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Renewable energy consumption – Economic growth nexus for China

Boqiang Lin [a,b,*], Mohamed Moubarak [c]

[a] Newhuadu Business School, Mingjiang University, Fuzhou 350108, PR China
[b] School of Energy Research, Collaborative Innovation Center for Energy Economics and Energy Policy, Xiamen University, Xiamen, Fujian, 361005, PR China
[c] School of Energy Research, Xiamen University, Xiamen 361005, PR China

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ABSTRACT

The aim of this paper is to investigate the relationship between renewable energy consumption and economic growth in China for the period 1977–2011. Autoregressive Distributed Lag approach (ARDL) to cointegration and Johansen cointegration techniques are employed by including intermittent variables namely carbon dioxide emissions and labor. We also employed Granger causality test in order to determine the direction of the causality among the variables. The results show that there is a bi-directional long term causality between renewable energy consumption and economic growth. This finding implies that growing economy in China is propitious for the development of renewable energy sector which in turn helps to boost economic growth. We also find that labor influences renewable energy consumption in the short term. However, there is no evidence of long or short run causality between carbon emissions and renewable energy consumption. This implies that actual level of renewable energy in China is still insignificant and not considerably exploited in order to contribute to the mitigation of carbon dioxide emissions.

Contents

1. Introduction

For the past three decades, China has experienced spectacular increase of energy consumption in order to sustain its growing economy. Energy consumption rose by approximately 7.3 times from 1977 to 2011 and the energy-related carbon emissions grew by 6.9 times during the same period [1]. In 2011, the carbon dioxide emissions in China were estimated around 8979.1 million tons which was equivalent to 26.4% of the global emissions [2]. This growing trend of carbon emissions has raised concerns about the consequences it may have on the socio-economic outlook of China and the global impact. One of the remedial measures that tend toward a sustained development is the promotion of production and consumption of renewable energy. The renewable energy generation in China grew by more than 17% from 1977 to 2011, but it represented only 8.8% of the total energy produced in 2011. Most of the energy consumed is from fossil fuels, which are high in pollutants and not-renewable. China should look for more sustainable energy sources that are clean, affordable and less dependent on foreign countries. An important quality of renewable energy is that it does not emit carbon dioxide. Therefore if used in large quantities, it can assist to contain the growing trend of carbon dioxide emissions in China and contribute to a more sustained economic growth [3,4]. The aim of this paper is to investigate the impact of economic growth on renewable energy consumption, specifically its effect on the Chinese economic growth (real GDP

* Corresponding author at: Newhuadu Business School, Minjiang University, Fuzhou, Fujian, 350108, PR China. Tel.: +86 0592 2186076; fax: +86 0592 2186075.
E-mail addresses: bqlin@xmu.edu.cn, bqlin2004@vip.sina.com (B. Lin).

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per capita). The significance of the study is to determine the main factors on which China should focus in order to; improve the production and consumption of renewable energy, reduce the country's dependency from coal consumption, mitigate carbon dioxide emissions and to push up the economic growth towards a more sustainable level. Therefore the analysis of factors affecting consumption of renewable energy would assist in formulating policies on energy and environmental matters.

The growing importance of renewable energy in China necessitates that further research to be done on the relationship between renewable energy consumption and economic growth. This may require further application of alternative testing approaches. It is for this purpose that we investigate the causal relationship between renewable energy consumption and economic growth in China for the period 1977–2011. We include labor and carbon dioxide emissions variables into the framework. Including these variables in the multivariate approach would help to provide important instruments for policy framework since these variables could be affected by or influence changes in energy consumption and economic growth. Moreover, this approach overcomes argument on the bivariate method which is subjected to omitted variable biasness. The determination of the direction of the causality among the variables is also essential, with key consequences for the energy policy. In case of no causality between economic growth and renewable energy consumption, it would imply that consumption of renewable energy in China may not be weakened in case of economic recession. On the contrary, if there is bidirectional causality, then renewable energy consumption can contribute to stimulate the economic growth, which in return may lead to increased consumption of renewable energy. In case of unidirectional causality running from economic growth to renewable energy consumption, it could imply that policies and measures targeted at promoting renewable energy consumption can be implemented without adverse effect on economic growth. On the contrary, if there is uni-directional causality running from renewable energy to economic growth, then increase in renewable energy consumption could enhance economic growth.

