



Testing Environmental Kuznets Curve hypothesis in Asian countries



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ABSTRACT

The aim of this study is to test the Environmental Kuznet Curve (EKC) hypothesis for 14 Asian countries spanning the period 1990–2011. We focused on how both income and policies in these countries affect the income–emissions (environment) relationship. The GMM methodology using panel data is employed in a multivariate framework to test the EKC hypothesis. The multivariate framework includes: CO₂ emissions, GDP per capita, population density, land, industry shares in GDP, and four indicators that measure the quality of institutions. In terms of the presence of an inverted U-shape association between emissions and income per capita, the estimates have the expected signs and are statistically significant, yielding empirical support to the presence of an Environmental Kuznets Curve hypothesis.

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1. Introduction

The relationship between energy consumption and economic growth as well as between economic growth and environmental pollution has been the subject of intense research in the last three decades. However, the empirical evidence remains controversial and is not conclusive to present policy recommendations that can be applied across countries (Acaravci and Ozturk, 2010). The relationship between economic growth, energy consumption and environmental pollutants are analyzed in three different ways in the energy economics literature (Zhang and Cheng, 2009). The first one focuses on the environmental pollutants and economic growth nexus which are closely related to testing the validity of the so-called Environmental Kuznets Curve (EKC) hypothesis. The EKC hypothesis postulates an inverted U-shaped relationship between the level of environmental degradation and income growth. In other words, environmental degradation increases with per capita income during the early stages of economic growth and then declines with per capita income after arriving at a threshold. The studies of Stern (2004), Dinda (2004), Luzzati and Orsini (2009), Halicioglu (2009), Acaravci and Ozturk (2010) and Al-Mulali et al. (2015) among others, provide extensive review surveys of the

literature which tested the economic growth–environmental pollution nexus and the EKC hypothesis.

The second one is related to the energy consumption and output nexus. Apergis and Payne (2009a), Ozturk (2010), Payne (2010), Ozturk et al. (2010) and Lau et al. (2011) provide an extensive review survey of the studies on the empirical results from causality tests between energy consumption and economic growth. The third one is the combined approach of these two methods which investigates the dynamic relationship between economic growth, environmental pollutants and energy consumption in the same framework. The studies of Richmond and Kaufman (2006), Soytaş et al. (2007), Zhang and Cheng (2009), Halicioglu (2009), Apergis and Payne (2009b, 2010), Ozturk and Acaravci (2010), Acaravci and Ozturk (2010), Pao and Tsai (2011), Ozturk and Uddin (2012), Shahbaz et al. (2014), among others, investigate the energy–growth–pollutant nexus in the same framework.

To our knowledge, there is no such a study that uses these variables in the same framework for the countries investigated in this paper. The goal of this study is to test the Environmental Kuznets Curve (EKC) hypothesis for 14 Asian countries spanning the period 1990–2011. The study is gaining interest in the relevant literature since much concern for sustainable development in Asia, especially in China and India, two economies recognized to experience high growth rates over the last years, without any concern relative to environmental pollution issues. Climate change is one of the greatest environmental issues in the Asian region. Given the countries' rapid pace of growth, their performance in mitigating environmental degradation inevitably attracts attention. In addition, these countries are characterized by substantial differences across their

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industrial structure and their level of urbanization, which both are expected to further deteriorate the relationship between their economic growth levels and the pollutant emissions, jeopardizing their substantial economic process (Jiang et al., 2008).

A number of studies document that the cost of inaction on reducing the consumption of fossil fuels would be many times the costs of action. Therefore, there is a growing need to take decisive steps to get the countries in the region on course to make any effort to combat climate change and achieve sustainable development and green growth. Lau et al. (2014) investigate the existence of a long-run relationship among carbon dioxide emissions, institutional quality, exports, and economic growth and further examines the causal relationship among these variables in Malaysia for the period 1984–2008. From the bounds test, it is found that a long run relationship does exist among the variables, even using different conditioning information sets. A positive and significant interaction term between carbon dioxide emissions and institutional quality indicator (i.e. law and order) implies that good institutional quality is important in controlling carbon dioxide emission in the process of economic development. Menegaki (2013) conducts data envelopment analysis for the purpose of calculating inefficiencies in the European countries' growth using as main inputs the variables typically used in the growth–energy literature nexus such as energy consumption, carbon emissions, employment and capital but also with a particular focus on renewable energy sources (RES) consumption. Countries with remarkable renewable energy performance have medium to low efficiency, while renewable energy laggards are among the most technically efficient countries in Europe. There are also specific cases in which a subset of countries in the sample display a number of similarities, in terms of the restrictions imposed on a number of transactions (i.e. related to both the real economic and to the financial sector), of the patterns governing their financial systems, and, of the manner a number of political and institutional idiosyncratic characteristics impact both the workings of the real economy and the country's energy needs. RES barriers in Europe are administrative (delays, lack of co-ordination between authorities, high costs of obtaining licenses, insufficient spatial planning, grid connection and access problems coupled with the obsolete existent infrastructure, which is necessary due to the intermittent nature of RES).

