***	0.012***	0.002	0.015***	0.008***	0.007***
	(4.62)	(5.19)	(1.19)	(8.05)	(4.56)	(3.88)
lnALUUC	-0.002	-0.003***	0.001	-0.003*	-0.001	-0.002
	(-1.60)	(-2.83)	(1.05)	(-1.89)	(-0.70)	(-1.50)
lnEET	-0.013**	-0.011***	-0.002	-0.013***	-0.008***	-0.005***
	(-2.23)	(-3.02)	(-0.57)	(-4.54)	(-3.77)	(-2.81)
lnHFT	-0.000	0.000	-0.001	-0.001	-0.000	-0.000
	(-0.24)	(0.09)	(-0.86)	(-0.69)	(-0.50)	(-0.48)
Constant	0.985***	0.977***	1.009***	0.943***	0.978***	0.969***
	(18.30)	(21.02)	(43.42)	(23.24)	(23.69)	(31.04)
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1290	1290	1290	880	880	880
r2	0.213	0.176	0.325	0.166	0.126	0.198

Table 6. Heterogeneity Regression Results—Urban Fiscal Pressure

	(1) GTFP	(2) TEC	(3) TC	(4) GTFP	(5) TEC	(6) TC
green	0.003***	0.001	0.002**	0.005***	-0.002	0.006***
	(2.83)	(1.29)	(2.52)	(3.15)	(-1.39)	(4.47)
lnHRPT	-0.001	0.002	-0.003	-0.008	-0.001	-0.007
	(-0.19)	(0.69)	(-0.74)	(-1.18)	(-0.12)	(-0.95)
lnGRPT	0.014***	0.009***	0.005***	0.013***	0.009***	0.003
	(7.32)	(5.46)	(3.30)	(4.56)	(3.52)	(1.63)
lnALUUC	-0.002	-0.001*	-0.001	-0.002	-0.003	0.002
	(-1.53)	(-1.69)	(-0.74)	(-0.78)	(-1.29)	(0.99)
lnEET	-0.011***	-0.008***	-0.003*	-0.012***	-0.009***	-0.004
	(-4.51)	(-3.57)	(-1.75)	(-2.65)	(-3.21)	(-1.26)
lnHFT	-0.001	-0.001	-0.001	-0.000	0.000	-0.001
	(-1.52)	(-0.82)	(-1.21)	(-0.20)	(0.29)	(-0.80)
Constant	0.929***	0.942***	0.987***	1.006***	0.973***	1.037***
	(31.61)	(35.00)	(38.39)	(16.03)	(15.82)	(29.25)
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1331	1331	1331	820	820	820
r2	0.197	0.199	0.343	0.221	0.134	0.212

6. Mechanism Tests

The theoretical analysis in the preceding sections indicates that the New Energy Demonstration City policy promotes green growth in pilot cities through the transformation of household energy consumption structure and the expansion of industrial scale. Drawing on the research of Wen Zhonglin [22], we establish the following model for investigation.

$$m_{it} = \alpha_1 + \beta_1 Treat\_time_{it} + \sum_{k=1}^{K} C_{1k} X_{kit} + \delta_i + \sigma_t + \varepsilon_{it}$$

In the equation above, m_{it} denotes the mechanism variables in this study, including the transformation of household energy consumption structure (CGRU), which is represented by the consumption of household energy sources (such as coal gas and natural gas); and industrial scale expansion (NIET), which is indicated by the number of industrial enterprises.

Table 5 presents the results of the mechanism analysis of how the New Energy Demonstration City policy promotes green growth in pilot cities. In regression model (1), the transformation of household energy consumption structure (CGRU) shows a significant negative impact on GTFP (green), with a regression coefficient of -1.5721 (t-value of -1.98). This indicates that an increase in household consumption of coal gas and natural gas may lead to a decline in GTFP. This result is consistent with the relationship between energy consumption and environmental impact. An increase in household energy consumption is typically accompanied by a rise in carbon emissions, which in turn exerts a negative effect on green growth. If household energy consumption is not accompanied by an improvement in energy use efficiency, it may lead to resource waste, thereby suppressing the increase in GTFP.

This phenomenon can be explained by the Environmental Kuznets Curve theory [23] and the Resource Curse theory. [24] The former posits an inverted U-shaped relationship between environmental pollution and economic development, while the latter suggests that over-reliance on traditional energy sources may inhibit technological innovation and the application of green technologies. This finding is in line with the prediction of Hypothesis 2.

