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ARTICLE

The Non-Linear Effect of China's Energy Consumption on Eco-Environment Pollution

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ABSTRACT

With the increase of total energy consumption, eco-environmental quality drops sharply, which has attracted concerns from all circles. It has become the top priority of construction of socialist ecological civilization to clarify the influences of energy consumption on the level of eco-environmental pollution. Ecological environmental pollution control cannot be one size fits all. It can avoid resource depletion and environmental deterioration via adjusting measures to local conditions to coordinate ecological environmental pollution and energy consumption problems. In this essay, entropy method is adopted to measure the composite indexes of eco-environmental pollution of 30 provinces and cities in China, based on which kernel density function is used to analyze the dynamic law of eco-environmental pollution. And then, traditional fixed effect model and panel quantile regression model are adopted respectively to analyze the influences of energy consumption on eco-environmental pollution. The research finds that composite index of eco-environmental pollution shows N-shaped curve of "rising-dropping-rising" during the sample period, with the overall difference decreasing gradually and the polarization disappearing gradually; in areas with higher eco-environmental pollution, energy consumption has aggravated eco-environmental pollution, while in areas with lower eco-environmental pollution, energy consumption could alleviate eco-environmental pollution to some degree; foreign direct investment could relieve eco-environmental pollution. Therefore, corresponding measures should be taken to improve the quality of eco-environment based on the changes of energy consumption in areas with different levels of eco-environmental pollution.

KEYWORDS

Kernel density function; quantile regression model; eco-environmental pollution; energy consumption

1 Introduction

What lies behind the rapid development of science and technology is the energy issue. As the material basis for human survival and social development, energy is related to sound development of production as well as peaceful and happy life of human beings. For over 40 years after China implemented the reform policy, the economy of China has achieved great achievements, to which energy consumption has contributed a lot. According to the report of China Statistical Yearbook, In 1978, total consumption of China' energy consumption was 57,144 tons of standard coal and in 2018, it was 4.6 billion tons of standard coal, in which 22.1% was clean energy, ranking the top in the world. However, while China enjoying the benefits brought by energy, its eco-environmental quality is also impacted greatly. On one hand, coal, oil and other polluting energies are consumed in large amount, which could easily cause resource depletion and deterioration of the eco-environment, for such energies could give off carbon dioxide, nitrogen oxide and other pollutants in use, and clean energy is used less. On the other hand, green technology is still undeveloped with low popularity. In view of this, it is especially important to know of the latest condition of eco-environmental protection both at home and abroad and to control eco-environmental pollution under the condition when energy consumption keeps increasing, which has attracted great concerns from the governmental departments and the academic circle. China has put forward to reduce excessive consumption of energy resources and defined clearly the objective of energy saving and emission reduction in the thirteenth five-year plan, that is, unit GDP energy consumption should be lowered 16%. The central and local governments have adopted a series of energy-saving and emission-reduction measures to alleviate the conflicts between eco-environment pollution and high-quality economic development.

