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A 3E Model on Energy Consumption, Environment Pollution and Economic Growth ---An Empirical Research Based on Panel Data

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Abstract

The negative effects of energy consumption and pollution have restrained the Chinese economy from further rapid growth. Therefore to clarify their relationship with economic growth can lay a solid foundation for the decision-making of energy conservation and pollution reduction and ensure the sustainable development of the Chinese economy. Using panel data on the 30 Chinese provinces from 2001 to 2008, this paper builds a 3E model of pollution, energy and production and conducts an empirical study on the interaction between pollutant emission, energy consumption and average GDP.

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Keywords-energy consumption; pollutant emission; simultaneous equations

1. Introduction

Because Chinese economic growth still relies on the development of heavy industries, export and the investment in fixed asset, current energy consumption grows rapidly. Energy consumption, which underlies economic growth with other factors of production, is one of the important inputs in most economic activities. Meanwhile, due to limited technologies, pollution is an inevitable byproduct of production. The increasingly prominent environmental and social cost of Chinese economic growth has had very serious negative effects. Given the status quo, the dilemma between economic growth and environment protection, and the coordinated development of energy, environment and economy and the

achievement of sustainable development have become the center of attention. In order to conduct an empirical research on the interaction between energy, environment and economy, this paper builds a group of simultaneous equations including production function, pollution function and energy function on the basis of the panel data of 30 Chinese provinces. The study examines the interaction and internal feedback mechanism between energy, environment and economy, meanwhile it also examines the effects of exogenous economic variables on the equilibrium of production, pollution discharge and energy consumption, on the basis of which reaches more realistic conclusions and proposes better policy suggestions.

2. The empirical model

2.1 The effects of the environment on economic growth

Pollution as a byproduct of output and energy consumption as a factor of production affect economic growth in different ways. First, given the current science and technology, pollution can not be eliminated from the production process; therefore it can be viewed as a factor of production [1]. Next, energy consumption as a way to consume natural resources is a factor of production, which influences the scale of output. At last, the scale of production is also affected by traditional factors of production including capital (physical capital and human capital) and labor. Building on the above-mentioned analysis, Mankiw [2] establishes the following endogenous growth model:

$$Y(t) = K(t)^\alpha H(t)^\beta (A(t)L(t))^{1-\alpha-\beta} \quad (1)$$

Of which $Y(t)$ is output; $K(t)$ is the stock of capital; $H(t)$ is the stock of human capital; $A(t)L(t)$ is effective labor. On the basis of this model, the new Cobb-Douglas function with the environment as a factor of production is written as:

$$Y(t) = K(t)^\alpha H(t)^\beta E(t)^\gamma (A(t)L(t))^{1-\alpha-\beta-\gamma} \quad (2)$$

Of which $E(t)$ is the environment, which includes resource consumption and pollution discharge. Take logarithm on both sides of equation (2) and translate it into the linear form. Then decompose the environment factor into energy consumption and pollution discharge. Given the high ratio of dependence on foreign trade in China's economic growth, we finally set up the following econometric model to measure the effects of environment on output and economic growth:

$$\begin{aligned} \ln g_{it} = & \alpha_0 + \omega_i + \alpha_1 \ln k_{it} + \alpha_2 \ln h_{it} \\ & + \alpha_3 \ln l_{it} + \alpha_4 \ln ec_{it} + \alpha_5 \ln E_{it} + \alpha_6 o_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

Of which the subscripts i and t stand for province i and year t ; g_{it} is income per capita; k_{it} is average fixed asset; h_{it} is average human capital; l_{it} is labor; ec_{it} is energy consumption; E_{it} is pollution; o_{it} is openness (i.e. the ratio of dependence on foreign trade); ω_i is specific cross-sectional effect; ε_{it} is the error term. Energy ec_{it} and pollution E_{it} are incorporated into the production function, representing the comprehensive effects of energy and environment on output.

2.2 The effects of economic growth on the environment

Pollution as a byproduct of production will increase as the scale of production rises. Energy is one of the factors of production and more output requires more input. Meanwhile, when the income per capita has reached a certain level, consumers will ask for a cleaner environment, which will encourage the

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