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Renewable Energy Consumption: Does It Matter for China's Sustainable Development?

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Abstract: In China, one of the most pressing issues that have to be addressed is how to best manage the link between energy consumption and sustainable development. Given this context, the goal of the current article is to investigate the effect of renewable energy consumption on sustainable development. Using provincial panel data from 2005 to 2020 and the province and year fixed effects model for an empirical study, we discover that renewable energy consumption has a favorable impact on sustainable development. Similarly, the findings suggest the influence of non-renewable energy consumption on sustainable development is weaker than that of renewable energy consumption. Moreover, the heterogeneity of the influence of renewable energy consumption and nonrenewable energy consumption on sustainable development in eastern, central, and western China has been demonstrated as well. Notably, the two-stage least squares approach and generalized system method of moments are utilized to examine the robustness of this issue, and the reliability and robustness of the conclusions presented in this study are also confirmed. To sum up, the results in this article provide more evidence that the use of energy is an important contributor to achieving sustainable development in China and realizing the target set for sustainable development in 2030.

Keywords: renewable energy consumption; nonrenewable energy consumption; sustainable development; province and year fixed effects model; two stage least squares approach; system generalized method of moments

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1. Introduction

The need for energy is increasing as the energy crisis and environmental degradation worsens. Increasing numbers of countries are strengthening the production and exploitation of renewable energy, reaping substantial social, economic, and environmental advantages. Despite China's fast-growing economy, there has been a mismatch between the supply and demand of conventional energy. As a result, China's future sustainable energy growth must inevitably include the strong development of renewable energy sources. Furthermore, it has been recognized that the most critical part is the fact that renewable energy has an advantage in terms of its solid path, which is incomparably superior. In fact, China is abounding in sources of renewable energy and has massive unmet market demand potential. The price gap between renewable energy and conventional energy is increasingly being closed because of the ongoing development of technological conditions and the incorporation of "green costs".

In fact, China has an abundance of sources of renewable energy. Specifically, the National Energy Administration of China in 2020 reported that the wind energy resources that can be developed and exploited are worth billions of kilowatts. More than two-thirds of China's area is characterized by favorable circumstances for solar energy usage. The average annual sunlight time in the northwest and Qinghai-Tibet Plateau is over 2000 h; the renewable energy of biomass energy resources is around 100 million tons of standard coal transformed by heat; and China also has vast geothermal resources with favorable

storage conditions. The thermal reserves of more than 40 discovered geothermal resources are equal to 100 million tons of standard coal, while the potential reserves amount to 135.4 billion tons of standard coal. The Chinese mainland's coastline stretches for over km, including over 6500 islands. The ocean area exceeds 4.7 million square kilometers, and the ocean's energy resources are around one billion kilowatts, of which 100 million kilowatts can be derived from tidal energy and 100 million kilowatts from wave and current energy. Consequently, given its significance as a substantial alternative source of energy, renewable energy will play a significant role in the future supply of energy. The investigation of alternative forms of energy has a wide-ranging and far-reaching impact on China's efforts to achieve sustainable development.

In light of what has been covered up to this point, the purpose of the present article is to investigate the consequences of sustainable development for both the consumption of renewable energy sources and the use of nonrenewable energy sources. In an empirical analysis using provincial panel data from 2005 to 2020 and the province and year fixed effects model, we demonstrate that renewable energy consumption has a positive influence on sustainable development. In a similar vein, the results indicate that the effect of the consumption of non-renewable energy on sustainable development is likely to be less significant than that of the use of renewable energy. Furthermore, it has been established that the effect of using renewable energy versus nonrenewable energy on sustainable development varies greatly across eastern, central, and western China. In order to investigate the resilience of this problem, the two-stage least squares technique and system GMM are used in particular. Additionally, the reliability and robustness of the results that are offered in this work are also proven.