It has been a long time to study the relations between energy consumption and eco-environmental pollution. Pei [1] with USA as the research object, found out that transformation of energy structure had caused new changes of the types of air pollutants, that popularization of energy service and increase of the consumption scale could enlarge the geographical scope of air pollution and that the energy efficiency depended on heavily on the evolution of degree of air pollution. Zhao et al. [2] considered that energy intensity could promote the emission of polluting gases in China, showing a feature of "inverted N-shape". Tsurumi et al. [3] taking sulfur dioxide, carbon dioxide and the amount of energy usage as the research objects, confirmed the rationality of EKC curve. Through studies, Zhang et al. [4] considered that the total factor energy efficiency had significant negative impact on haze pollution as well as significant spatial spillover effect, indicating that the improvement of total factor energy efficiency not only could significantly reduce the level of haze pollution in the region, but also had significant negative impact on haze pollution in the surrounding areas. Ma et al. [5] and Dong [6] studied the influences of energy on haze pollution from the perspective of energy structure respectively. Leng et al. [7] studied the influences of energy on haze pollution from the point of energy price. Ma et al. [8] considered that discharge of industrial solid wastes was the reason for energy consumption and that energy consumption showed various causalities in the case of emission of heterogeneous pollutants. Poon et al. [9] studied the influences of China's energy consumption on the emission of sulfur dioxide and soot particulate. According to Bilgen [10], the structure of energy consumption could cause emission of sulfied, nitrogen oxides, carbon dioxide and other pollutants, which could in turn cause the changes of the global climate. Li et al. [11] adopted computable general equilibrium (CGE) model to analyze the relations between energy efficiency and environment quality and it was found from the results that the environment quality could not be improved only by improving energy efficiency. Zhou et al. [12] thought that haze pollution was much more severe in areas with higher energy consumption level. Yao [13] studied the influences of energy consumption on the atmospheric environment in Xinjiang. Zhou et al. [14] Established a regression model to study the relationship between energy consumption and regional environmental pollution. Wang et al. [15] believed that the quality of energy consumption inhibited haze pollution, and the consumption scale promoted energy consumption.

In summary, although there are abundant research results related to the relations between energy and eco-environment pollution, some limitations still exist. In fact, energy consumption is a double-edged sword, and the linear relationship cannot fully reflect the relationship between the two. Moreover, the ecological environment is considered from the perspective of single air pollution, and other ecological environmental pollution such as solid waste and wastewater pollution are not considered. In fact, energy will bring waste water, waste water and other ecological environment pollution in the process of production and consumption Waste gas and solid waste pollution. Therefore, this paper takes waste water, waste gas and solid into account in the calculation of Eco-environmental pollution index, and then studies the relationship between different ecological environmental pollution levels and energy environment.

Therefore, this essay adopts entropy method to measure the eco-environmental pollution level of 30 provinces and cities in China and uses non-parametric kernel density method to estimate the evolution features of the eco-environment pollution in China, and then based on the panel data of 2004 to 2017, the panel quantile regression model is adopted to estimate the relations between energy consumption and eco-environment pollution, and suggestions are raised based on the analysis results.

2 Model Setup, Indicator Selection and Data Source

2.1 Non-Parametric Kernel Density Model

Kernel density function is one of the non-parametric estimation methods. Its basic principle is to assume random variables X1, X2, … , XN is independent and its empirical distribution function is:

$$F_N(x) = \frac{1}{N}\sum_{i=1}^{N} I(X_i \le x) \tag{1}$$

In Eq. (1), N represents the number of observation points, $I(x)$ is the exemplary function, that is, when x is true, $I(x) = 1$, otherwise $I(x) = 0$. Kernel density estimation is:

$$\begin{aligned} f(x) &= [F_N(x+h) - F_N(x-h)]/2h = \frac{1}{2h}\left[\frac{1}{N}\sum_{i=1}^{N} I(x-h \le X_i \le x+h)\right] \\ &= \frac{1}{h}\frac{1}{N}\sum_{i=1}^{N}\left[\frac{1}{2}I\left(-1 \le \frac{x-X_i}{h} \le 1\right)\right] = \frac{1}{Nh}\sum_{i=1}^{N} K\left(\frac{X_i - x}{h}\right) \end{aligned} \tag{2}$$

In Eq. (2), h is the broadband, $K(\cdot)$ is the Kernel function. Besides satisfying the nature of general continuous density function, it also satisfies $K(-x) = K(x)$; $\sup K(x) < +\infty$; $\int_{-\infty}^{+\infty} K^2(s)dx < +\infty$, in which X_i is the sample observation and x is the mean value.

2.2 Quantile Regression Model

When the data complies to parametric empirical distribution, it is better to adopt the traditional least square method; however, if the data are special, it is not so rational to adopt least square method. Panel quantile regression was based on the theory of "quantile regression" raised by Koenker et al. [16], which could not be affected by the abnormal value of the sample data. Its principle is to study the relations between the explaining variable and the explained variable based on the distribution of the explained conditions. The regression curves at different quantiles are different, so it could reflect more comprehensively the relations between the variables than traditional regression model. Since China has vast territory and that the ecological environment pollution in different regions varies greatly, it is more suitable to adopt the panel quantile regression model in this essay.

