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The environmental Kuznets curve and the role of coal consumption in India: Cointegration and causality analysis in an open economy

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ABSTRACT

This study investigates the dynamic relationship between coal consumption, economic growth, trade openness and CO_2 emissions in case of India. In doing so, Narayan and Popp, Journal of Applied Statistics 2010; 37:1425–1438, structural break unit test is applied to test the order of integration of the variables. Long run relationship between the variables is tested by applying the ARDL bounds testing approach to cointegration developed by Pesaran et al. Journal of Applied Econometrics 2001; 16:289–326.

The results confirm the existence of cointegration for long run between coal consumption, economic growth, trade openness and CO_2 emissions. Our empirical exercise indicates the presence of environmental Kuznets curve (EKC) in long run as well as in short run. Coal consumption as well as trade openness contributes to CO_2 emissions. The causality analysis reports the feedback hypothesis between economic growth and CO_2 emissions and same inference is drawn between coal consumption and CO_2 emissions. Moreover, trade openness Granger causes economic growth, coal consumption and CO_2 emissions.

Contents

1. Introduction

The Kyoto Protocol requires that industrialized countries reduce their collective emissions of greenhouse gasses by 5.2% of 1990 levels by the period 2008–2012. The country-specific targets in the Kyoto Protocol may be difficult for some nations to achieve. Developing countries, including India, have absolved of any responsibility towards reducing emissions in the first commitment period, that is, 2008–2012, of the Kyoto Protocol. However, India estimates a 24% cut by 2020 in its carbon intensity i.e., the amount of carbon dioxide emitted for each unit of GDP, compared with 2005 levels, and by 2030, it estimates it could achieve a reduction in its carbon emissions by 37% from 2005 levels, according to provisional government figures (The Indian Express [71]).

Theoretically, the environmental Kuznets curve (EKC) hypothesis postulates the existence of an inverted-U shape relationship between real GDP per capita and measures of environmental degradation such as SO_2 and/or CO_2 emissions. However, the empirical evidences, either using time series and/or pooled data of a group of countries, on the EKC hypothesis vary from country to country, instead. Further, the results are not uniform across pollutants. This has created tow problems being faced by environmental

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policy makers: to ensure that useful knowledge informs policy (without being misused and/or distorted) and to understand how to respond to this knowledge (Boehmer-Christiansen [1]). However, in the present context we have limited ourselves to provide evidence of the EKC hypothesis for India. Our contribution lies, particularly in two directions. First, we employed the ARDL method which is amenable for short time series data as in this paper and second, we provide empirical evidence of the EKC by incorporating coal consumption and trade as additional determinant of CO_2 emissions in case of India.

The rational for selecting India for our analysis is that it has implemented a variety of programs and policy initiatives since the introduction of the National Forest Policy in 1988. India has become one of the fast growing countries next to China. However, in the same time consumption of coal has increased rapidly which was 35.55 mote in 1965 has reached the height of 249.86 mote in 2009. The close relationship between coal consumption and economic growth of India is evident from following Fig. 1. Further if we see the relationship between percentage growth rates of GDP and coal consumption, we find that recently percentage growth rate in the coal consumption is more than twice of the percentage GDP growth rate. This situation is evident in Fig. 2.

With this background we set objective to test the environmental Kuznets curve hypothesis (EKC) in augmented equation framework. According to the EKC hypothesis environmental degradation increases at initial level of economic growth and then starts to decrease at a higher level of economic growth. Hence, the relationship between measure of environmental degradation, (in our case it is CO_2 emissions) and measures of economic growth (in our case it is measured by real GDP per capita) is the inverted-U shaped curve. The objective of present study is to investigate the EKC for the Indian economy over the period of 1966–2011. In addition, we also include coal consumption and trade openness.

The rest of the paper consists of: Section 2 reviews a selected literature encompassing the EKC and the variables listed above, Section 3 has the theoretical and the econometric model including the ARDL estimation strategy. The empirical results are reported in Section 4 followed by the conclusion and policy implications.