This work makes three separate contributions to the growth of the current body of knowledge, all of which are based on the results that were presented above in the article. (1) According to an examination of the current literature in China about the influence of renewable energy consumption on sustainable development, few academics have examined adjusted net savings as a proxy for sustainable development. This article may contribute to the advancement of research on this topic. (2) The contribution of renewable energy consumption to the expansion of sustainable practices is much larger than that of nonrenewable energy sources. (3) It has been noted that the influence of renewable energy on sustainable development varies significantly across eastern, central, and western areas.

In light of this, the remaining parts of this work are structured as follows: The literature review is presented in Section 2, variable descriptions and model specifications are provided in Section 3, results and discussions are presented in Section 4, and Section 5 gives a summary of the whole article.

2. Literature Review

Energy and sustainable development are hot frontier subjects that have grabbed the attention of many researchers who desire to investigate them. The goal of this section is to investigate the link between energy and sustainable development in terms of samples, techniques, time spans, and other relevant factors and to provide a theoretical and objective foundation for this article.

As a result of its growing industrialization and urbanization, China has become the world's largest energy user and carbon dioxide emitter. Renewable energy is an excellent alternative to depleting fossil fuels since it is an energy source that produces less pollution and less carbon dioxide. In contrast to the majority of current investigations, such as Adenle [1], Yadav et al. [2], Oh et al. [3], and Atabi [4], which primarily outline the challenges associated with policy initiatives and technologies surrounding renewable energy or conduct various instances for a particular type of renewable energy, Bao and Fang [5] investigated the geographic disparity and continuity between the main renewable energies and their significant, influential indicators in China. They discovered that China's sustainable development is greatly aided by the use of renewable energy. In comparison

to the pre-industrial period, the modern era confronts more severe challenges from global warming. Efforts to address these environmental problems have increased requests for pro-green legislative initiatives, renewable energy and green finance in particular. As a result, Ibrahim et al. [6] investigated the influence of renewable energy, green financing, technical innovation, and economic complexity on sustainable development in China, as measured by sustainable economic growth and carbon neutrality. Their investigation was predicated on yearly time series data spanning the years 1996 to 2018, with estimates provided by an autoregressive distributed lag model. They demonstrated that renewable energy and technical breakthroughs were essential components whose participation was not insignificant if the other factors were to produce desired and consistent growth and environmental consequences that fostered sustainable development. As a matter of fact, sustainable development has evolved into a worldwide demand as a result of the volatility of the environment all over the globe, which has received a lot of attention from academics and politicians. In incorporating green finance, Zhou and Li [7] investigated the impact that renewable energy sources such as wind power, biofuels, solar power, and hydropower had upon China's efforts to achieve sustainable development. Using data from 1986 to 2019 and the autoregressive distributed lag model for conducting an empirical inquiry, it was discovered that renewable energy sources and green finance in China had a positive relationship with sustainable development and a negative relationship with carbon emissions. Moreover, Bojnec and Papler [8], Oyedepo [9], Ahmed, et al. [10], and Kaygusuz [11] acknowledged the validity of these results.

The rebounding impact generated by technological advancement is well acknowledged. Few investigations, such as Midilli and Dincer [12], Riti et al. [13], Li and Lu [14], and Taghvaee et al. [15] have quantified and contrasted the reverse causality of fossil and non-fossil energy independently since fossil and non-fossil energy use have distinct implications on sustainable development. Using data envelopment analysis—the Malmquist index, the logarithmic mean Divisia index, and Jacobian matrix methods, Chen et al. [16] estimated and compared the rebound impacts of China's fossil and non-fossil energy sources from 2006 to 2014. They came to the conclusion that non-fossil sources of energy had a greater rebound impact than fossil fuel sources of energy when it came to sustainable development. In a similar vein, Paramati et al. [17] investigated the link between the use of renewable and non-renewable energy sources and sustainable development using annual data spanning from 1980 to 2012 on 17 countries that are members of the G20 (an intergovernmental forum comprising 19 countries and the European Union). They came to the same result regardless of whether they used cross-sectional dependency and heterogeneity in the study. In addition, Adebayo et al. [18] utilized the autoregressive distributed lag approach, dynamic ordinary least squares, and fully modified ordinary least squares to examine the use of coal energy and renewable energy for the purpose of sustainable development in South Africa from 1980 to 2017. They discovered that South Africa's energy consumption was shifting away from the use of coal and toward the consumption of energy that comes from renewable sources in order to achieve sustainable development. In the meantime, Long et al. [19] conducted studies on this subject in China from 1952 to 2012 using the Granger causality test. They discovered that carbon emissions, as a significant contributing component, made it more difficult to achieve sustainable development. Furthermore, Solarin [20], Oyedepo [21], Adeli, et al. [22], and Zhang et al. [23] recognized the validity of these findings.

