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Endogenous Economic Growth Model of Energy Depletion and Pollution Control Based on Empirical Analysis of Inter provincial Panel Data

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Abstract: In recent years, with the continuous development of China's economy, energy depletion(ED) has become an indispensable part of resources. The development of many sites is still mainly high pollution and high energy efficiency. With industry as the main source of pollution, the environmental pollution caused by source reduction has also become the focus of attention. How to deal with the complex relationship between economic development and resource exploitation, environmental protection and R & D investment has become the key to sustainable development. Based on the empirical analysis of inter provincial panel data(IPPD), this paper studies and analyzes the endogenous model of sustainable economic growth of energy consumption and pollution control(PC). This paper briefly introduces the relationship between ED, PC and sustainable economic growth, puts forward the panel unit root test algorithm, analyzes and discusses the endogenous model of ED, PC and economic growth through the empirical analysis of IPPD, and achieves good results, which is of great significance to the sustainable development of China's economy.

1. Introduction

The problem of environmental pollution is a complex problem that needs to be solved urgently for most countries in the world at present. As a large country carrying resources and environmental capacity with a population of 1.4 billion, in the face of the growing trend of environmental problems, how to effectively deal with it and restore the damaged ecological environment system to its former natural state as soon as possible. This paper analyzes the endogenous model of sustainable economic growth of ED and PC, and makes an empirical analysis of the IPPD.

Many scholars at home and abroad have studied and analyzed the endogenous model of sustained economic growth based on the empirical analysis of IPPD. Lazar D investigated the relationship between pollution and growth in 11 central and Eastern European countries. The comprehensive results with robustness to different estimators and control variables show that the nonlinear relationship between GDP and carbon dioxide in the group of central and Eastern European countries is increasing. However, in the classification at the national level, the relationship between GDP and CO2 is very diverse among central and Eastern European countries. Therefore, although the overall trend is upward, some central and Eastern European countries have managed to achieve higher GDP and lower carbon dioxide emissions [1]. Dosi g proposed a model based on multinational and multi industry agents to study the different growth patterns of interdependent economies. Every country has a Schumpeter style endogenous technological change engine, which interacts with the Keynesian / caldery demand generation mechanism. The simulation results show that the continuous income gap between countries leads to polarization and the formation of clubs. In addition, each country has experienced structural changes in its production structure in the process of development. This dynamic is the result of a virtuous (or vicious) cycle between knowledge accumulation, trade performance and growth dynamics at the enterprise level [2].

Using the recently developed econometric method panel data analysis method, including the causality test of unit root test, this paper constructs an endogenous model of economic sustainable growth of ED and PC for provinces, cities and autonomous regions in China, and studies and analyzes the causality between ED, PC and economic growth based on IPPD [3-4].

2. Endogenous Model of Sustainable Economic Growth for ED and PC

2.1. ED and PC

Environmental PC is a global problem. In the face of the severe forms of governance faced by China, we should study the responsibilities and obligations of local governments in the process of governance, coordinate and deal with the relationship between different levels of governments vertically, the interests between horizontal levels of governments, the contradictions between government and enterprises, and between the government and the public. From the perspective of improving governance capacity, we should put forward the optimal solution of governance methods and governance path selection. By analyzing the environmental pollution problems existing in local cities, we can find the problems existing in the local economic development, such as unreasonable industrial structure, weak awareness of environmental protection, lack of functions of environmental PC departments, from the source of pollution problems, and put forward optimization suggestions for local development from the perspective of environmental PC [5-6].

Based on the characteristics of long-term existence, large scope of influence and deep degree of harm of environmental pollution, its governance should avoid blindness and unscientific. Governance in accordance with laws and regulations is the best way to improve scientific rationality [7]. At present, in terms of environmental PC, China mainly promulgates the general "environmental protection law" first. Most of the legal provisions are based on the consideration of the overall interests of China's environment. It is a comprehensive law and regulation with strong representation. With regard to the treatment of environmental pollution, various places have carried out different forms of practice, mainly by optimizing the industrial structure and transforming economic development to meet the overall requirements of the country on energy conservation and emission reduction, energy consumption reduction, resource conservation and environmental

protection [8-9].