Table 7. Results of Mechanism Tests

	(1)	(2)
	CGR	NIET
green	-1.5721**	185.3245***
	(-1.98)	-3.71
lnHRPT	11.9998***	293.2640**
	-2.99	-2.04
lnGRPT	2.3009	632.0372***
	-1.07	-7.68
lnALUUC	1.3718*	-5.0777
	-1.72	(-0.16)
lnEET	0.9635	184.1062**
	-0.61	-2.23
lnHFT	-0.2581	14.5726
	(-0.51)	-0.77
Constant	-1.2e+02**	-1.4e+04***
	(-2.56)	(-7.88)
City Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
N	2112	2163
r2	0.8522	0.9754

In regression model (2), the number of industrial enterprises (NEIT) has a significant positive impact on GTFP (green), with a regression coefficient of 185.3245 (t-value of 3.71). This indicates that an increase in the number of industrial enterprises promotes the improvement of GTFP. The expansion of industrial scale helps to achieve economies of scale by optimizing the allocation of production factors, sharing environmental technologies, and reducing production costs, thereby enhancing production and environmental efficiency. Additionally, theories of technological innovation and industrial agglomeration also support this phenomenon, suggesting that a greater number of industrial enterprises promotes technological innovation and agglomeration effects, driving the research and application of green technologies, which in turn increases GTFP. [25] These results suggest that the expansion of industrial enterprises within the New Energy Demonstration City policy has a positive effect on green growth, which is in line with the prediction of Hypothesis 3.

7. Conclusions and Implications

The study employs a DID model to empirically examine the impact of the New Energy Demonstration City policy on urban green innovation vitality using panel data from 217 prefecture-level and above cities in China between 2012 and 2021, and reaches the following conclusions: ① The New Energy Demonstration City policy significantly enhances the GTFP of pilot cities, a finding that is supported by robustness tests. ②The policy positively affects GTFP by promoting the transformation of household energy consumption structure, which is consistent with the Environmental Kuznets Curve theory and the Resource Curse theory. ③By facilitating the expansion of industrial enterprises, the policy generates economies of scale, technological innovation, and agglomeration effects, thereby further boosting GTFP. ④The effectiveness of the new energy policy is significantly influenced by the resource endowments and fiscal conditions of different cities, with resource-based and fiscally strained cities benefiting more from the policy. The conclusions of this study provide important guidance for the construction and policy promotion of New Energy Demonstration Cities, especially in enhancing urban green innovation vitality. The policy implications are mainly reflected in the following aspects.

(1) Expanding the Scope of New Energy Demonstration Cities and Summarizing Experiences

In the construction of New Energy Demonstration Cities, it is essential to summarize the experiences of existing cities, identify successful policy measures and practice models, and form replicable cases that can be promoted to more cities with corresponding conditions. This will help drive the transformation of urban energy structures and enhance the level of ecological civilization. By establishing interconnected and shared regional cooperation models, not only can interactions in green technological innovation be promoted among cities, but also green industrial chains and innovation platforms can be formed, further promoting the popularization and application of new energy technologies. Layered management of different regions should be implemented, gradually expanding the pilot scope of demonstration cities, while strengthening cross-city cooperation and resource sharing to ensure the maximized effect of the demonstration city policy nationwide.

(2) Tailoring Differentiated Policy Combinations According to Local Conditions

Considering the differences in resource endowments, geographical locations, and innovation foundations among cities, the New Energy Demonstration City policy should adopt differentiated development strategies tailored to local conditions. Resource-based cities should focus on promoting a shift in energy consumption concepts and driving the innovation and application of green technologies through stricter policy measures. Cities with a better innovation foundation should promote green technological innovation and industrialization through market-oriented policy combinations. In the eastern region, efforts should be made to increase self-sufficiency in the new energy industry, reduce dependence on traditional resources, and promote the agglomeration of green high-tech industries. The central region should focus on cultivating green and low-carbon awareness, attracting green technology talents, and enhancing the level of high-quality economic development. The western region can leverage its natural resource advantages to attract the transfer of green and low-carbon industries, enhance local new energy absorption capacity, and promote the localization of the new energy industry through fiscal support policies.

(3) Promoting Green Industrial Agglomeration and Technological Innovation to Enhance Industrial Chain Synergy

The New Energy Demonstration City policy has driven green technological innovation and industrial agglomeration effects by promoting the expansion of industrial enterprises, thereby not only improving GTFP but also accelerating the development of green industries. To further strengthen this effect, the construction of green industrial clusters should be prioritized, integrating upstream and downstream resources of the industrial chain to enhance technological innovation and market competitiveness. The government should encourage cooperation among enterprises, especially in green technology research and the industrialization of new energy, to promote the market-oriented application and industrial upgrading of green technologies. This process should also be combined with local characteristics to build new energy projects with local advantages, driving technological innovation and the scaled development of green industries.

(4) Strengthening Green Financial Support to Promote Financing and Development of New Energy Projects

The New Energy Demonstration City policy has provided strong support for green technological innovation and industrial transformation. The government can provide special green fiscal subsidies to support local governments and enterprises in implementing green projects, thereby alleviating the fiscal pressure on local governments. Meanwhile, green financing instruments such as green bonds and green credit can help local governments and enterprises obtain the necessary funds to promote the construction of green infrastructure. In addition, strengthening cooperation between local governments and social capital can enhance the policy implementation capacity of weaker regions, ensuring the effective implementation of new energy policies and the improvement of GTFP.

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