On the basis of the literature review that was just given, the gaps between this study and the literature that was documented before having evolved in three distinct ways. First, few academics have used adjusted net savings as a proxy for sustainable development, according to a review of the existing literature in China on the effect of renewable energy consumption on sustainable development. Second, when measured against the effect of using nonrenewable energy sources, the contribution that the use of renewable energy makes toward the advancement of sustainable practices is far more important. Third, it

has been shown that the influence of renewable energy on sustainable development varies significantly across eastern, central, and western areas.

3. Variable Description and Model Specification

3.1. Variable Description

Dependent variable: The principle of sustainable development refers to growth that not only satisfies the requirements of present people but also does not compromise future generations' capacity to fulfill their own needs. When looking at previous studies, various researchers and academics have settled on a variety of distinct criteria to symbolize sustainable development. For example, Ridzuan et al. [24] achieved sustainable development by focusing on economic growth, income distribution, and the condition of the environment. Yumashev et al. [25] and He and Wang [26] utilized the human development index as an indicator of the level of sustainable development. The adjusted net savings were utilized by Rahman et al. [27] and Wu et al. [28] as a measure of sustainable development. This article adopts adjusted net savings as a proxy variable for sustainable development based on a complete evaluation. The following are some of the reasons why we decided to go with option-adjusted net savings as our proxy variable for sustainable development. In previous studies examining the link between renewable energy and sustainable development, the gross domestic product was employed as the sustainable development index. Meanwhile, the majority of scholarly investigations in this domain applies real gross domestic product per capita to assess development. Academics, on the other hand, believe that development is linked to the sustainable development of human welfare. Since gross domestic product per capita develops as a flow variable, it is commonly agreed that it is not a suitable criterion for sustained improvement in human well-being. In order to put it another way, gross domestic product measures the value of the products and services generated by the economy in a given year relative to the pricing of those commodities and services on the market. This flow, or, in other words, the gross domestic product, may be increased in an economy by making use of capital stocks for a given amount of time, such as reserves of non-renewable resources or human capital. Nevertheless, due to the reduction in capital stocks that occurs as a direct result of usage, the gross domestic product will be lower in the future as a consequence of this. As a result, Bentzen [29] argued that an increase in gross domestic product growth rates over a specific time period was likely to equate to a reduction in the future extent of social welfare once the effects on future generations were considered. To summarize, adjusted net saving is a more effective metric of sustainable development than gross domestic product. The gross national savings may be calculated by taking the gross savings and subtracting from them the proportion of the generated capital that is allocated to depreciation. Adjusted net saving is the difference between national net saving and adjusted net saving when the public authority's expenditures for education are subtracted from the decline in the natural capital's revenue resulting from its use and the release of carbon dioxide.

