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Nonrenewable energy, renewable energy, carbon dioxide emissions and economic growth in China from 1952 to 2012

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ABSTRACT

This paper mainly investigates the relationship among energy consumption, carbon emissions and economic growth in China from 1952 to 2012. First, we implement unit root and cointegration analysis to test the stationary. Furthermore, we analyze the mutual influence among energy consumption, carbon emissions and economic growth through Granger causality analysis. Next, we also conduct static and dynamic regression analysis on the determinants of carbon emissions and economic growth. Last, we predict the future influence of different energy consumption on carbon emissions and economic growth. We find that coal has dominant impact on economic growth and carbon emissions. GDP (Gross Domestic Product) has bi-directional relationship with CO_2 (carbon dioxide) emission, coal, gas, and electricity consumption. It is imperative to change energy consumption structure in China. We had better decrease coal consumption rate. It is significant to develop hydro and nuclear power in China.

Contents

1. Introduction

According to the Environmental Performance Index (EPI) [1] produced by Yale University and Columbia University in 2012, China was ranked 116 in 132 countries worldwide for their environmental performance. Smog, which has appeared in many Chinese cities, harms people's health and interferes with economic sustainable development. In the context of rapid economic development, China's environmental pollution has become more severe,

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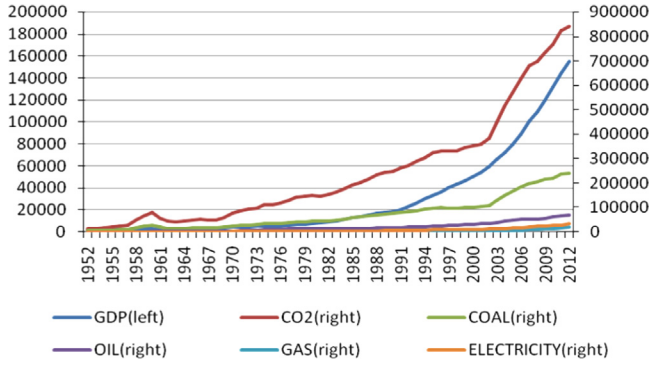

Fig. 1. GDP, CO_2 emission and Energy consumption in China. (a) The unit of GDP is 100 million RMB; (b) the Unit of CO_2 is 10,000 t; (c) the Units of coal, oil, gas and electricity are 10,000 t coal equivalent. (d) GDP has been deflated based on 1990. (e) the data are from China Compendium of Statistics 1949–2008 [3], and China Statistical Yearbook [4].

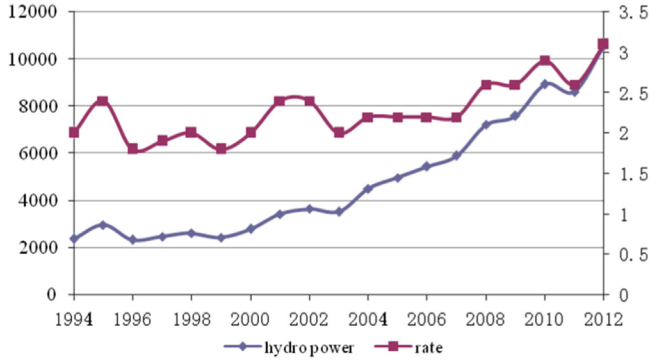

Fig. 2. The installed capacity of hydro power consumption and its rates in China. (a) Hydro power is indicated by the left value with the unit of 10,000 t coal equivalent, and its rates are indicated by right value with the unit of percentage. (b) The data are from China Compendium of Statistics 1949–2008 [3], and China Statistical Yearbook [4].

and it is necessary to reverse the deterioration of the environment. China aims to reduce carbon dioxide emissions by 3.1% [2]. Because China is still in the phase of industrialization, the economy has close links with fossil energy consumption and environmental pollution. It is imperative to decrease fossil energy consumption, especially for coal, and rather increase renewable energy consumption such as wind, solar, and hydro power, as well as biomass and marine energy use.