For random variable Y, distribution function $F(y) = P(Y \le y)$. Define $Q_y(\tau) = \inf\{y : F(y) \ge \tau\}$ as the τ quantile function of Y, in which, $0 < \tau < 1$, inf is the greatest lower bound, $Q_y(\tau)$ is the inverse function of conditional distribution function of the explained variable. $\rho_\tau(\mu)$ is the test function:

$$\rho_\tau(\mu) = \mu\left(\tau - I_{\mu<0}\right) = \begin{cases} \tau\mu & \mu \ge 0 \\ (\tau-1)\mu & \mu < 0 \end{cases} \tag{3}$$

In Eq. (3), $I_{\mu<0}$ is the indicative function and the quantile regression linear model is:

$$Q_y(\tau|x) = \beta_1(\tau)x_1 + \beta_2(\tau)x_2 + \cdots + \beta_p(\tau)x_p \tag{4}$$

In Eq. (4), $\beta_i(\tau)x_i(i = 1, 2\cdots, p)$ is the parameter corresponding to τ quantile.

In order to explore the impact of energy consumption on the ecological environment pollution in the process of economic and social development, the STIRPAT model was constructed based on the IPAT model proposed by Ehrlich et al. [17]. The specific forms are as follows:

$$I_{it} = aP_{it}^{b}A_{it}^{c}T_{it}^{d}e^{\epsilon_{it}} \tag{5}$$

In Eq. (5), a is a constant term, B, C and D are the index terms of population P, wealth a and technology t respectively, which are the residual of the model, I is the province and city, t is the year, and the eq is logarithm, which can get the following equation:

$$\ln(I_{it}) = a + b\ln(P_{it}) + c\ln(A_{it}) + d\ln(T_{it}) + \epsilon_{it} \tag{6}$$

According to the basic principle of quantile regression model, this essay studies mainly the relations between energy and eco-environment pollution of 30 provinces and cities of China, with the aim to explore the influences of energy on eco-environment pollution at different quantile levels. The model is established as follows:

$$Pol_{i,t} = \alpha_0 + \alpha_1 Ei_{i,t} + \alpha_j x_{j,i,t} + \mu_{i,t} \tag{7}$$

In Eq. (7), $Pol_{i,t}$ is the eco-environment pollution index of the provinces and cities, $Ei_{i,t}$ is the kernel explaining variable—energy, $x_{i,t}$ is the other control variable that could affect eco-environment pollution, $\mu_{i,t}$ is the residual term.

Explaining variable: Eco-environment pollution (Pol). Eco-environment pollution includes mainly domestic pollution and industrial pollution. Wastewater emission (unit: ten thousand tons), carbon dioxide emission (unit: ten thousand tons), fume (dust) emission (unit: ten thousand tons), and industrial solid waste emission (unit: ten thousand tons) are selected to construct the composite index of eco-environment pollution and entropy method is used to measure the pollution emission index of 30 provinces and cities of China. The larger the eco-environment pollution index is, the more serious the eco-environment pollution would be.

Kernel explaining variable: Energy consumption intensity (Ei). By referring to the study of Lei et al. [18], energy consumption intensity is manifested by the energy consumed every ten thousand yuan industrial output.

Control variable: The level of economic development, environmental pollution control, industrial structure, fixed asset and foreign direct investment are selected as the control variables. The level of economic development (Pgdp) is manifested by per capital gross regional product; environment pollution control is manifested by the proportion of the investment in environmental pollution control to gross regional product; industrial structure (Ind) is evaluated by the added value of the secondary industry/the third industry; fixed asset (Fix) is manifested by the proportion of the total investment in fixed assets to gross regional product; foreign direct investment (Fdi) is manifested by the proportion of foreign direct investment to gross regional product.

