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Economic welfare impacts from renewable energy consumption: The China experience

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ABSTRACT

Over the last years renewable energy sources have increased their share on electricity generation of China due to environmental and security of supply concerns. In this work author assesses the role of both the amount and share of renewable energy consumption in economic welfare using Cobb–Douglas type production functions. This assessment is carried out by multivariate OLS and SPSS software for China from 1978 to 2008. Results indicate that a 1% increase in renewable energy consumption (REC) increases real GDP by 0.120%, GDP per capita by 0.162%, per capita annual income of rural households by 0.444%, and per capita annual income of urban households by 0.368% respectively; the impact of renewable energy consumption share (SREC) on economic welfare is insignificant, and an increasing share of REC negatively affects economic welfare growth to a certain extent. In this paper, the cost, structural demand, accounting mechanism and policy reasons of renewable energy development are interpreted. Marginal effects analysis show that the shape of sound and robust renewable energy institutions and policies would matter for increasing the standards of economic welfare in the context of speeding up renewable energy development and increasing share of renewable energy consumption, especially the goal-oriented policy refinement should be addressed efficiently in improvement households income while increasing share of renewable energy consumption.

Contents

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1. Introduction

1.1. Development of renewable energy in China

Development of renewable energy resources in China can be traced to the 1950s, shortly after the foundation of the People's Republic of China. From 1958 to 1960, in total 41 tidal power stations were built in coastal provinces such as Fujian, Guangdong and Zhejiang. In 1971 the photovoltaic (PV) panels were installed on Dongfanghong-2 Manmade Satellite2. However, pressures of energy shortage and energy related environmental pollution at that time were not as significant as they are today. Development of renewable energy in China remained at experiment level with immature technologies and limited scales for about 30 years [1,2].

China, following some advanced countries, started its nationwide development of renewable energy resources from the end of the 1970s and especially after the reform and opening-up in 1978. Rising concern of environmental protection and the two oil crises in 1973 and 1979 stimulated China's determination to reduce its reliance on coal and imported oil. From 1978 to 2000, the Chinese government involved renewable energy development into its Five-year Plan and national laws such as the *China Electric Power Act* in 1995 and the *China Energy Saving Law* in 1998. As a result, renewable energy consumption in China increased steadily. About 7 million household biogas pools and more than 70,000 centralized biogas stations were constructed in China in this period. Two single crystalline silicon solar cell production lines were introduced in the mid 1980s. In 1989 China built its first grid-connected wind farm in Xinjiang [2–5].

From the beginning of the 21st century, the Chinese government used market incentives, in addition to command and control management and direct subsidies, to stimulate renewable energy production. The Chinese government started numerous renewable energy demonstration projects such as Integrated Rural Energy Development Program with Rural Economic Development, the China Brightness Program and the China Renewable Energy Scale-up Program. Activation of the *Renewable Energy Law* in 2006 provided legal authority and created a new era for renewable energy development in China. International cooperation via Clean Production Mechanism (CDM) transferred both financial and technical resources from developed countries to China. These policies and programs resulted in great development of renewable energy utilization, especially small hydro, wind power, solar thermal and bio-energy, in China [2].

In 2008, the amount of renewable energy consumption in China equaled to about 239 Mtce, which accounted for 8.4% of China's total primary energy consumption (Fig. 1). By the end of 2008, the installed capacity of hydropower is 145.26 GW [6]. China had the largest small hydropower capacity (60 GW), the largest solar water heater installation (140 million m^2 collector areas), the third largest bio-ethanol production (1.9 billion L), and the fourth largest wind power generation capacity (12 GW) in the world. All these data prove the fact that China is going to overtake developed countries to be a leading producer and "a pioneer leading the way" in developing renewable energy resources [2,7].

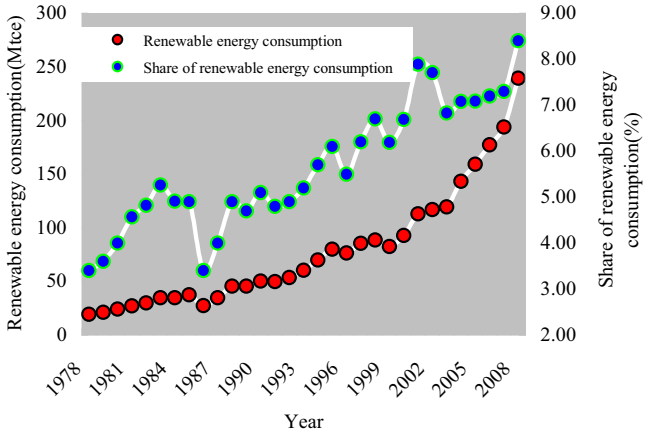

Fig. 1. Renewable energy consumption for China from 1978 to 2008.

Renewable energy is in a rapid development stage in China, and some technologies are in commercialization or near commercialization and have large development potential from resource, technology and industry points. Renewable energy has begun to play a key strategic role in the energy structure. According to the national target, renewable energy consumption will represent 15.5–19.7% of the total primary energy in China in 2020. It is expected that it will reach 26.4–43.0% in 2050 and renewable energy will be important substitute energy at that time [8,9].

1.2. Literature survey

Modeling the relationship between energy consumption and income in emerging economies has been a very active area of research [10–33]. These studies typically concerned the effects of energy conservation policies on economic growth. Some of them found that energy consumption contributed to economic growth both directly and/or indirectly, others that economic growth determined energy consumption, others that energy consumption and real gross domestic production (GDP) were interdependent and that there was bidirectional causality among them or even that there was no causality relationship among variables [34].

Renewable energy as a means to mitigate the environmental impact of carbon emissions while satisfying the energy needs for economic growth, thus, in recent years, increasing attention being paid to renewable energy, as a result research on the relationship between renewable energy consumption and economic growth has emerged in the literature. Nonetheless, this branch is not as developed as the previous one and the number of published researches is rather small. In a recent study, Domac et al. [35] argued that bio-energy should help increase the macroeconomic efficiency through the creation of employment and other economic gains. Later, Awerbuch and Sauter [36] defended that renewable energy sources had a positive effect on economic growth by reducing the negative effects of oil prices volatility. Furthermore, they contributed to energy supply security. These effects have to be considered when fully assessing the comparative costs of renewable energy and fossil fuels. Ewing et al. [37] used the generalized forecast error variance decomposition analysis to investigate the effect of disaggregated energy consumption (coal, oil, natural gas, hydro power, wind power, solar power, wood and waste) on industrial output in the USA. The authors found that non-renewable energy shocks (coal, gas and oil) had more impact on output variation than other energy sources. Even so, several renewable sources also exhibited considerable explanatory power. In their 2007 study, Chien and Hu [38] noted that renewable energy source significantly increased the technical efficiency (TE) of the economies studies. They used the data envelopment analyzes (DEA) method to estimate the TE for 45 OECD and non-OECD economies for 2001–2002. Similarly, these authors [39] also studied the effects of renewable energy consumption on GDP for 116 economies in 2003 through the Structural Equation Modeling (SEM) approach. They decomposed GDP by the "expenditure approach" and concluded that renewable energy consumption had a positive indirect effect on GDP through the increasing in capital formation. However, the authors found that renewable energy use did not improve the trade balance having no import substitution effect. Sari et al. [40] used the autoregressive distributed lag (ARDL) approach to examine the