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Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development

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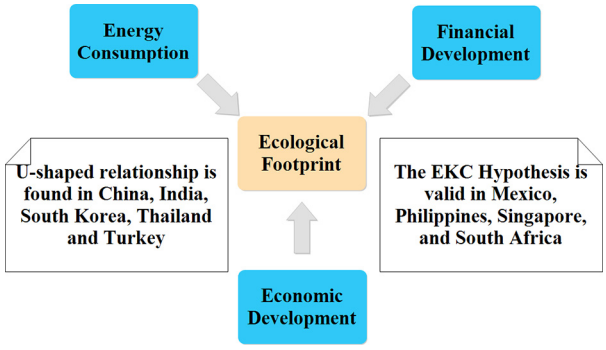
HIGHLIGHTS

- This study examines the validity of environmental Kuznets curve hypothesis.
- There is bidirectional causality between economic growth and ecological footprint.
- The study found a unidirectional causality from economic growth to energy consumption.

GRAPHICAL ABSTRACT



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ABSTRACT

Climate change has become a global phenomenon due to its threat to sustainable development. However, economic development plays a complementary role in both climate change and sustainability. Thus, the environmental Kuznets curve hypothesis is critical to climate change policy formulation and development strategies. Accordingly, this study examined the validity of environmental Kuznets curve hypothesis by investigating the relationship between economic growth, energy consumption, financial development, and ecological footprint for the period from 1977 to 2013 in 11 newly industrialized countries. For this purpose, the study employed both augmented mean group (AMG) estimator and heterogeneous panel causality method which are suitable for dependent and heterogeneous panels. The results of the estimator show that there is an inverted U-shaped relationship between economic growth and ecological footprint. According to the causality test results, it is concluded that there is bi-directional causality between economic growth and ecological footprint.

1. Introduction

In recent decades, increasing visible signs of climate change and global warming have contributed to raising the awareness of

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environmental degradation (Ipcc, 2014). Similarly, the effect of economic activities on environmental degradation has become one of the most attractive topics for researchers. In this regard, the environmental Kuznets curve hypothesis is the most examined hypothesis which explains the relationship between income level and environmental pollution. According to the EKC hypothesis, environmental degradation is increased with the first stages of economic growth to a certain point, and after turning point, the economic development leads to environmental improvements, thus, an inverted U-shaped relationship between economic growth and environmental degradation (Panayotou, 1993).

Most of the studies on the relationship between economic growth and pollution have focused on utilizing carbon dioxide emissions as an indicator of environmental degradation (Salahuddin et al., 2015; Wang et al., 2016). However, carbon dioxide emissions is a portion of environmental degradation. In recent years, the ecological footprint of Wackernagel and Rees (1998) is accepted as the more comprehensive indicator to determine the degree of environmental degradation because it considers cropland, grazing land, fishing grounds, forestland, carbon footprint, and built-up land. Based on the above reasons, the main aim of this study is to examine the effect of economic growth and other possible predictors (energy consumption and financial development) on the ecological footprint for the period 1977–2013 in 11 newly industrialized countries namely South Korea, Singapore, Brazil, China, Turkey, Thailand, Malaysia, Mexico, India, South Africa and Philippines.

The developmental dynamics of the 11 newly industrialized countries make them viable candidates to be studied, to understand their role in ecological footprints and provide more insight into climate change mitigation. The contributions of this study to the existing literature are as follows; first, this is the first study to examine the relationship between economic growth and ecological footprint in newly industrialized countries. Second, as an estimation of a bivariate empirical model may lead to unreliable results, this study uses a multivariate empirical model using energy consumption and financial development as explanatory variables. Third, unlike previous studies, the methodologies used in this study consider cross-sectional dependency and country-specific heterogeneity among countries. Moreover, the empirical findings of each country can be separated using a parameter estimator and causality procedure, therefore, the obtained results will be more policy-oriented.

2. Literature review

There are several studies on the EKC hypothesis in many developed, developing and least developed economies. However, there are different outcomes leading to different policy implications. This suggests the complexity of the EKC hypothesis based on methodologies, the period of the data, and the geographical dynamics. Two categories of previous research are discussed (Table 1).