Following Atkinson and Hamilton [30] and Arrow et al. [31], the adjusted net savings can be obtained from the gross national savings by having four adjustments that exemplify the substitute of investment on the made advancements of the economy or pondering the return on investment. This is accomplished so that the adjusted net savings can be calculated from the gross national savings. The first modification is a subtraction from an assessment of the fixed capital consumption in order to account for the produced capital's amortization. This relates to the capital's substitution value that is spent during production. The second modification is concerned with evaluating the investments that contributed to human capital and applying this estimate to human capital. This is represented by public expenditures on education. The third modification addresses the societal burden that comes with polluting the environment and is broken down into two distinct sections. One section is to measure the global warming costs. This article estimates the social cost of carbon dioxide emissions and subtracts it from national savings, assuming a US$30 social cost per ton of carbon. The other section is to calculate local environmental disturbances.

The World Bank subtracts national savings from health costs from urban air pollution. The fourth modification made to the adjusted net savings takes into account the investment return or the investment made in the productive foundation of the economy, both of which are connected to the environmental variables. As for this point, the net national savings are reduced by the number of energy sources, net forest, and minerals residues used during manufacturing. During this step, the rents of the sources that are pertinent are calculated and determined in order to complete the procedure. Because of this, the adjusted net savings take into account the negative effects that carbon emissions have on the environment as well as on society.

Independent variable: Solar, wind, tidal, geothermal, water, and biogas are all examples of renewable energy that may be harvested from the environment. One can never use it all up. There is no need to manually replenish the infinite supply of energy. When compared to infinite energy, it is a subset of the latter. Following He and Zhang [32], He and Huang [33], He et al. [34], He [35], and He and Zhang [36], renewable energy consumption is used as an independent variable in this article.

Control variable: In fact, sustainable development may also be impacted in a variety of different ways by many other issues. For this reason, this work makes reference to the reputable body of previous studies and also augments the model with a few pertinent control variables. Following Yang et al. [37], Fang et al. [38], and Zhang et al. [39], urbanization is introduced in this article. Following Guang-Wen et al. [40], Ali et al. [41], and Ahmad et al. [42], non-renewable energy consumption is introduced in this article. Following Li et al. [43], Wang et al. [44], and Ma et al. [45], infrastructure is introduced in this article.

Moreover, the China Bureau of Statistics and the statistics yearbooks of each province in China provide all of the data that are utilized in this study. The fundamental information about these investigated variables is presented in Table 1, with the goal of assisting readers in developing a more intuitive understanding of these variables.

Table 1. Variable description.

Variable	Form	Definition
Sustainable development	sus	Ratio of adjusted net savings to gross domestic product
Renewable energy consumption	new	hydro-power generation (100 million kilowatt hours) in log
Urbanization	urb	Ratio of urban population to total population
Nonrenewable energy consumption	non	Thermal power generation (100 million kilowatt hours) in log
Infrastructure	inf	Road mileage (km) in log

3.2. Model Specification

In order to investigate the effect of renewable energy consumption on sustainable development, a baseline model is constructed as following shows.

$$sus_{i,t} = a_0 + a_1 new_{i,t} + a_2 non_{i,t} + a_3 urb_{i,t} + a_4 inf_{i,t} + \mu_t + \eta_i + \epsilon_{i,t}, \quad (1)$$

where i denotes the province; t denotes the year; a_0 denotes the constant; $[a_1, a_4]$ denote the estimated coefficients; μ denotes the year-fixed effect; η denotes the province-fixed effect; ϵ denotes the error term.

Moreover, the robustness test is carried out in order to ensure that the estimated findings can be relied upon. Following He and Zhang [32], the system generalized method of moments is employed in this article. The basic form is shown as follows:

$$sus_{i,t} = b_0 + \sum_{i=1}^{n} b_i sus_{i,t-1} + \sum_{j=1}^{m} b_j cv_{i,t} + \epsilon_{i,t}, \quad (2)$$

where b_0 denotes the constant; n and m denote maximum lagged periods; [b_i,b_j] denote estimated coefficients; cv denotes control variables, including renewable energy consumption, urbanization, nonrenewable energy consumption, and infrastructure.

