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Panel estimation for CO_2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries

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ABSTRACT

This paper empirically examines the dynamic causal relationships between carbon dioxide emissions, energy consumption, economic growth, trade openness and urbanization for the panel of newly industrialized countries (NIC) using the time series data for the period 1971–2007. Using four different panel unit root tests it is found that all panel variables are integrated of order 1. From the Johansen Fisher panel cointegration test it is found that there is a cointegration vector among the variables. The Granger causality test results support that there is no evidence of long-run causal relationship, but there is unidirectional short-run causal relationship from economic growth and trade openness to carbon dioxide emissions, from economic growth to energy consumption, from trade openness to economic growth, from urbanization to economic growth and from trade openness to urbanization. It is found that the long-run elasticity of carbon dioxide emissions with respect to energy consumption (1.2189) is higher than short run elasticity of 0.5984. This indicates that over time higher energy consumption in the newly industrialized countries gives rise to more carbon dioxide emissions as a result our environment will be polluted more. But in respect of economic growth, trade openness and urbanization the environmental quality is found to be normal good in the long-run.

1. Introduction

The increase of greenhouse gases emissions is a major threat to the environment of the world. The rapid economic growth and expansion of the process of industrialization of newly industrialized countries (NIC) impel intensive use of energy and other natural resources as a result more residues and wastes are being released in nature that could lead to environmental degradation. Carbon dioxide (CO_2) is regarded to be the main source of greenhouse effect and has captured great attention in the recent years. Most of the CO_2 emissions come from fossil fuels consumption such as coal, oil and gas.

The Intergovernmental panel on Climate Change (IPCC) report of 2007 reveals that over the last three decades, GHG emissions have increased by an average of 1.6% per year[1] with carbon dioxide (CO_2) emissions from the use of fossil fuels at a rate of 1.9% per year. The CO_2 emissions from energy consumption are rapidly increasing in NIC in recent years compare to other societies. The amount of CO_2 emissions of nine NIC namely Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand and Turkey to world CO_2 emissions from energy consumption in 1980 was 13.90% and in 2009 it became 37.35%, which indicates remarkable cumulative increase of 2.69 times. The amount of CO_2 emissions of nine NIC to world CO_2 emissions from energy consumption over a period of time is shown with the following Fig. 1.[2]

Fig. 1 clearly indicates that the amount of CO_2 emissions of nine NIC from energy consumption is increasing rapidly over a period of times. In the absence of additional policy actions, these emission trends are expected to continue heavily. It is projected that with current policy settings global energy demand and associated supply patterns based on fossil fuels the main drivers of GHG emissions will be continued to grow (IPCC, 2007). Despite continuous improvements in energy intensities, global energy use and supply are projected to continue to grow, especially as developing countries pursue industrialization. Should there be no substantial change in energy policies, the energy mix supplied to run the global economy in the 2025–2030 time frame will essentially remain unchanged and more than 80% of the energy supply will be based on fossil fuels, with consequent implications for GHG emissions. On this basis, the projected emissions of energy-related CO_2 in 2030 will be 40–110% higher than in 2000 (IPCC (2007)). For 2030, GHG emission projections (Kyoto gases)

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[1] Total GHG (Kyoto gases) emissions in 2004 amounted to 49.0 $GtCO_2$-eq, which is up from 28.7 $GtCO_2$-eq in 1970—a 70% increase between 1970 and 2004. In 1990 global GHG emissions were 39.4 $GtCO_2$-eq.

[2] Source: International Energy Statistics: own calculations, units are given in million tones.

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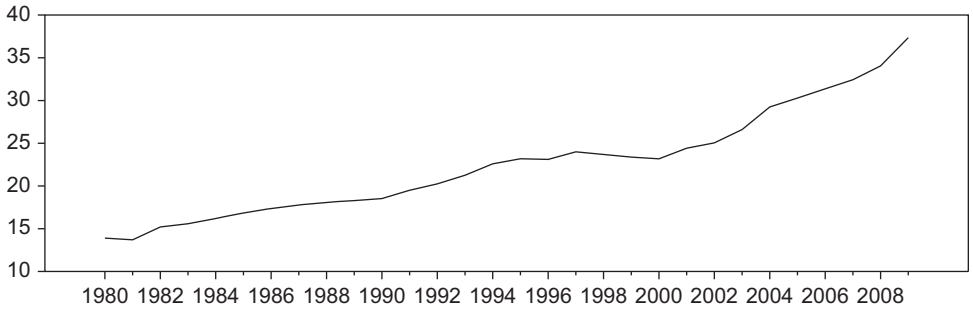

Fig. 1. Percentage of CO_2 emissions of nine NIC of world total.

consistently show a 25–90% increase compared to 2000, with more recent projections being higher than earlier ones. The increasing volume of CO_2 emissions due to expanding and widening of the process of industrialization of newly industrialized countries is the most important determinant factor of the ascending greenhouse threats and CO_2 emissions. Therefore the research of this aspect is becoming more important for all the societies from developing countries to developed countries.