The first strand of studies examines environmental pollution, energy consumption, and macroeconomic nexus using both time series and panel data. Remuzgo and Sarabia (2015) revealed a decline of global carbon dioxide emissions by 22% due to economic development. Wang et al. (2016) revealed that shocks in carbon dioxide emissions have a small effect on GDP and energy consumption. In China, energy intensity was revealed as the main contributor to carbon dioxide emissions (Ouyang and Lin, 2015). In USA, China, Japan and India, Azam et al. (2016) confirmed a positive relationship between carbon dioxide emissions and economic growth. In Senegal, Sarkodie and Owusu (2017) revealed an increase in carbon dioxide emissions from the effect of energy consumption, financial development, and industrialization while urbanization and GDP reduce carbon dioxide emissions in the long-term. In Nigeria, it was evident that industrialization had no effect on carbon dioxide emission (Lin et al., 2015). In Sri Lanka, there was evidence of a long-run equilibrium relationship, a bidirectional causality between industrialization and energy consumption, and unidirectional causality from carbon dioxide emissions to energy consumption (Sarkodie and Owusu, 2016). In Pakistan, Mohiuddin et al. (2016a) showed evidence of long-run relationship and a unidirectional causality from energy consumption to carbon dioxide emissions. In Malaysia, there was evidence of a unidirectional causality from energy consumption to carbon dioxide emissions (Gul et al., 2015). Jammazi and Aloui (2015) confirmed a bidirectional causality between electricity consumption and economic growth and Salahuddin et al. (2015) a unidirectional causality from electricity consumption to carbon dioxide emissions.

The second strand of studies investigates the environmental Kuznets curve hypothesis. For example, Saidi and Mbarek (2016) tested the validity of EKC in 19 countries from 1990 to 2013 using the ARDL method. Their study found no proof of EKC in the 19 emerging economies. Baek (2015) found no existence of the EKC hypothesis in the 12 nuclear energy intense countries, however, nuclear energy reduces carbon dioxide emissions in the long-run. Apergis and Ozturk (2015) revealed the existence of EKC in the Asian countries while Osabuohien et al. (2014); Sarkodie (2018) validated the existence of EKC in Africa. Tiwari et al. (2013) confirmed the existence of EKC in both long run and short run equilibrium relationship in India. Shahbaz et al. (2012) confirmed the presence of EKC in a long run equilibrium relationship in Pakistan. Hamit-Haggar (2012) revealed the presence of EKC in a long run relationship and a unidirectional causality from energy consumption to greenhouse gas emissions. Pao and Tsai (2011) validated the EKC and found a bidirectional causality between foreign direct investment and carbon dioxide emissions. Nasir and Rehman (2011) revealed a positive effect of energy consumption and foreign trade on carbon dioxide emissions and confirmed the validity of the EKC. Acaravci and Ozturk (2010) revealed a long-run equilibrium relationship running from energy consumption and economic growth on carbon dioxide emissions and validated the presence of EKC in Denmark and Italy.

It is important to note that the above-mentioned literature employs a single environmental pollution indicator (carbon dioxide emissions) to examine the EKC hypothesis which is limited to consumption-based approach making it difficult to understand the dynamics of environmental pressures since available biocapacity is not considered. Significantly, the country's biocapacity affects the outcome of the EKC hypothesis. The analysis of the ecological footprint of emerging economies is critical to mitigating climate change and its impact.

3. Data and methodology

To examine the validity of environmental Kuznets curve (EKC) hypothesis, the annual data for the period 1977 to 2013 is investigated for 11 newly industrialized countries: Brazil, China, India, Malaysia, Mexico, Philippines, Singapore, South Africa, South Korea, Thailand, and Turkey. The 11 newly industrialized countries can be categorized under Very High Human Development, High Human Development and Medium Human Development based on the 2016 Human Development Index (HDI) report. Very High Human Development includes South Korea and Singapore, High Human Development includes Brazil, China, Turkey, Thailand, Malaysia and Mexico, and the Medium Human Development includes India, South Africa, and Philippines (UNDP, 2016).

According to the HDI report, Singapore, a population of 5.6 million population is ranked 5th with HDI = 0.925, exports and imports account for 326.1% of GDP, environmental sustainability stands at 9.4 t of carbon dioxide emissions per capita, a Multidimensional Poverty Index (MPI) not applicable and an Income/Composition of Resources of $78,162 Gross national income (GNI) per capita (UNDP, 2016). Singapore's energy consumption was 47,513.8 GWh of electricity in 2015, comprising of 42.3% industrial related, 36.8% commerce and services, 15% household consumption, 5.1% transport and 0.6% others. Energy imports (173.7 Mtoe) in 2015 were 65.3% petroleum products, 28.5% crude oil, 6% natural gas, 0.4% coal and peat and 0.1% others.