4. Findings and Discussion

4.1. Basic Statistics Description

This subsection's objectives are to investigate the fundamental facts pertaining to the highlighted variables and to provide a statistical groundwork for the subsequent empirical study that will follow. Specifically, the correlation test and unit root test are given substantial consideration. Tables 2 and 3 display the findings.

Table 2. Results of unit root test.

Variable	ADF Test	PP Test
sus	−5.722 ***	−5.111 ***
new	−3.517 ***	−3.680 ***
non	−4.017 ***	−3.819 ***
inf	−3.783 ***	−5.836 ***
urb	−5.043 ***	−5.190 ***

Note: *** a 1% significant level; ADF test denotes Augmented Dickey–Fuller test (ADF) test; PP test denotes Phillips–Perron test.

Table 3. Results of correlation test.

Variable	sus	new	non	inf	urb
sus	1.000				
	(—-)				
new	0.262 ***	1.000			
	(7.586)	(—-)			
non	0.261 ***	−0.196	1.000		
	(7.563)	(−1.081)	(—-)		
inf	0.225 ***	0.106 ***	−0.159 ***	1.000	
	(6.469)	(2.982)	(−4.509)	(—-)	
urb	0.278 ***	−0.495 *	0.412	−0.106 ***	1.000
	(8.092)	(−1.589)	(1.262)	(−2.987)	(—-)

Note: * a 10% significant level; *** a 1% significant level; *t*-value shown in the parenthesis.

The findings of the unit root tests, which include the ADF and PP tests, are shown in Table 2. It has been discovered that each of the five variables under investigation is stationary at its own level. Then, the correlation test is conducted. The results are shown in Table 3. It is possible, in the broadest sense, to draw the conclusion that there is a positive association between renewable energy consumption and sustainable development. In the meantime, the primary conclusion that can be drawn is that infrastructure, urbanization, and nonrenewable energy consumption are all positively correlated with sustainable development.

4.2. Effect of Renewable Energy Consumption on Sustainable Development

In this subsection, our purpose is to investigate the effect of renewable energy consumption on sustainable development. This article employs the year and province-fixed effects model to investigate this subject since the individual characteristic variables that do not change with time and the time characteristic variables that do not change with provinces both have the potential to have an influence on the findings of our estimations. Meanwhile, the reasonableness of our approach is further supported by the reputable body of academic literature, such as Swain and Karimu [46] and Brazovskaia et al. [47], as well as the result of the Hausman test. The results are shown in Table 4.

Table 4. Results of the effect of renewable energy consumption on sustainable development.

Variable and Model	Province and Year-Fixed Effects
new	0.147 ***
	(2.851)
non	0.042 *
	(1.716)
inf	0.153 ***
	(3.481)
urb	0.351 ***
	(7.675)
c	−0.154
	(−1.614)
R2	0.761
Hausman test	89.956 ***

Note: * a 10% significant level; *** a 1% significant level; c constant; *t*-value shown in the parenthesis.

It has been determined, on the basis of the findings that are shown in Table 4, that the use of renewable sources of energy has a beneficial impact on the process of achieving sustainable development. In a similar vein, it has been discovered that the use of nonrenewable energy sources has a beneficial impact on the process of sustainable development. However, the impact of this is far smaller than that caused by the usage of renewable energy. It is probable that these findings might be explained by the fact that, in China, after the reform and opening up, the economy of China has truly climbed to the position of the second largest economy in the world by relying on the significant use of energy sources that are not renewable. However, the fast expansion of the economy will also bring with it significant issues for the environment. When the natural environment is no longer able to support the level of economic growth that is being pursued, sustainable development will come to a halt at some point in the foreseeable future. If this is the case, the strain that the model of economic development that is geared toward renewable energy consumption has on the environment will be manageable. As a consequence, we may conclude that this outcome is realistic and consistent with the current state of affairs in China. In addition to that, these results are affirmed by Zhang et al. [48]. Moreover, the findings indicate that infrastructure favorably influences sustainable development. It is intuitive that infrastructure facilitates sustainable development in China. Meanwhile, Thacker et al. [49], Morozova et al. [50], Merry [51], Yang et al. [52], and Mahmood et al. [53] maintain the same viewpoint. In addition, it has been shown that urbanization has a favorable impact on the process of sustainable development. Furthermore, this finding is supported by Xu et al. [54], Zhang et al. [55], and Liu et al. [56].

