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Viewpoint

Economic growth and CO_2 emissions in Malaysia: A cointegration analysis of the Environmental Kuznets Curve

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HIGHLIGHTS

- We tested the dynamic relationship between economic growth and CO_2 emissions.
- The Environmental Kuznets Curve hypothesis was tested using bounds testing approach.
- The empirical analysis confirms the existence of EKC for Malaysia.
- Causality results in an absence of causality between CO_2 and income in the short-run.
- There is uni-directional causality from income to CO_2 emissions in the long-run.

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ABSTRACT

This paper attempts to establish a long-run as well as causal relationship between economic growth and carbon dioxide (CO_2) emissions for Malaysia. Using data for the years from 1980 to 2009, the Environmental Kuznets Curve (EKC) hypothesis was tested utilizing the Auto Regressive Distributed Lag (ARDL) methodology. The empirical results suggest the existence of a long-run relationship between per capita CO_2 emissions and real per capita Gross Domestic Product (GDP) when the CO_2 emissions level is the dependent variable. We found an inverted-U shape relationship between CO_2 emissions and GDP in both short and long-run, thus supporting the EKC hypothesis. The Granger Causality test based on the Vector Error Correction Model (VECM) presents an absence of causality between CO_2 emissions and economic growth in the short-run while demonstrating uni-directional causality from economic growth to CO_2 emissions in the long-run.

1. Introduction

The increasing threat of global warming and climate change has called for more attention and discussion of global environmental issues. Higher global average air and ocean temperatures, widespread melting of snow and ice and a rising global average sea level are some profound evidence of global warming. The Intergovernmental Panel on Climate Change (IPCC) reported a possible increase from 1.1 to 6.4 °C in global temperatures and a rise from 16.5 to 53.8 cm in sea level by 2100 (IPCC, 2007). The major increase in Greenhouse Gas (GHG) is attributed largely to carbon dioxide emissions (CO_2) as the principal gas leading to global warming and climate change (The World Bank, 2007).

The 1971 Nobel Prize winner, Simon Kuznets, suggested that as per capita income increases, income inequality also increases at first but then after a turning point starts to decline (Kuznets, 1955). The inverted-U shaped relationship between income per capita and income inequality can be represented by a bell-shaped curve, a popular phenomenon known as the Kuznets Curve. A similar inverted U-shaped relationship was also found between per capita income and environmental degradation in the early 1990 s through cross-country analysis (Grossman and Krueger, 1991; Shafik and Bandyopadhyay, 1992; Panayotou, 1993). Ever since, the Environmental Kuznets Curve (EKC) hypothesis has become an independent research issue which has provoked a large body of theoretical and empirical literature. An inverted U-shape relationship between economic growth and environmental degradation is described by the EKC in which, environmental degradation increases with economic growth, reaches its maximum level and decreases when the economy reaches the given critical high level of income.

The major explanations on the possibility of an inverted U-shaped relationship between economic growth and environmental pollution are based on three different channels: *scale* effect, *composition* effect and *technique* effect (Grossman and Krueger, 1991). Based on the *scale* effect, economic growth has a negative impact on the environment. All else being equal, with

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economic growth an increase in production will result in increased pollution and environmental degradation. On the other hand *composition* effect may be positive for the environment. During economic development, the structure of the economy changes, as in the earlier stages pollution increases with the changes in a country's economic structure from mainly agricultural production to more resource intensive heavy manufacturing industries and in later stages of development pollution decreases as the structure shifts towards service and light manufacturing industries. Finally *technique* effect suggests that, with economic growth dirty and obsolete technologies are replaced by new and cleaner ones which improves environmental quality. Based on EKC, the negative impacts of *scale* effects on the environment tend to dominate in the initial stages of economic growth but the positive impacts of *composition* and *technique* effects that tend to decrease emissions levels prevail at the declining stage (Stern, 2004).

Testing the EKC hypothesis becomes increasingly important as it predicts that economic growth is a solution for environmental problems in the future with no policy intervention. The EKC hypothesis has been tested for many indicators of environmental degradation including: deforestation (Panayotou, 1993; Koop and Tole, 1999; Bhattarai and Hammig, 2001; Bulte and van Soest, 2001), carbon emissions (Holtz-Eakin and Selden, 1995; Dinda, 2001; Robers and Grimes, 1997), sulfur dioxide (Grossman and Krueger, 1991; Selden and Song, 1994; De Bruyn, 1997; Stern et al., 1996; Kaufmann et al., 1998) and municipal waste (Shafik and Bandyopadhyay, 1992; Shafik, 1994; Vincent, 1997; Rothman, 1998; Koop and Tole, 1999; Bhattarai and Hammig, 2001).

