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Do population density, economic growth, energy use and exports adversely affect environmental quality in Asian populous countries?

Mohammad Mafizur Rahman

School of Commerce, University of Southern Queensland, Australia

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ABSTRACT

This study aims to investigate the relationship between carbon dioxide (CO_2) emissions, energy use, economic growth, exports and population density for a panel of 11 Asian populous countries over the period of 1960–2014. The panel cointegration tests and panel Granger causality tests are employed to examine this relationship; the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods are used to explore the long run effects of other variables on the CO_2 emissions. The main results are: (i) energy use, exports and population density adversely affect environmental quality in the long run; (ii) there exists a short-run unidirectional Granger panel causality running from energy consumption, gross domestic product (GDP) and exports to CO_2 emissions, from energy consumption and exports to GDP, from exports to energy consumption, from population density to exports, and a bidirectional panel causality between GDP and population density; and (iii) a long-run bidirectional Granger causality between these variables is also present. Important policy implications are noted based on these findings.

1. Introduction

The problem of increased carbon dioxide (CO_2) emissions has been a major concern in environmental and development economics for more than three decades due to its various detrimental effects. CO_2 is a major greenhouse gas (GHG), which is the primary cause of the global warming and climate change; hence it has captured the great attention of researchers and policy makers around the globe. With rapid industrialization, economic development and increased population, CO_2 emissions are continuously increasing worldwide. From 1990–2013, total GHG concentration in the atmosphere has increased by 34%, where CO_2 is responsible for nearly 80% of that increase [1]. IEA [2] also reports that in 2013, global CO_2 emissions have increased by 2.2% compared to 2012, and this growth rate was 5.4% for China and 3.5% for the Asian region excluding China.

The issue of CO_2 emissions is still the much needed important research agenda because of its global significance. Despite the adverse effects, CO_2 is directly linked with economic growth and development, as most of the CO_2 emissions are caused by fuels consumptions such as coal, oil and gas, which are the main sources of power of automobile and industry [3]. Researchers [4] and policy makers mostly view that to maintain the environmental quality, reduction of the global temperature should get priority irrespective of the levels of development. In contrast, it is also viewed that aggressive implementation of emission reduction policies will adversely affect the growth and development potentials of many economies [5]. The empirical findings of Anderson and Karpestam [6], Wang et al. [7], Narayan and Smyth [8] and Shahbaz et al. [9], among others, support the later statement implying that reduction of CO_2 emissions without proper development of low carbon technologies will not help in achieving the sustained economic growth for an economy. The essence of the Kyoto Protocol-1997 and the United Nations Climate Change Conference in Copenhagen – 2009 is that both developed and developing countries will have to forgo their high income growth and aspiration of high economic growth, respectively, to achieve a sustainable environmental protection [5]. Hence further empirical investigation of the link between CO_2 emissions, economic growth and energy consumption incorporating some other relevant variables is very significant in the debate on sustainable development with environmental protection.

Though enough attention is not paid, population growth might be one of the major factors for increased CO_2 emissions. More people means increased demand for energy for power, industry and transportation that results in increased fossil fuel emissions [10–13]. The study of Murtaugh and Schlax [14] revealed that one child can produce 20 times more greenhouse gas than a person can save by a big reduction of driving, recycling, use of energy efficient appliances and bulbs, etc.

E-mail address: mafiz.rahman@usq.edu.au.

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Therefore, population density should be considered as an important variable in analysing the CO_2 emissions, growth and energy consumption nexus.

Furthermore, export or trade is also interrelated with energy consumption, and hence with CO_2 emissions. For example, climate change can affect trade via the changed pattern of agricultural production. On the other hand, trade can also influence energy use and climate change through increased production and transportation activities [15,16]. The study of Zhao and Hong [17], among others, found that net exports had an effect on the energy consumption in China while Rahman and Mamun [15] found no Granger causality between energy use and international trade in Australia. Given this fact export or trade is still the important variable to be considered in the investigation of carbon emissions, growth and energy consumption nexus.

Given the above background, this study aims to explore the effects of population density, economic growth, energy use and exports on the CO_2 emissions of 11 Asian most populous countries namely Bangladesh, China, India, Indonesia, Iran, Japan, Korea, Pakistan, the Philippines, Vietnam and Thailand. These populous countries are selected because population and human activities are the main reasons for environmental degradation. The total population of these 11 countries are 51.83% of the world population where just two countries – china and India- contribute 36.52% population in the world [19]. Also five of our sample countries (China, India, Japan, Korea and Iran) are among the top ten CO_2 emitting countries in the world in 2013 [2], and three countries- China, Japan and Korea- are among the world's top 7 exporting countries [20].

The main contributions of this research in the literature are: (i) To the best of knowledge, it is the first empirical study of its kind that involves 11 populous Asian countries; (ii) we have added 'population' as an important variable to analyse the emissions-growth-energy nexus, which was mostly ignored in the past analyses of energy literature; this might help to mitigate the omitted variable bias (iii) we have addressed the endogeneity bias and serial correlation problem adopting the appropriate methodology; (iv) we have tested the robustness of findings; (v) we have verified the combined existence of the environmental Kuznets curve (EKC) in these countries; and (vi) finally, we have initiated a policy discussion that would help the policy makers of these countries.

