Renewable and Sustainable Energy Reviews 59 (2016) 1101–1110

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

An econometric study of the impact of economic growth and energy use on carbon emissions: Panel data evidence from fifty eight countries

Saidi Kais *, Hammami Sami

Faculty of Economics and Management, University of Sfax, Tunisia

ARTICLE INFO

Article history:
Received 9 November 2014
Received in revised form
6 January 2016
Accepted 13 January 2016
Available online 29 January 2016

Keywords:
Carbon emissions
Energy use
Economic growth
Dynamic panel
GMM system

ABSTRACT

The aim of this paper is to provide new empirical evidence on the impact of economic growth and energy use on carbon emissions (CO_2 emissions) for fifty eight countries over the period 1990–2012 by using a panel data model. We also apply this model in order to implement three regional sub-groups; European and North Asian region, Latin American and Caribbean region, and the Middle Eastern, North African and sub-Saharan region. The results revealed that the energy use has a positive impact on the carbon dioxide emissions for all the panels. The impact of economic growth on the environment has received increased attention as global warming and other environmental problems become more serious. Indeed, the per capita GDP has a positive and statistically significant impact on carbon for the global panel, for the Europe and North Asia, and for the Middle Eastern, North Africa, and sub-Saharan Africa. Furthermore, our empirical results indicate the presence of an inverted U-shaped curve between carbon dioxide emissions and GDP per capita.

Contents

1. Introduction

The relationship between economic growth and carbon dioxide emissions is considered as one of the most important empirical relationships tested in the economic literature, (see e.g., Copeland and Taylor [23], Payne [62], Halkos and Tzeremes [34], among others). The environmental Kuznets curve (EKC) was firstly defined by Simon Kuznets [43]. The EKC hypothesis assumes that the environmental quality first deteriorates until a certain level of income is reached and then improves as economic development proceeds. In addition, some studies confirmed that the EKC hypothesis posits an inverted U-shaped relationship between economic growth and environmental degradation [15,21,32,44,73]. This hypothesis indicates that an additional increase of economic growth can improve the environmental quality or CO_2 emissions. The works of [82,22,25,49] provided an extensive study on the economic growth-environmental pollution nexus with EKC

* Corresponding author. Faculty of Economics and Management, University of Sfax, Sfax 3018, Tunisia. Tel.: +216 40 70 77 07.
E-mail addresses: saidikais.fsegs2014@gmail.com (S. Kais), sami_hammami2005@yahoo.fr (H. Sami).

http://dx.doi.org/10.1016/j.rser.2016.01.054
1364-0321/

hypothesis. Since there is a large and growing world-wide consumption of fossil fuels, the amount of CO_2 emissions in our environment has been increasing.

The linkage between economic growth, energy use, and carbon dioxide emissions has been an active research area, For instance, Mehrara [53] investigated the relationship between per capita energy use, and economic growth in a panel of 11 selected oil exporting countries during the 1971–2002 periods. Their empirical results showed a unidirectional causality from per capita GDP to per capita energy use. The findings imply also that the energy conservation through reforming energy price policies has no damaging repercussions on per capita GDP for this group of countries. Akbostanci and Turut-Asik [2]; analyzed the link between pollution emissions and income in Turkey by using time series for 1968–2003 and 1992–2001 periods. Their results supported the existence of the EKC hypothesis that could not be reached.

Apergis and Payne [9] used the sign vector error correction model for six Central American countries to analyze the causal link between CO_2 emissions, energy consumption and economic growth. Energy consumption has a positive and statistically significant impact on CO_2 emissions while real output exhibits the inverted U-shape pattern associated with the EKC hypothesis. In addition, the results indicated a unidirectional causality from energy consumption and, respectively, to emissions along with a bidirectional causality between energy consumption and economic growth. More recently, Zhang and Cheng [87] has investigated the existence and the direction of causality relationship between economic growth, energy consumption, and CO_2 emissions in China. Empirical results showed a unidirectional Granger causality running from per capita GDP to energy consumption, and a unidirectional Granger causality running from energy consumption to CO_2 emissions in the long run. For 43 developing countries, Menyah and Wolde-Rufael [54] analyzed the causation between CO_2 emissions and economic growth. Their empirical analysis showed that the income elasticity in the long run is smaller than the short run, implying that CO_2 emission has fallen with a rise of the income.