The research data adopted in this essay come mainly from China Statistical Yearbook, China Energy Statistical Yearbook and China Environment Statistics Yearbook from 2004 to 2017. Partial missing values were filled by mean interpolation. Descriptive statistics are shown in Tab. 1.

3 Empirical Analysis

3.1 Temporal and Spatial Distribution of Eco-Environmental Pollution

Because of the long span of the research years, if all the years are selected, the graph will not be clear and the display is disorderly. Moreover, the kernel density function studies the evolution process of dynamic curve, and the change trend of adjacent years is not big, so the evolution trend will not be destroyed by a certain period of years. So, the nuclear density functions in 2004, 2009, 2014 and 2017 were plotted to observe the dynamic evolution of ecological environment pollution, as shown in Fig. 1. According to the overall dynamic evolution characteristics of eco-environmental pollution in China, the peaks of Kernel density function curve from 2005 to 2017 shifted to the left and then to the right, indicating that eco-environmental pollution first increased, then decreased and then increased during the sample period; The curve rises as a whole and the broadband becomes narrower, which indicates that the difference between the polluted areas of the ecological environment is gradually narrowing; In addition, the curve changed from bimodal to unimodal, indicating the gradual disappearance of the two-stage differentiation.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Source
Pol	420	0.3931	0.1721	0.1114	0.8111	China Environmental Statistics Yearbook
Ei	420	1.0654	0.7926	0.1993	4.1939	China energy statistical yearbook
lnPgdp	420	10.3193	0.6820	8.3730	11.767	China Statistical Yearbook
Epcil	420	0.0135	0.0145	0.0001	0.2631	China Statistical Yearbook
Ind	420	1.1469	0.3334	0.2360	1.8903	China Statistical Yearbook
Fix	420	0.6668	0.2327	0.2460	1.3715	China Statistical Yearbook
Fdi	420	0.0244	0.0188	0.0004	0.0819	China Statistical Yearbook

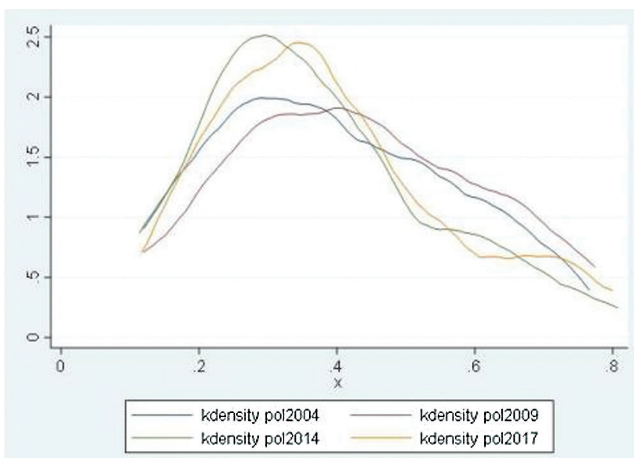

Figure 1: Dynamic evolution of eco-environmental pollution in China, 2004–2017

3.2 Nonlinear Effects of Energy Consumption on Ecological Environment Pollution

Stationarity Test

Because the panel data includes the characteristics of time series data and section data, the stability of the data must be verified before regression. In this paper, LLC (Levin-Lin-Chu test), IPS (Im-Pesaran-Shin unit-root test) and HADRI (panel unit root test was proposed by Hadri) are selected to test. Considering the different test results of different methods, this paper considers that as long as two or more of the three methods are considered stationary, the variable data is considered stationary, and the results are shown in Tab. 2. Tab. 2 shows that all variables have passed LLC test, IPS test and hadri test, and the original hypothesis of unit root is rejected. Therefore, all variables are stable and can be directly used for Hausman test and regression estimation