This study is important because our research findings may provide new avenues for policy makers to formulate and execute a comprehensive economic, trade, population and energy policy for the sustainable growth in these countries. If energy use does not Granger cause gross domestic product (GDP) growth, energy conservation policy may be undertaken in these countries for improving environmental quality without compromising economic growth. If exports or economic growth Granger causes CO_2 emissions, economic growth has to be sacrificed or energy efficient technology has to be used for production to protect environment. If population density Granger causes CO_2 emissions, proper policy should be undertaken for optimum population growth and re-structuring and de-centralising the towns.

The rest of the paper is organised as follows: Section 2 reviews relevant literature; Section 3 describes model, data and methodology; Section 4 presents and analyses the empirical findings; and finally, Section 5 concludes the paper with policy implications.

2. Review of literature

Over the last few decades attempts are made to examine the potential determinants of carbon emissions [21]. In the literature, country specific studies in a bivariate framework are dominant although a few multivariate panel studies (e.g. Farhani and Rejeb [22]) are also visible. Researchers also include some relevant variables such as trade (see Dogan and Turkekul [23]). However, satisfactory and unanimous results are yet to be achieved due to numerous factors like lack of data, use of varied econometric models and methodologies, omitted variable bias, etc. These inconclusive outcomes are not helpful for policy makers to adopt plans for the long term growth [24,25]. Therefore proper knowledge of actual direction of causality among the relevant variables is very crucial.

We would discuss the past empirical studies under five strands of research. The first strand of research focusses on the relationship between economic growth and environmental quality. That is, it tests the existence of EKC hypothesis which states that the relationship between economic growth and CO_2 emissions (proxy for environmental quality) is like an inverted –U shaped nonlinear curve implying that at early stage of development, growth and carbon emissions are positively linked, and after a certain level of development when an economy matures and has the capacity to use carbon efficient technologies, carbon emissions decrease with the increase of economic growth. The studies that tested this hypothesis include, among others, Grossman and Krueger [26], Dinda and Condoo [27], Akbostanci et al. [28], Lean and Smyth [29], Ozturk and Acaravci [24], Pao and Tsai [30], He and Richard [31], Pao et al. [32], Shahbaz et al. [33], Tiwari et al. [34], Kasman and Duman [35] and Ertugrul et al. [21]. However, the obtained results are not unanimous to establish the EKC hypothesis for all economies. For example, while most of these studies validated the existence of the EKC, the studies of Dinda and Condoo [27], Akbostanci et al. [28] and He and Richard [31] found the contradictory results. Akbostanci et al. [28] found an increasing long run linear relationship between CO_2 emissions and economic growth for the Turkish economy. He and Richard [31] also found no strong evidence of the empirical presence of the EKC for the Canadian economy when dealing with 57 years of data.

The second strand of research deals with the relationship between energy consumption and economic growth. In this group, the studies of Akarca and Long [36], Yu and Hwang [37], Stern [18] and Cheng [38] found no causal relationship between energy consumption and income in the USA economy. Yu and Choi [39], Erol and Yu [40] and Rahman and Mamun [15] also found the same results for the UK, France and Australia, respectively. On the other hand, a bi-directional causality among these two variables is found by the studies of Masih and Masih [41], Glasure [42] and Oh and Lee [43] in South Korea, Asafu- Adjaye [44] in Thailand and the Philippines, and Chang [45] in China. Unidirectional causality from energy consumption to output growth is found by the studies of Asafu-Adjaye [44] for Indonesia, Moritomo and Hope [46] for Sri Lanka, Soytas and Sari [47] for Turkey, Shiu and Lam [48] for China, Squalli [49] for Venezuela, Narayan and Singh [50] for Fiji, Bowden and Payne [51] for the USA and Menyah and Wolde-Rufael [52] for South Africa. The reverse unidirectional causality is also revealed by some studies such as Cheng and Lai [53] for Taiwan, Cheng [54] for India, Chang and Wong [55] for Singapore, Soytas and Sari [47] for South Korea, and Ozturk and Acaravci [24] for Turkey.

The third strand of research combines the earlier two approaches where a dynamic relationship between energy consumption, carbon emissions and economic growth is examined, and the obtained results are also mixed in the literature. For example, the studies of Uddin et al. [56] on Sri Lanka, Shahbaz et al. [9] on Indonesia and Ang [57,58] on France and Malaysia reveal that economic growth Granger causes energy consumption and CO_2 emissions. Soytas et al. [59] also found similar result- unidirectional causality running from energy consumption to CO_2 emissions- for the USA where they have used augmented vector auto regression (VAR) approach. Applying the multivariate causality test Chang [45] and Zhang and Cheng [60] found the evidence that economic growth Granger causes energy consumption in China, and that ultimately leads to carbon emissions. The similar results are also found by Menyah and Wolde-Rufael [52] in South Africa and Kasman and Duman [35] in new EU member and candidate countries. Unidirectional causality running from economic growth to energy intensity and carbon emissions is also confirmed by Hossain [3,61] for Greece and Japan where he used Johansen multivariate cointegration approach. On the other hand, non-causality between income and