2.2. Relationship between Energy Consumption and Economic Growth

Generally speaking, ED will increase rapidly with economic growth. Energy is a strong driving force to promote rapid economic development. In the later stage, that is, the decline stage, ED will gradually decline with economic growth. This is because at this time, economic growth is no longer driven by energy alone, but the result of joint action with other factors such as technological progress. However, due to the influence of policies and political events, the relationship between China's energy consumption and economic development is different from this Law [10].

The implementation of total energy conservation will not restrict economic growth, but will hinder economic growth in the long term. Therefore, in this region, it is feasible to implement the energy-saving development strategy in the short term, but it will hinder economic development in the long term. Therefore, in the long run, we should change the energy consumption structure, reduce the consumption proportion of disposable energy, increase the consumption proportion of clean energy, reduce energy consumption, improve energy efficiency, and take the path of clean energy development [11-12].

3. Panel unit Root Test Algorithm

Panel data analysis technology is a relatively new econometric method developed in recent years. Because it contains both time series and cross-sectional individuals, it can mine more and more comprehensive information and better reflect the relationship between variables. LLC test method: for panel data, establish the following equation:

$$b_{it} = \sigma_i b_{it-1} + \lambda_i X_{it} + \mu_{it} \quad (1)$$

Where, is the exogenous variable, which represents any fixed or random effect term, is the error term, which represents the random disturbance term after the exogenous variable. IPS test method is an extension of LLC test method. It is assumed that the sequence is partially stable and partially nonstationary, that is:

$$K_1^{IPS} : \gamma_i = 0, \forall i = 1,2,..., N_1, \gamma_i = N_1 + 1, N2 + 2,...N \quad (2)$$

IPS test is a Lagrangian multiplier test based on the group mean. LM statistics are:

$$LM_\gamma^* = \frac{\sqrt{N}\{\overline{t_{N\cdot T}} - \frac{1}{N}\sum_{i=1}^{N} R[(t_{iT}(p_i,0) \mid \sigma_i = 0)]\}}{\sqrt{N\sum_{i=1}^{N} \mathrm{var}[(t_{iT}(p_i,0) \mid \sigma_i = 0)]}} \sim N(0,1) \quad (3)$$

It means that the average value of the time series one test statistic corresponding to each individual gradually obeys the standard normal distribution when the original hypothesis is established. The test method is also applicable to the case with heteroscedasticity.

4. Empirical Analysis of IPPD based on Sustained Economic Growth

4.1. Selection of Indicators and Sources of Data

Considering the desirability and comparability of the data, the sample range of this paper is 567

data from 29 provinces and autonomous regions in China. The indicators are domestic energy consumption and economic situation.

4.2. Unit Root Inspection

Before the root test, draw a scatter diagram to ensure that the interference component and custom component include time component and interrupt component, and the influence component is not the influence component and time component. Each region has a culture of time and time interference, so when testing a single root, select the time culture and attack rules. The specific test results are shown in Table 1.

Table 1. Unit root test results of variables in the block

Variable	LNGDP	△LNGDP	LNEC	△LNEC
Inspection method	Statistic p value			
Levin, Lin&Chu t*	0.29341 0.632	-3.42532 0.0002*	-0.8911 0.1823	-4.62647 0.0000*
Breitung t-stat	0.44356 0.6434	-2.89564 0.0017*	1.76321 0.9432	-3.92834 0.0000*
Im,Pesaran and Shin W-stat	-1.2766 0.1009	-3.53179 0.0002*	-0.0738 0.4706	-4.12997 0.0000*
ADF-Fisher Chi-square	39.2358 0.0133**	50.0634 0.0002*	22.5548 0.3112	54.2493 0.0002*
PP-Fisher Chi-square	34.4721 0.0440 **	4 48208 0.9999	6.75859 0.9974	59.8845 0.0000 *