Table 2: Stationarity test

Variable	LLC	IPS	HADRI	Stationarity Judgment
Pol	–7.2536(0.0000)	–4.2682(0.0000)	6.9927(0.0000)	Stationarity
Ei	–2.5882(0.0048)	–3.0552(0.0011)	13.1361(0.0000)	Stationarity
lnPgdp	–8.1449(0.0000)	–1.6316(0.0514)	14.3436(0.0000)	Stationarity
Epcil	–6.1705(0.0000)	–1.8561(0.0317)	2.8525(0.0022)	Stationarity
Ind	–2.6329(0.0042)	–3.7238(0.0001)	18.3400(0.0000)	Stationarity
Fix	–1.7398(0.0409)	–3.7978(0.0001)	10.2412(0.0000)	Stationarity
Fdi	–2.6851(0.0036)	–8.3198(0.0000)	16.2191(0.0000)	Stationarity

Hausman Test

In order to determine whether the regression equation is a fixed effect or a random effect, Hausman test is needed for the equation. The test value p is less than 0.001, so the fixed effect model is more suitable for comparison. Mixed effect model is added to the model. The test results are shown in Tab. 3.

Table 3: Empirical estimation results

Variable	OLS model	Fixed-effect model
Ei	0.0181***	0.0178***
	[2.61]	[2.63]
lnPgdp	–0.0266**	–0.0299***
	[–2.47]	[–2.76]
Epcil	0.0876	0.0960
	[0.54]	[0.61]
Ind	0.0205*	0.0152
	[1.69]	[1.28]
Fix	0.0531**	0.0595***
	[2.54]	[2.82]
Fdi	–0.297	–0.307
	[–1.16]	[–1.20]
_cons	0.596***	0.631***
	[5.04]	[5.46]
N	420	420
adj. R^2	0.1420	0.0638
Hausman	/	30.26(0.0001)
F^2	/	10.59(0.0000)

Notes: t statistics in brackets, $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

As can be seen from Tab. 3, at the national level, the impact of energy consumption on eco-environmental pollution is significantly positive, indicating that the increase in energy consumption has exacerbated eco-environmental pollution. As for that control variable, the elasticity coefficient of economic development level to ecological environment pollution is 0.213, that is, the ecological environment pollution is correspondingly reduced by 0.213% for every 1% increase in the level of technical and economic development. The regression coefficients of fiscal expenditure, human capital, urbanization level and trade openness are all positive, which indicates that the improvement of these variables has a positive impact on economic development, while FDI and financial development level have no significant impact on economic development.

Panel Quantile Regression

In this paper, panel quantile regression model is selected to further study whether there is a significant difference in energy consumption under different quantiles of eco-environmental pollution and analyze the trend of the difference. In order to make the study continuous, five representative quintiles (5%, 15%, 30%, 50%, 70%, 85%, 90%) were selected for analysis.

In order to show the change of energy consumption quantile with quantile more intuitively, this paper uses stata15.0 to describe the change diagram of quantile regression coefficient. As shown in Fig. 2, the quantile estimates of energy consumption are shown in the Tab. 4. In the range of 0.05–0.9, with the change of quantile, the quantile coefficient of energy consumption has different effects.

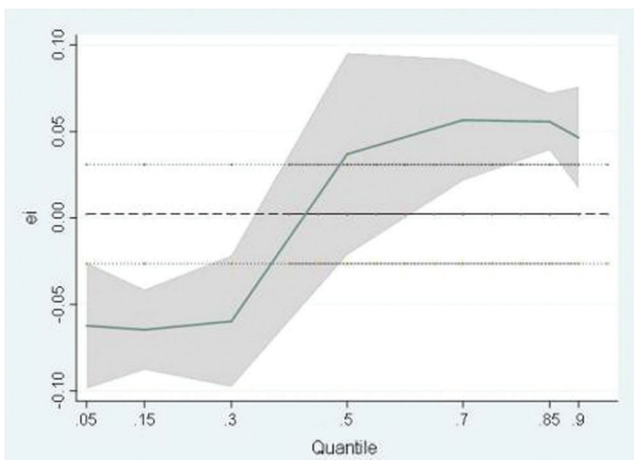

Figure 2: Change diagram of panel quantile regression coefficient

Tab. 4 shows the panel quantile regression results. It can be found from the table that, with the change of quantile, the influence of each variable on the ecological environment pollution presents different change trends, and the significance has also changed, and the effect of energy consumption on different quantile levels is quite different.