4.3. Robustness Test

Because the findings of this article might possibly be influenced by other factors that were not taken into consideration, this could result in endogenous issues and cause our findings to be biased. Similarly, the influence of sustainable development on the usage of renewable sources of energy will also bring up endogenous issues. Therefore, in light of the aforementioned two reasons, it is required to conduct robustness tests in order to ensure the robustness and reliability of the findings included in this work. Following Tiba and Belaid [57], Adebayo et al. [18] (2021), and Alsaleh et al. [58], both generalized systems moments of method and two-stage least squares are used to reexamine the effect of renewable energy consumption on sustainable development. The results are shown in Table 5.

Table 5. Results of robustness test.

Variable and Method	Two Stage Least Squares	System-GMM
sus		0.889 ***
		(4.245)
new	0.318 ***	0.219 ***
	(4.515)	(4.503)
non	0.189 ***	0.136 ***
	(5.853)	(4.936)
inf	0.099 ***	0.013 *
	(9.681)	(1.901)
urb	0.222 ***	0.124 ***
	(7.068)	(3.824)
c	−0.121	0.061
	(−1.416)	(1.162)
Anderson canon. LM test	79.614 ***	
Sargan test	1.047	
Cragg-Donald Wald F test [59]	36.291 ***	
Hausman	192.813 ***	
AR(1)		−3.519 ***
AR(2)		1.540
Hansen J-test		8.231
Diff-in-Hansen test		1.036

Note: *** a 1% significant level; * a 10% significant level c constant; *t*-value shown in the parenthesis; instrumental variable lags of these variables [60].

It has been discovered, as the findings in Table 5 demonstrate, that both the consumption of renewable energy and the use of nonrenewable energy has a favorable impact on sustainable development. In a similar vein, infrastructure and urbanization both have a favorable impact on the process of sustainable development. These findings are in agreement with the results that are shown in Table 4. As a consequence, it is possible to deduce that the findings that are shown in Table 4 are trustworthy and dependable.

4.4. Heterogeneity Analysis

The eastern, central, and western areas of China each have major differences in all aspects due to historical considerations, factors related to the geographical environment, factors related to the distribution of the people, factors related to policy, and circumstances related to transportation. Therefore, to better precisely assess the influence that renewable energy consumption has on sustainable development, we separated China into three areas, including the eastern area, the central area, and the western area, in order to fully evaluate this topic. The results are shown in Table 6.

According to the findings shown in Table 6, we may draw the conclusion that the consumption of renewable energy contributes the most to sustainable development in the western area, while it contributes the least to the eastern area. Due to the area's high topography, a large number of hydropower plants may have been constructed in the western region. The concept of economic development based on renewable energy is more evident in the western area. Then, the central and eastern areas are rather flat, and the economic development model based on renewable energy is less apparent in the central and eastern regions. It is thus logical for us to reach this conclusion, which also corresponds with the real situation in China. Similarly, we have come to the conclusion that the use of nonrenewable sources of energy plays a more important role in achieving sustainable development in the eastern area than it does in the central or western areas. It is conceivable that this is due to the fact that the majority of China's heavy industry is located in the eastern area, and the growth of heavy industry requires the use of a significant amount of fossil energy. Since China's reform and opening began, the national strategy has been to develop the east first. As a result, the majority of the country's energy consumption is focused on the eastern region. As a result, it is consistent with the reality of China that

the eastern area's contribution of non-renewable energy to sustainable development is greater than that of the central and western areas. As a result, we are able to reach the conclusion that the influence that the consumption of renewable energy has on the progress of sustainable development in the eastern, central, and western areas of China is notably different from one another.