According to the above root matrix test method, a series of power sum programs are developed as the test results of first-order and second-order differential. The results show that, except for a few cases, for each item of energy use and economic development, analyzing the relative power of energy use and economic development in many fields cannot dispel the myth that there is only one root. Test the regression formula. Using a series of first-order variants of energy efficiency and system development, several experimental methods in class I and class II environments hardened the empty shadow with a single root at a significant level of 1%, indicating that local energy (lnec) and economic growth series (lnGDP) are all combinations of sequence I (1). The second-order variance of class III series local system development (lnGDP) passed the single root test at a significant level of 1%, and most of the second-order changes in power consumption in each region also exceeded the critical level. The personal Center for energy utilization and economic development in the same region is part of order I (2). Due to the lack of stability of panel data, using the minimum rectangle method will lead to serious recession. Therefore, it is necessary to analyze the correlation coefficient of relevant variables, and then analyze the relationship between cognitive models in depth.

4.3. Residual Error Test

According to the theory, the residual distribution of the regression equation with long-term cointegration relationship obeys the normal distribution, that is, the residual sequence is stable. In

order to further confirm the cointegration relationship, we conducted unit root test on the residuals of cointegration regression equations in various regions. The results are shown in Table 2 and figure 1.

Table 2. Test results of unit root of residuals in different areas

Inspection method	Class I area		Class II area		Class III area	
	Statistic	P value	Statistic	P value	Statistic	P value
LLC	-2.3373	0.0097	-6.7286	0.0000	-4.09361	0.0000
IPS	-4.2157	0.0000	-1.0619	0.1441	-2.5262	0.0058
ADF-Fisher	56.8846	0.0001	41.4055	0.1233	13 5304	0.0090
PP-Fisher	49.7652	0.0006	50.7004	0.0191	13.5821	0.0088

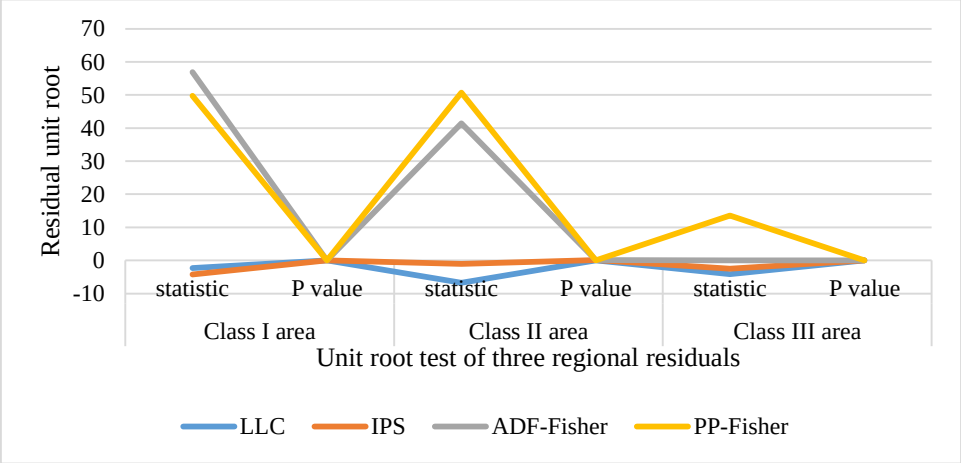

Figure 1. Unit root test of three regional residuals

It can be seen from the above chart that at the significance level of 5%, all the regions passed the test except IPS and ADF Fisher test in class II regions, which shows that the residuals in all regions are stable and the cointegration relationship is stable.

Next, test the causal relationship between energy consumption and economic growth in different regions. The test results are shown in Table 3 and Figure 2.

Table 3. Causality test results

Region	Class I		Class II		Class III	
Influence	EC#GDP	GDP#EC	EC#GDP	GDP#EC	EC#GDP	GDP#EC
Short-term	0.7464	1.2532	1.8325	1.7554	1.0536	0.0343
Long-term	0.5834	1.4453	2.2567	1.5643	4.0424	1.0642
F critical value	1.4578		1.8642		4.3621	
Joint inspection	0.8484	1.0252	1.8532	1.3462	1.9532	1.5323