Energy consumption has a significant impact on eco-environmental pollution in both fixed-effect model and quantile model. From the trend of the estimated values of the different quantile point coefficients, the overall trend shows an upward trend. At 0.05, 0.15 and 0.30 decimal point, that coefficient sign is negative, the degree of ecological environmental pollution decreases by 0.0642–0.0699 percentage point for every 1% increase in ecological environmental consumption, and it is positive at 0.50, 0.70, 0.85 and 0.9 decimal points, and the degree of environmental pollution increases by 0.0107–0.0547 percentage point for every 1% increase in environmental consumption. In general, it showed the rule of first relief and then aggravation. This indicates that the energy consumption aggravates the ecological environment pollution in the areas with high level of ecological environment pollution, while in the areas with low level of ecological environment pollution, the energy consumption is beneficial to alleviate the ecological environment pollution. The possible reasons for this phenomenon are that there are many factors affecting the ecological environment. Besides the factors considered in the model, there are also many factors such as scientific and technological factors, geographical location and so on. The activities related to the ecological environment, such as promoting production and management by energy consumption, are the comprehensive effects of these environmental factors. For the regions with high degree of ecological environment pollution, because of low energy conversion efficiency, irrational industrial structure, irrational energy structure and large amount of coal and other energy for industrial development, this high energy consumption and high pollution mode of production will inevitably lead to high degree of ecological environment pollution [19]; For areas with low levels of environmental pollution, they mainly concentrated in green technology and clean technology and other high-level applications, although the energy consumption is large, the industrial structure is reasonable, and the tertiary industry occupies a higher proportion. Increasing energy consumption will further promote the level of science and technology and economic progress, and then increase investment in the treatment of ecological environmental pollution, form a virtuous circle, which is conducive to reducing ecological environmental pollution.

Table 4: Panel quantile regression results

Variable	5%	15%	30%	50%	70%	85%	90%
Ei	–0.0645***	–0.0642***	–0.0699***	0.0107*	0.0547***	0.0403***	0.0376***
	(0.0004)	(0.0005)	(0.0000)	(0.0060)	(0.0039)	(0.0081)	(0.0055)
lnPgdp	–0.0385***	–0.0258***	–0.0573***	–0.0400***	0.0552***	0.0909***	0.0966***
	(0.0001)	(0.0006)	(0.0003)	(0.0099)	(0.0191)	(0.0126)	(0.0086)
Epcil	0.398***	–0.0521	–0.152***	1.425***	–0.107	0.243	0.218*
	(0.0020)	(0.0346)	(0.0037)	(0.2489)	(0.3995)	(0.5865)	(0.1294)
Ind	0.0749***	0.141***	0.181***	0.0933***	0.316***	0.286***	0.412***
	(0.0000)	(0.0006)	(0.0005)	(0.0357)	(0.0421)	(0.0677)	(0.0271)
Fix	–0.0385***	–0.0617***	–0.0792***	0.0641*	–0.130***	–0.130***	–0.123***
	(0.0005)	(0.0035)	(0.0005)	(0.0359)	(0.0308)	(0.0441)	(0.0154)
Fdi	–1.732***	–1.854***	–0.964***	–1.035***	–1.208***	–0.900	–2.407***
	(0.0050)	(0.0272)	(0.0248)	(0.1273)	(0.1592)	(0.6016)	(0.3413)
N	420	420	420	420	420	420	420

Notes: Standard errors in parentheses,* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Observe control variables. The influence of economic development level on eco-environmental pollution is significant, which restrains eco-environmental pollution below 0.5 quartile level and promotes environmental pollution above 0.5 quartile level. This also verifies the viewpoint of Xie et al. [20]; The influence of industrial structure on ecological environment pollution is significantly and positively correlated, which indicates that industrial pollutants such as waste water, waste gas and solid waste will not change fundamentally in a short time, and are still the main source of pollutants. This part verifies the viewpoint of Zhang et al. [21].