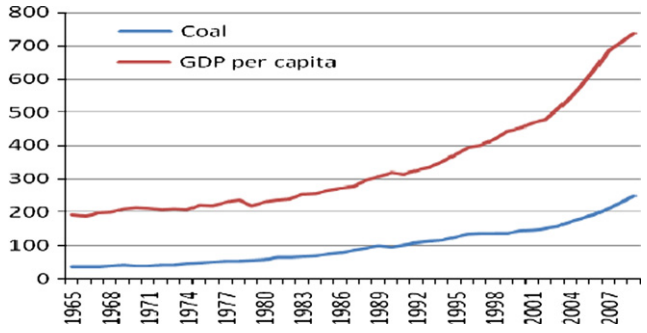

Fig. 1. Coal consumption and GDP per capita.

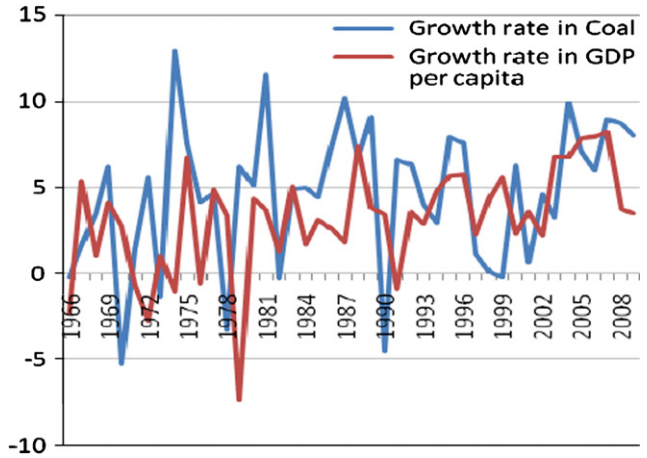

Fig. 2. Percentage growth rate in coal consumption and GDP.

2. Literature review

There has been increasing attention on the impact of economic growth on environment degradation since the last few decades of the previous century. The pioneering attempt in this area was made in the early 1990s by Grossman and Krueger [2,3] which investigated the environmental impacts of the North American Free Trade Agreement. Their study postulated, estimated and ascertained an inverted-U shaped relationship between measures of several pollutants and real GDP per capita which was, contemporaneously, confirmed by Shafik and Bandyopadhyay [4] and Panayotou [5]. Theoretically, the EKC does not only depend on levels of per capita GDP, but also on a series of factors causing changes in economic growth that can affect environment. In general, economists analyze mechanisms behind the EKC by examining scale effect, structural effect and technique effect (Song et al. [6]). However, few scholars (for example, Panayotou [5]) believe that EKC is caused by up-gradation from the adjustment of economic structure. According to the structural effect hypothesis (Stern [7]) economic development passes through the various states starting form preliminary, rapid-development and high-grade, industrial structure first upgrades from agriculture to a high-pollution industry, finally turns to information concentrated industry, which leads to the improvements in environmental quality. However, as Stokey [8] pointed out, due to the technique effect economic growth can break through one threshold point after arriving at a certain stage of economic development. Hence, at a low income level, only the high pollution technique can be used, but once leaping over the threshold point of economic development, cleaner technologies can be adopted which lowers the degradation in the environmental quality. Further, some scholars attribute the demand factors to the cause of EKC (for example, Lopez [9]), which asserts that demand for a clean environment will be increased over the real income per capita. Giving the importance of scale effect, Andreoni and Levinson [10] suggested that in the static model of single department, the EKC can be derived technically, only if pollution control is increasing in scale.

Further, Suri and Chapman [11] bring the contribution of industrial products of the imports and exports to industrial products of national production into the analytical framework of the EKC. That is to say, the low emissions correspond to the growth of industrial products of the imports, while the high emissions correspond to that of the exports. This implies that there is a strong relationship between trade and environmental quality, so the evolution of environmental quality can be predicted effectively. The empirical studies of EKC started by Grossman and Krueger [2] and followed by Lucas et al. [12], Wyckoff and Roop [13], Suri and Chapman [11], Heil and Selden [14], Friedl and Getzner [15], Stern [7], Nohman and Antrobus [16], Dinda and Coondoo [17] and Coondoo and Dinda [18] but presented mixed empirical evidence on the validity of EKC. Song et al. [6], Dhakal [19], Jalil and Mahmud [20] and, Zhang and Cheng [21] supported the existence of EKC in China. The findings of Fodha and Zaghdoud [22] revealed the existence of EKC between the SO_2 emissions and economic growth but not for the CO_2 emissions in