Finally, Saidi and Hammami [69] studied the linkages between energy consumption and economic growth using data from Tunisia. Their empirical findings showed that there exists a bidirectional causal relationship between energy consumption and economic growth in the long-run. In the same way, Mounir et al. [55] affirmed that there is a unidirectional relationship from GDP to CO_2 emissions in the short term for Tunisia. Alshehry and Belloumi [4] examined the relationships between energy consumption, carbon emissions (CO_2 emissions) and economic growth in Saudi Arabia during the 1971–2010 periods. Their results showed that there exists a long-run unidirectional causality stand from energy consumption to per capita GDP and carbon emissions, bidirectional causality between carbon emissions and economic growth. In the short-run, there is unidirectional causality running from carbon emissions to energy consumption and economic growth. In the same way, Saidi and Hammami [70] examined the causal link between per capita energy consumption, per capita CO_2 emissions and per capita GDP in fifty eight countries. Their results indicate that there is a bidirectional causality relationship between per capita energy consumption and per capita GDP and a bidirectional causality relationship between energy consumption and CO_2 emissions.

The purpose of this paper is to investigate the impact of economic growth and energy use on carbon emissions (CO_2 emissions) for a panel of fifty eight countries. The present study is different from the previous ones in the following ways. First, Empirical models are estimated using panel generalized method of moments (GMM system) regression techniques. Second, we used, as an investigating technique, a dynamic panel data model, which follows the spirit of the conventional 'growth model' framework. Since they depict only short-run impacts, growth model cannot be modeled within a co-integrating framework. The reason is that all the variables in a growth form model are stationary, while co-integration (long-run impacts) demands that all the variables, as a pre-requisite, need to be non-stationary. Our approach is to estimate the short-run elasticities but not the long-run one given our growth form modeling approach. There is a strong motivation for us to apply a growth form approach to examine the impact of economic growth and energy use on carbon emissions (CO_2 emissions). Third, our literature survey typically suggests that few studies have examined the impact of growth and energy on the environment. They mainly consider Europe and North Asia, Latin America and the Caribbean, and the Middle East, North Africa and sub-Saharan Africa.

The rest of the article is divided into six main sections. Section 2 gives a brief review of literature; the data source and descriptive statistic are outlined in Section 3. The empirical model and econometric methodology are discussed in Section 4. The empirical findings are reported in Section 5, and finally in Section 6, there are the conclusions and policy implications that were drawn.

2. A brief review of literature

2.1. Literature review on economic growth and carbon dioxide emissions

Numerous existing studies suggested that economic development and technology advancement significantly influence carbon dioxide emissions. For instance, Perman and Stern [63] analyzed the relationship between sulfur emissions and per capita GDP for 74 countries, using a co-integration analysis to test the EKC hypothesis. These authors showed that the EKC is a problematic concept, at least in the case of sulfur emissions. Markandya et al. [51] investigated the linkage between sulfur emissions and economic growth for 12 Western European countries. The results showed that there is an inverted U-shaped relationship between per capita GDP and carbon emissions. In addition, environmental regulations are found to reduce the EKC and they can also shift the turning point of the curve. According to the EKC hypothesis, Managi [50] showed that economic growth and the reduction of environmental degradation are compatible goals. Besides, the author affirmed that there is an inverted U-shaped relationship between economic performance and environmental pollution. However, this study tested the hypothesis that there are increasing returns to abating pollution. The findings showed the importance of including an environmental productivity variable in the EKC framework.

A recent study by Soytas et al. [80] has investigated the effect of energy consumption and output on carbon dioxide emissions in the United States, using the Granger causality relationship between income, energy consumption, and carbon emissions. The findings showed that income does not Granger cause the carbon emissions in the US in the long run. Hence, income growth by itself may not become a solution to the environmental problems. Furthermore, Soytas and Sari [81], using the same approaches and variables as that of Soytas et al. [80], investigated the causality relationship between economic growth, carbon dioxide emissions and energy consumption in Turkey. The most interesting result is that the carbon emissions seem to Granger cause energy consumption. The lack of a long run causal relationship between economic growth and CO_2 emissions may imply to reduce carbon emissions; Turkey does not have to forgo economic growth. To the