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What drives carbon dioxide emissions in the long-run? Evidence from selected South Asian Countries

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ABSTRACT

This study empirically investigates the relationship between CO_2 emission and four of its potentially contributing factors (i.e., energy consumption, income, trade openness and population) using time series data from 1971 to 2013 on five selected economies of South Asia. After confirming that all the series are stationary using unit root test process, the study incorporates three different and advance panel cointegration tests i.e. Pedroni- Kao- and Johansen-Fisher-panel cointegration. All the panel cointegration tests confirm that all the variables cointegrated. The long-run association between the variables is checked using FMOLS-grouped and individual cross-section country in the panel. The FMOLS grouped results show that energy consumption, trade openness and population increases environmental degradation in the panel countries with exception of income which has negative impact and sounds the existence of Environmental Kuznet curve between income and emission. The innovative accounting approach using variance decomposition test and impulse response function is applied to examine the causality amongst the underlined vectors. The results show that there is bidirectional causality between energy consumption and trade openness and uni-directional causality running from energy consumption, trade openness and population to CO_2 emission. The results enumerate that the energy consumption and population density will increase in long-run and foresee further environmental degradation in the region.

1. Introduction

In recent years, the relationship between economic growth and environment has been the most debatable topic in both development and environmental economics literature [3]. While considering the environmental consequence of economic growth, the trade-off between economic growth and environmental quality depends upon the optimal use of energy [70]. Hence, the opportunity cost of opting either-increases, if the country is developing [55]. There is a wide range of literature available on growth-emission nexus, but the findings have been mostly inconclusive [4]. Consequently, this notion is becoming highly challenging for the policy makers unless empirical evidences are sufficiently robust and appropriate for policy use.

Since, the economic development has become the top most priority of developing countries, a major portion of their policies and efforts is also directed towards achieving such goal. Thence, over the few decades, the implications of such growth intensive exercise have resulted rapid economic transformation in many of the developing countries. Today, developing countries account more than 50% of world GDP and it is expected to rise to 60% by 2030 [52]. Notwithstanding the various socio-economic policy reforms, trade openness has been common and the most compelling factor behind such economic growth performance [41]. The benefits of trade liberalization are well established in economic theory dating back to Adam Smith's Comparative Advantage theory and the developing countries with open economic policies are the largest beneficiaries of trade liberalization [22]. Furthermore, the last few decades have observed the historic growth trend in global economy which is mainly associated with the trade openness in the form of agreements such as; WTO, NAFTA and ASEAN (See. [60]). Such agreements have made the flow of goods smooth- changing the composition of the total world industrial production. Over the last few decades, global economy has experienced a huge expansion in world aggregate demand and industrial output [54]. Such trends- no doubt produced great economic results for individual countries, however accompanied by some negative impacts especially on environment [67]. As the global economy has transformed into an inorganic economy, it has resulted in global warming due to climate change.

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Rapidly deteriorating environmental conditions is one of the biggest challenges that world is facing today. The ever rising world temperatures, the air-water-soil pollution, the changing pattern of rain are the signs of rapid environmental degradation and mainly associated with the industrialization [2]. The sea level is rising and the threat of global warming is always hanging in the atmosphere. However, the projections are even worse. A recent World Bank report declared that world means temperature is expected to rise 4 °C above the pre-industrial era. Heat extremes, sea-level rise, marine ecosystem, water availability, all have been projected to the dangerous level in the near future (World [15]). Scientific community unanimously declared greenhouse gases as the major cause of the global warming trend. Water vapor, nitrous oxide-N_2O, methane-CH_2, and Carbon dioxide-CO_2 are the major contributors of the greenhouse effect. Of these, water vapor acts as feedback to the climate as it increases the chances of rains. N_2O, CH_2 and CO_2 ethane, nitrous act as "forcing" of climate change as they block the heat from escaping the surface of the earth making the atmosphere warmer. Of these, CO_2 is the most abundantly found in the atmosphere and poses greatest threat to the environment. These greenhouse-gases (GHG) are produced through natural activities as well as through human activities including deforestation, use of fertilizers, biomass burning, and fossil fuel burning.[1]

Environmentalists believe industrial revolution as the root cause of increased GHG emission, which further results in global warming followed by extreme climatic events [46]. Energy being the life blood of modern industry and non-industrial sectors is the major source of emission [63]. The recent data using the comparative analysis between atmospheric samples held in ice-cores and more recent direct measurements, reveals that atmospheric CO_2 has substantially increased since the industrial revolution [50]. Carbon dioxide information analysis center[2] reports that the per capita CO_2 emission has almost doubled since 1950 and similar trend is observed in global energy consumption. With such trends, research has been diverted in the last few decades to investigate the impacts of industrial revolution and economic growth on the climate change. Environmentalists are of the opinion that the production of enormous volume of industrial output requires the use of energy resources. The increase in energy consumption not only produces greenhouse gases, but also reduces the volume of non-renewable resources. Owing to highly energy intensive and fossil fuel driven, the establishment of new industrial units in developing countries largely compromise ecosystem. Therefore, the negative impacts of potential environmental degradation are more severe in developing and emerging countries than developed countries. Thus, investigating the effects of economic growth on environment in developing countries has become an important research topic for both growth and environmental economists.