It can be seen from the above analysis results that when the ecological environment pollution is relatively serious, the pollution effect of energy consumption is prominent, and the regions with high comprehensive degree of ecological environmental pollution are often accompanied by the pressure of economic development. In order to ensure the soft landing of economy and the distorted concept of political achievements, the industrial structure is unreasonable, so the energy consumption aggravates the environmental pollution. The area with low comprehensive degree of ecological environmental pollution is usually the tourism area with more developed economic development or green environmental protection. The former has the economic first mover advantage, has experienced the pain of pollution, and the industrial enterprises with high pollution are constantly moving out. Instead of high-tech industry and green environmental protection industry, the energy consumption structure is becoming more reasonable, so the energy consumption will not aggravate the environment Environmental pollution, the latter has a small demand for industry, strong subjective awareness of environmental protection, wide objective forest coverage and more use of green energy.

4 Conclusions and Recommendations

The relationship between energy consumption and ecological environment pollution is inseparable. Energy consumption has stimulated economic development and caused great pollution to the ecological environment at the same time. In this paper, the comprehensive index of eco-environmental pollution of 30 provinces and cities in China is measured by entropy method, and then the impact of energy consumption on eco-environmental pollution is estimated by panel quantile regression. The results show that the peak of the nuclear density curve of environmental pollution in China increases first, then decreases and then increases, the regional differences gradually narrow, and the two-stage differentiation gradually disappears; Energy consumption has a far-reaching impact on ecological environment pollution. The conclusions based on the traditional panel fixed effect model are not accurate enough. At different quantile level, the effect of energy consumption on eco-environmental pollution is quite different, that is, the influence of energy consumption on eco-environmental pollution presents an inverted U-shape distribution in different eco-environmental pollution areas. Energy consumption can restrain eco-environmental pollution in areas with high environmental pollution, while energy consumption aggravates environmental pollution in areas with high energy consumption.

Based on the empirical analysis of this paper, the following policy recommendations are made.

Further adjust the structure of energy consumption. Overall, energy consumption aggravates the ecological environment pollution with a significant positive effect. But there are great differences between regions. We will actively promote energy reform policies to relieve the pressure brought about by pollution of the ecological environment. In regions with high comprehensive degree of ecological environment pollution, we should strictly control the total energy consumption, increase the development and utilization of clean energy and green energy, reduce the use of coal resources, and guide consumers to participate in environmental protection, change their lifestyles, and use more energy-saving and emission-reducing products.

Carry out the goal of energy conservation and emission reduction, and prevent and control the ecological environment pollution. In cities with relatively developed industries and backward service industries, attention is paid to key polluting industries, and special measures are taken to control paper-making, cement, iron and steel, petroleum and chemical industries, and supervision is exercised in examination and approval, target assessment, and other links to ensure the safety of the ecological environment.

Perfect laws and regulations. We will improve relevant laws and regulations on the discharge of pollutants such as waste water and waste gas, restrict enterprises in the form of legislation, and strengthen the low-carbonization of high-carbon energy sources.

Implement regional linkage prevention and control. Although the Chinese government has implemented a series of energy-saving and emission-reduction policies and achieved remarkable results, due to its vast territory, the central and western regions in general, and the central and western regions in particular, have not improved significantly. The main reason is the lack of joint prevention and control mechanism among regions, which requires the coordinated development of regions, strengthen the green technology cooperation among regions, and solve the problem of ecological environment pollution from the inside and outside of China.

Compared with the areas with low ecological pollution level, the areas with high ecological pollution should control the energy consumption structure, strictly restrict the use of energy such as coal and fuel oil, gradually increase the proportion of clean energy such as hydrogen and water energy, and increase the energy use efficiency in areas with low ecological pollution level.

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