Fig. 1 below shows that CO_2 emission in China has increased significantly with the development of the economy from 1952 to 2012. Prior to the 1978s economic reforms and opening up of China, both GDP and CO_2 emission grew slightly. Afterwards, CO_2 emission has been increasing tremendously with economic development. It seems that coal consumption has close links with carbon emissions and economic growth in China.

We also notice that carbon emission has increased rapidly with coal consumption. In China, mostly electricity, cement production and other economic activities are linked with coal consumption which emits a great deal of CO_2 into the natural atmosphere. It therefore appears that, it is necessary to adjust the energy consumption structure in order to reduce nonrenewable energy use and expand renewable energy consumption in the economy. In this way, carbon emission could be reduced, and the environment protected from further deterioration.

On February 28th 2005, China approved a Renewable Energy Law, which was implemented on January 1st, 2006. The purpose of the law is to promote the exploration and efficient use of wind, solar, water, biomass, geothermal and ocean energy to increase

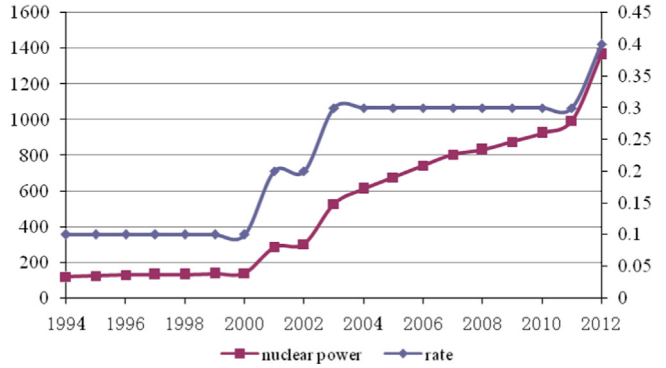

Fig. 3. The installed capacity of nuclear power consumption and its rates in China. (a) Nuclear power is indicated by the left value with the unit of 10,000 t coal equivalent, and its rates are indicated by right value with the unit of percentage. (b) The data are from China Compendium of Statistics 1949–2008 [3], and China Statistical Yearbook [4].

energy supply, improve energy structure, guarantee energy safety, protect the environment and facilitate the sustainable development of the economy and society. After the issue of Renewable Energy Law in 2005, a great deal of renewable energy policies have been proposed as follows: laws by National People's Congress; regulations and development planning by State Council and its ministries administrative measures, price policy; finance and tax policy; technology standards; comprehensive measures and other special measures (Zeng et al. [5]). All these policies have promoted the development of renewable energy in China. The installed capacity of renewable energy has increased up to 27.5% of the total installed capacity in China by the end of 2011.The installed capacity of hydro power was 230 million KW by 2011, accounting for 21.8% of the total capacity in China, which has dominated the renewable energy market in China. The installed capacity of nuclear power has increased to 12.57 million KW, up by 1.19 of the total capacity in China (Zeng et al. [5]). The wind power has also developed quickly, with the installed capacity of 62.73 million KW by 2011(CWEA [6]). The installed capacity of solar photovoltaic has increased from 0.1 million KW to 2.24 million KW from 2004 to 2011(CEC [7]).

The installed capacity of hydro power reached 10573.91 (10,000 t coal equivalent) in 2012, its consumption rate has increased from 2% to 3.1% from 1994 to 2012 (see Fig. 2). The installed capacity of nuclear power was 1364.376 (10,000 t coal equivalent) in 2012, but its consumption rate has increased from 0.1% to 0.4% among all energy consumptions from 1994 to 2012 (see Fig. 3). We can see that the hydro and nuclear rates are still not higher, compared with other fossil energy. It is significant to increase the consumption rate of hydro and nuclear power.

This paper, therefore, mainly investigates the relationship among energy consumption, carbon emissions and economic growth by comparing nonrenewable and renewable energy consumption with economic growth. The remainder structure of the paper is as follows. Section 2 presents literature review about energy consumption and economic growth. Data and methodology are discussed in Section 3.We conduct discussion of results in Section 4, while conclusion and policy implications are put forward in Section 5.

2. Literature review

There is quite an extensive theoretical and empirical studies focusing on the relationship between energy consumption and economic growth in both the industrialized and emerging economies, with mixed findings. In effect, there are three main