The number of studies has been conducted on the relationship between economic growth and environment, with per capita income as proxy for economic growth and CO_2 emission as proxy for environmental degradation. Most of these studies test the Environmental Kuznet Curve (EKC) hypothesis. The EKC hypothesis suggests that the relationship between national income and environment is inverted-U shape. It means that the initial phase of economic development reduces the environmental quality, but after the certain threshold level, the environmental quality improves with increasing economic growth. The notable studies that evident such relationship are- [12,13,28,42,63–65,68,69,7]. The rationale behind EKC hypothesis is that economic growth brings technological changes which introduces more environmental friendly techniques of production [69] and that with high income, citizens demand for cleaner environment leading to strict environmental regulations [28].

Other studies have been conducted to test the causal relationship between economic growth and environmental degradation adding more variables like energy consumption, trade openness, urbanization and population [6,23]. Some studies have used data from individual countries while others used cross country data from different regions. Data from developed countries show that the environment has improved in the last few decades and emissions decreased [18], however the developing countries have showed mixed results. A possible reason for this can be that the developing countries have not achieved the level of economic development yet that induces a cleaner environment. However, developing countries have the opportunity to learn from history and to divert their attention to combating environmental degradation in the early stage of their development. Such awareness can help low income countries to develop policies for a cleaner yet environmental friendly production [28]. The increasing research on the topic has already changed the approach of the growth economists and governments to consider environmental concerns while making development policies [18]. Hence, it necessitates further investigations on developing countries that would be helpful in explaining the relationship of economic growth and the environment.

This study aims to investigate the growth-environment nexus in case of selected five South Asian countries (India, Pakistan, Bangladesh, Nepal and Sri Lanka). Because, South Asia is a home of 21% of global population, accounts 4% of global GDP, shares 6% of global energy consumption and contributes 3% to total world merchandise exports [75]. However, region's annual GDP is expected to grow at 8% and energy demand is projected to rise at 7.4% annually till 2020.[3] The competing growth rate between two indicators shows that the regional gross domestic production is highly energy intensive and this notion further caution about the emission potential of the industries. Fig. 1 illustrates the trend in the variables and graph of each cross-section country depicts strong positive correlation between GDP, CO_2 emission, energy consumption (EN), trade openness (TR) and population density (POP). However in recent years, the region has faced frequent natural disasters. For example: in 2004, South Asian tsunami affected 7 countries and killed more than two hundred thousand peoples; the 2008 earthquake in Pakistan followed by two floods in 2010 and 2011- making 10 million people homeless, and recent earthquake in Nepal killed around 9000 people.[4] Moreover the financial loss, health risks and future projections of climate change impacts are far intimidating. The consecutive natural and calamities and changing biodiversity has raises several questions for both environmental and development economists. The recent and projected emission trend forecasts more severe climatic changes and their negative repercussions on ecosystem. The future economic loss from such negative may exceed the threshold level.

This study uses time series data from five selected countries of South Asia (India, Pakistan, Bangladesh, Sri Lanka, and Nepal) to empirically investigate the relationship between CO_2 emissions and four of its potentially contributory factors i.e. energy consumption, income (GDP), trade openness and population. All the countries are developing economies and in transition to industrialization. In such phase of economic development, countries tend to increase their energy consumption to match up with the demands of new industries. However, the study of countries in their initial stage of development is important in order to understand their pattern of CO_2 emission. Developing countries have the opportunity to learn from the history of developed countries and to divert their attention to combat environmental degradation at the early stage of their development. Such awareness can help low income countries to develop policies for a

[1] For details see OECD Environmental Outlook to 2050. http://www.oecd.org/env/indicators-modeling-outlooks/49846090.pdf (Accessed 08.02.2016).

[2] CDIAC, report available at: http://cdiac.ornl.gov.

[3] Projections are made by Asian Development Bank (ADB) and the percentage is compounded growth rate.

[4] For detailed analysis see. UNESCAP report available at: http://www.unescap.org/sites/default/files/Technical%20paper-Overview%20of%20natural%20hazards%20and%20their%20impacts_final.pdf.