Table 6. Results of heterogeneity analysis.

Variable and Model	Eastern Area	Central Area	Western Area
new	0.156 ***	0.159 **	0.181 ***
	(4.309)	(2.305)	(5.150)
non	0.092 ***	0.069 ***	0.010 *
	(2.765)	(3.702)	(1.877)
inf	0.547 ***	0.446 ***	0.717
	(3.931)	(4.338)	(0.115)
urb	0.057	0.030	0.021 ***
	(0.163)	(1.120)	(7.469)
c	0.721 **	−0.718 ***	−0.500 ***
	(2.050)	(−3.917)	(−3.461)
Year-fixed effect	yes	yes	yes
Province-fixed effect	yes	yes	yes
Hausman test	267.464 ***	15.873 ***	50.770 ***
R^2	0.475	0.437	0.402

Note: *** a 10% significant level; * a 10% significant level; c constant.

5. Conclusions

The increased demand for energy is a result of the intensifying energy crisis and environmental damage. China has started to increase the development and exploitation of renewable energy sources in an effort to achieve sustainable development. Therefore, this article examines the effect of renewable energy consumption on sustainable development using China as a case study. Using the year and province fixed effects model for empirical study. The conclusions are drawn as follows: (1) The use of both renewable and nonrenewable energy has a favorable impact on sustainable development. Furthermore, the influence of the consumption of renewable energy on sustainable development is greater than that of the use of nonrenewable energy. In the meantime, the findings of the robustness test demonstrate that the article's conclusions are solid and reliable. (2) There is heterogeneity between the eastern, central, and western regions in terms of the impact of renewable energy consumption on sustainable development. (3) Sustainable development is affected by both urbanization and infrastructure.

In light of the results that are presented in this article, several policy implications are provided. First, because renewable energy consumption has a positive impact on sustainable development, the Chinese government should make every effort to develop renewable energy to achieve sustainable development. Second, due to the greater influence of the consumption of renewable energy on sustainable development than that of the use of nonrenewable energy, the Chinese government should devote considerable resources to researching nonrenewable energy alternatives. Third, since the influence of renewable energy on sustainable development in China's eastern, central, and western regions is heterogeneous, the Chinese government should pay greater attention to the balanced growth of these three regions in order to achieve sustainable development across the whole of China.

In addition, the findings of this paper contribute to the expansion of the existing body of knowledge in three distinct ways. First, as a result of evaluating the current literature in China that is connected to the influence that the consumption of renewable energy has on sustainable development, it was discovered that few academics have utilized adjusted net savings as a proxy for sustainable development. This article may contribute to the advancement of research in this field. Second, when compared to the impact of using nonrenewable energy sources, the

contribution that renewable energy consumption makes to the advancement of sustainable practices is far more significant. Third, it has been discovered that there is a significant amount of variation between the eastern, central, and western areas in regard to the effect that the use of renewable energy has on sustainable development.

Obviously, this article has several limitations and future directions. First, in this article, the sole proxy for sustainable development that is used is the adjusted net savings; however, in the future, researchers may utilize additional proxy variables for sustainable development, which may yield findings that are more intriguing. Second, this study exclusively employs the province and year-fixed effects model in order to conduct its investigation into the relationship between the use of renewable energy and sustainable development. Future researchers may employ spatial econometric models to investigate this topic due to the heterogeneity of this topic in the eastern, western, and central areas of China. This may lead to more trustworthy conclusions. Third, regarding the control variables, it is possible that this study does not take into consideration all of the factors that have the potential to affect the estimated findings of this study. By including control variables in their research, future researchers will be able to replicate the reliability of the findings presented in this work. Fourth, concerning the choice of samples, this study solely chose China as the target of the investigation. Based on the findings of this work, future researchers may consider other countries, such as Vietnam and the Philippines, as research objects to further investigate this issue, which may lead to unexpected outcomes.

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