In respect of empirically examine the relationship between economic growth, energy consumption and carbon emissions, which is considered as a proxy variable for environmental quality (Soytas et al., 2007), there has been basically three research strands.

The first strand of research focuses on the environmental pollutants and economic growth nexus. The literature on environmental quality and economic growth study mainly focuses on the testing of the existence of environmental Kuznet's curve (EKC). In this context several research works are as: Grossman and Krueger (1991), Shafik (1994), Heil and Selden (2001), Friedl and Getzner (2003), Dinda and Coondoo (2006), Tamazian and Rao (2009), He and Richard (2010) and Lean and Smyth (2010). The results of such researches are however contradictory and in many cases researchers have failed to establish the inverted U relationship with the real life data.

Despite enormous amounts of literature on energy and output, the second strand of the research mainly focuses on studies that examine the causal relationships between energy consumption and output growth, particularly in the developed and developing countries. A number of studies in this context that have found no causality between energy consumption and income are described by Akarca and Long (1980), Yu and Hwang (1984), Yu and Choi (1985), Erol and Yu (1987), Stern (1993) and Cheng (1995). A number of studies that have found two-way causation are that of Masih and Masih (1997), Asafu and Adjaye (2000), Glasure (2002) and Oh and Lee (2004a, 2004b). Studies that have found unidirectional causation from output to energy consumption are Glasure and Lee (1998), Cheng and Lai (1995), Cheng (1999), Chang and Wong (2001), Soytas and Sari (2003), Narayan and Smyth (2008). A number of studies that have found the direction of causality from energy consumption to output growth are Yu and Choi (1985), Masih and Masih (1996), Asafu and Adjaye (2000), Yang (2000), Soytas and Sari (2003), Morimoto and Hope (2004), Altinay and Karagol (2005), Narayan and Singh (2007), Squalli (2007). In addition, researchers have attempted to incorporate not only output/income or economic development *per se* but also extended their analysis for financial development or for variables capturing openness or trade intensity of a country. The study of Grossman and Krueger (1991) is pioneering in this regard. In recent years Halicioglu (2009) while using Turkish data also incorporated trade into the framework of CO_2 emissions, income and energy consumption for empirical analysis. Their analysis revealed that for Turkish economy income is the most crucial determinant of CO_2 emissions, followed by energy consumption and finally trade. They found two types of relationships among these variables, where one type of relation revealed that CO_2 emissions are determined by not only energy consumption and income but also through trade. The second type of relationship showed those carbon emissions, energy consumption along with foreign trade, all play important role in determining the level of income of Turkey. The importance of foreign trade in determining the level of CO_2 emissions has also been emphasized by Andersson et al. (2009). In their analysis, while attempting to analyze the emission generated in the transport sector, they concentrated on the export of China and found that trade plays an important role in generating emission in transport sector and greater emission is attributable to exports than imports.

Finally, a third stream of research has emerged, which combines earlier two approaches by examining dynamic relationship between carbon emissions, energy consumption and economic growth. A number of studies in this context are of Toda and Yamamoto (1995), Soytas et al. (2007), Akbostanci et al. (2009), Halicioglu (2009), Jalil and Mahmud (2009), Soytas and Sari (2009), Tamazian and Rao (2009), Zhang and Cheng (2009), He and Richard (2010), Lean and Smyth (2010) and Narayan and Narayan (2010).

According to the knowledge of the author, still now no one has emphasized the importance of urbanization in determining the level of carbon dioxide emissions for the panel of NIC. That is why in this paper the principal purpose has been made to examine the dynamic causal relationship between carbon dioxide emissions, energy consumption, economic growth, trade openness and incorporating the variable urbanization for the panel of NIC using the time series data. Also another attempt has been made to examine the Narayan and Narayan (2010) approach for this panel.

The organizational structure of the paper is as follows: Section 2 discusses data sources and some descriptive statistics; Section 3 provides empirical model for this study; Section 4 discusses econometric modeling framework with empirical analyses and Section 5 concludes with a summary of the main findings and policy implications.

2. Data sources and some descriptive statistics

Annual data for carbon dioxide emissions (CO_2) (metric tons per capita), energy consumption (EN) (kg of oil equivalent per capita), trade openness (OPEN) (% of exports and imports of GDP), per capita real GDP (PGDP) (constant 2000 US $) and urbanization (UR) (% urban population of total) are downloaded from the World Bank's Development Indicators. The data is for the period 1971–2007. The newly industrialized countries (NIC), namely Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand and Turkey are considered for this panel analysis. The descriptive statistics, mean value, standard deviation and coefficient of variation of different variables for individuals and also for the panel are given below in Table 1.