The Asian countries are in dire need of transitioning to a low-carbon future. Given that these economies are heavily dependent on imports with no let-up expected in the near future and relies on fossil fuels to meet their energy needs, while energy demand will continue to grow at levels where these countries will surpass the rest of the world in terms of global energy demand (United Nations, 2010). According to Deacon and Mueller (2004), a country's political system is linked to the way its natural resources and environmental assets can both affect the sustainability of the economic growth path. In other words, both the political environment and the institutional mechanisms have a crucial role to play in assisting the economy to adopt more environmental friendly production patterns. When a country's natural resources or environmental services are capable of generating significant rents, but institutions of democratic governance and the rule of law are not well-established, then potential corruption by government officials can encourage rent-seeking behavior, dissipating the benefits those resources or environmental services would otherwise confer. Moreover, the mix of private versus public good outputs produced by a country's natural resources may be affected by its political system. In that sense when a country's government does not represent the interests of the entire population, but rather acts on behalf of a select group, the use of resource stocks to provide public good amenities may be under-emphasized. Finally, creating property rights that provide incentives for

efficient use of natural resources and environmental conservation requires that economic agents are able to promote a political environment that is able to enforce rules to solve market failures and avoid opportunistic behavior (Deacon and Mueller, 2004).

Given the above motivation, we focus on how both income and policies in these countries affect the income–emissions (environment) relationship. To test the EKC hypothesis, the Generalized Method of Moments (GMM) methodology by Arellano and Bond (1991) has been employed in a multivariate framework which includes: CO₂ emissions, GDP per capita, population density, land, industry shares in GDP, and four indicators that measure the quality of institutions. The rest of the paper is organized as follows. The next section presents the methodology, data and results. The last section concludes the paper.

2. Data, methodology and results

Annual data from 1990 to 2011 are obtained from the *Datstream* database for 14 Asian countries which are Bangladesh, China, India, Indonesia, Iran, Japan, Republic of Korea, Malaysia, Nepal, Oman, Pakistan, Saudi Arabia, Singapore and United Arab Emirates. The multivariate framework includes data on: CO₂ emissions (CO₂), GDP per capita (YC) in 2005 U.S. dollars, population density expressed in thousands persons per square kilometer (POPD), land expressed in square kilometers (LAND), industry shares in GDP measured as the ratio of industrial GDP to total GDP (SHARE), and four indicators that measure the quality of institutions, such as: (i) political stability and absence of violence, reflecting perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism (POL), (ii) government effectiveness, reflecting perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (GOV), (iii) the quality of regulation, reflecting perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development (REG), and (iv) the control of corruption, reflecting perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption (COR).

Tests of dynamic heterogeneity (i.e. variation of the intercept over countries and time) across a cross-section of the relevant variables indicate that the relationships are characterized by heterogeneity in both dynamics and error variances across groups.¹

The functional form depicting the Kuznets curve issue includes quadratic and higher order terms which associate emission levels to a number of determinants. The primary goal of this work is to explore the link between income and carbon dioxide emissions under the spectrum of various energy policies. To this end, our methodological approach is close to that presented by Panayotou

¹ Following Holtz-Eakin et al. (1985) and Holtz-Eakin (1986) several tests of dynamic heterogeneity were performed. First, the ADF (3) test examines the null hypothesis that the regression parameters are equal across equations using an *F*-test. The ADF (3) test statistic for parameter equality, 17.89, rejects the null hypothesis at the 1 percent significance level. Second, a Chow-type *F*-test on a 3rd order autoregressive model, AR(3), for each of the relationships is estimated to test the null hypothesis of parameter equality. The AR(3) test statistic, 25.62, rejects the null hypothesis which indicates heterogeneity in the cross-sectional parameters at the 1 percent significance level. Third, the White test for group-wise heteroskedasticity is used to test the null hypothesis of homogeneity error variance across countries. White's chi-square test statistic, 33.44, rejects the null hypothesis of homogeneity error variance across countries at the 1 percent significance level.

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