Hence, we provide a more robust methodology based on four steps in order to investigate the existence of long run relationship and causality among renewable energy consumption, economic growth, carbon dioxide emissions and labor force. Firstly, the autoregressive distributed lag (ARDL) method is employed to determine the cointegration relationship among the variables. This method provides better results in case of small simple size, like in this paper [5]. Once the long run relationship is established, we apply the Johansen cointegration test for robustness evidence. This procedure is to strengthen our findings and be sure that similar results can be obtained by not one method only. Following this, we use Granger causality procedure to determine the direction of the relationship among the variables.

The remainder of the paper is as follows: Section 2 provides a brief literature review on the relationship between renewable energy and economic growth. Section 3 presents the data and explains the methodology employed. The empirical analysis is provided in Section 4, while the conclusion and policy implications are outlined in Section 5.

2. Brief literature review

The relationship between energy and economic growth has been analyzed in several empirical studies using diverse approaches. However, there has been a lot of divergence in the results obtained. Hossain et al. [6] examined the dynamic causal relationships between electricity consumption and economic growth for five different panels. They found a bidirectional causality between economic growth and electricity consumption for high income, upper middle income and global panels. They also found unidirectional short-run causality from economic growth to electricity consumption for lower middle income panel, no causal relationship for low income panel and concluded that over times higher electricity consumption gives rise to more economic growth in these panels. Zhang and Cheng [7] investigated the existence and direction of Granger causality between economic growth, energy consumption, and carbon emissions in China from 1960 to 2007. Their results suggest the existence of a unidirectional Granger causality running from GDP to energy consumption, and a unidirectional Granger causality running from energy consumption to carbon emissions in the long run. Which suggest that neither carbon emissions nor energy consumption leads to economic growth. Tang et al. [8] attempted to re-investigate the relationship between electricity consumption and economic growth in Portugal. Their results confirmed the presence of cointegration among the variables and the existence of bi-directional causality between electricity consumption and economic growth in the short- and long-run. Therefore, they suggested that energy conservation policies should not be implemented because it would deteriorate the process of economic growth. The hypothesis of causality between energy consumption and economic growth has also proved to be neutral in several studies such as [9–12] used Toda–Yamamoto procedure to investigate the causality between renewable energy, non-renewable energy and economic growth in the USA. He did not find any causality among these variables. Using the same methodology, Yildirim et al. [13] applied the Toda–Yamamoto procedure and bootstrap-corrected causality test in order to study the causality between renewable energy and economic growth in the USA. They also found no causality between economic growth and total renewable energy consumption. Based on random effect model, a study conducted by Menegaki [14] failed to show any causality between economic growth and renewable energy for the case of Europe. He suggested that the absence of causality may be due to the uneven and the limited exploitation of renewable energy sources in Europe. Chien and Hu [15] used data envelopment analysis (DEA) model and argued that more use of renewable energy leads to improved technical efficiency in the economy. Similar results were provided by Fang [16] who investigated the case of China by employing Cobb–Douglas type production functions and found that renewable energy consumption increased the GDP per capita by 0.162%. However, the conclusion of that study argued that growing share of renewable energy consumption may have a negative impact of economic growth. Similarly, Ocal and Aslan [17] found that renewable energy consumption has a negative impact on economic growth for the case of Turkey. Chang et al. [18] attempted to investigate the development of renewable energy sector under different economic growth rate regimes by applying panel threshold regression (PTR) model in OECD member-countries. The results showed that countries with high-economic growth are able to increase the renewable energy use, while countries with low-economic growth are unable to grow the consumption of renewable energy. Apergis and Payne [3] used panel cointegration and error correction model to study the causality relationship between renewable energy and economic growth for twenty OECD countries. According to their findings, there is a long run equilibrium relationship between real GDP, renewable energy consumption, real gross fixed capital formation and the labor force. They also found bi-directional causality for long and short run between renewable energy and growth. Similar results were found for the case of Eurasia [19]. Employing similar methodology, Apergis and Payne [20] found the existence of unidirectional causality running from economic growth to renewable electricity consumption in the short term and also bidirectional causality between these variables in the long term in emerging economies. Tugcu et al. [4] investigated the relationship between renewable and non-renewable energy consumption and economic growth in the G7 countries. They employed Autoregressive Distributed Lag approach to cointegration