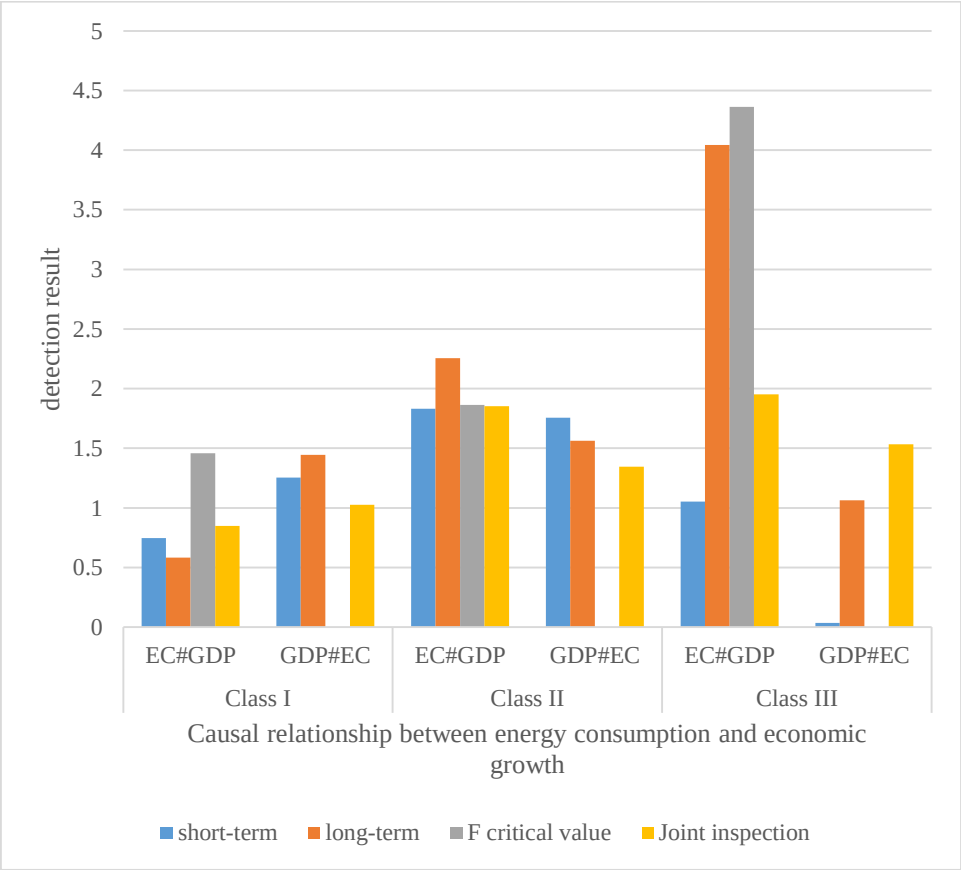

Figure 2. Causal relationship between energy consumption and economic growth

It can be seen from the above figure that in the short-term test of "energy is not the reason for the development of Granger system" in type I area, the f factor is 0.7656, and the CP value is 0.6578, indicating that at the significance level of 5%, receiving null energy consumption is not the description of the reason for economic growth: in the long-term test, the value of F factor is 0.5850, and the CP value is 0.8244, indicating that at the significance level of 5%, Accepting energy consumption is not the myth of economic growth. In the long-term and short-term average test, the F value is 0.8873, and the CP value is 0.6074, indicating that at the significant level of 5%, accepting unrealistic expectations, energy consumption is not the economic reason. As mentioned above, energy consumption is not the reason for long-term or short-term economic growth or average energy test.

5. Conclusion

Based on the empirical analysis of IPPD, this paper studies and analyzes the endogenous model of sustainable economic growth of energy consumption and PC, which has achieved good results, but there are also shortcomings: the empirical analysis data of IPPD is too few, and the experimental test process has not been considered for energy consumption and PC in remote areas, and the experimental test comparison needs to be increased; In the long run, economic growth will drive the growth of energy consumption in the same direction, and energy consumption is irrelevant

to economic growth. Therefore, the implementation of energy conservation and emission reduction will not restrict economic development. The endogenous model of sustainable economic growth of energy consumption and PC needs further in-depth study.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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