However, the empirical evidence in support of delinking CO_2 emissions and economic growth has not yet been conclusive compared to other air and water pollutants. Whereas some research found a linear relationship between CO_2 emissions and per capita income (Shafik and Bandyopadhyay, 1992; Shafik, 1994; Azomahou et al., 2006) others reported an inverted U-shaped relationship (Robers and Grimes, 1997; Cole et al., 1997; Schmalensee et al., 1998; Galeotti and Lanza, 1999; Apergis and Payne, 2009; Lean and Smyth, 2010) or even an N-shaped relationship (Shafik, 1994 ; Grossman and Krueger, 1995).

Many literatures (Hill and Magnani, 2002; Dinda, 2004; Stern, 2004) show that most studies on the EKC used either panel or cross-section data for a group of developed and/or developing countries to establish a link between economic growth and environmental degradation. While these studies provide a general understanding of how the variables are related, they are unable to offer much guidance on policy implications for each country (Ang, 2008). This is because individual countries do not possess the same pollution path as was assumed in panel data analysis (Stern et al., 1996; Carson et al., 1997; Lindmark 2002; Friedl and Getzner, 2003). For example Vincent (1997), in a study for Malaysia, concluded that pollution-income relationships from the cross-country studies (Grossman and Krueger, 1991; Shafik and Bandyopadhyay, 1992; Panayotou, 1993; Selden and Song, 1994) fail to accurately predict the trends in air and water pollution in Malaysia. In particular, none of the pollution-income relationships (total suspended particulates, biochemical oxygen demand, chemical oxygen demand, ammoniacal nitrogen, pH and suspended solids) estimated for Malaysia have the hypothesized EKC form, which is inconsistent with the predictions of the cross-country studies. The lack of a common EKC for all countries shows the necessity to carry out studies on individual countries to ensure institution of effective, sustainable, development policies. Stern et al. (1996) believe that "a more fruitful approach to the analysis of the relationship between economic growth and environmental impact would be the examination of the historical experience of individual countries, using econometric and also qualitative historical analysis" (p.1159).

Since then a new trend of research appeared in which the EKC hypothesis is tested using time series data for individual countries. Studies using time series data for a single country include those of Dijkgraaf and Vollebergh (1998) for individual OECD countries; De Bruyn et al. (1998) for Netherlands, West Germany, UK and USA; Roca et al. (2001) for Spain; Day and Grafton (2003) for Canada and Friedl and Getzner (2003) for Austria. As pointed out by Lindmark (2002) a major advantage of individual country studies is bringing the analysis closer to the dynamic. In other words EKC is a long-run phenomenon as it depicts the development trajectory for a single economy that grows through different stages over time (Dinda, 2004).

With the improvement of time series econometric techniques, the focus of research has changed to testing cointegration and causal relationship on the basis of the EKC hypothesis. Egli (2004) argues that the distinction between short and long-run effects of economic growth on environmental degradation is important therefore equations with explicit short and long-term dynamics should be preferred.

Recent work by Akbostanci et al. (2009) investigated the cointegration relationship between economic growth and CO_2 emissions for Turkey. In another study Fodha and Zaghdoud (2010) explore the cointegration and causal relationship between economic growth and pollutant emissions (CO_2 and SO_2) based on the EKC hypothesis for Tunisia. In a recent study Jaunky (2010) tested the cointegration and causal relationship between economic growth and CO_2 emissions on the basis of the EKC hypothesis for 36 high-income countries. They provided evidence in support of the EKC hypothesis in the cases of Greece, Malta, Oman, Portugal and the United Kingdom. Another study by Esteve and Tamarit (in press) modeled the long-run relationship between CO_2 emissions and income for Spain. They conclude a non-linear relationship between the variables pointing to the existence of an EKC.

Some studies included other potential determinants of CO_2 emissions such as energy consumption by Ang (2007), Soytas and Sari (2007), Menyah and Wolde-Rufael (2010) and Ozturk and Acaravci (2010); foreign trade in order to test the pollution haven hypothesis by Halicioglu (2009), Jalil and Mahmud (2009) and Nasir and Rehman (2011); urbanization by Zhang and Cheng (2009), Iwata et al. (2010) and Hossain (2011) and employment by Sari and Soytas (2009) and Ghosh (2010).

However, the multivariate studies also produce conflicting results on the existence of EKC. While Ang (2007) and Iwata et al. (2010) for France, Jalil and Mahmud (2009) for China and Nasir and Rehman (2011) for Pakistan succeed in finding an inverted-U shaped curve between economic growth and CO_2 emissions, others could not (Soytas and Sari, 2007; Halicioglu, 2009; Ozturk and Acaravci, 2010 all for turkey; Menyah and Wolde-Rufael, 2010 for South Africa).

Inconclusive results regarding the existence of EKC in studies on individual countries cannot be extrapolated as evidence of similar results for all countries. For example, existence of the decoupling phase of the EKC between economic growth and CO_2 emissions in Turkey is not yet apparent in testing when employing different econometric methodologies with different time periods and different additional variables. Soytas and Sari (2007), Akbostanci et al. (2009), Halicioglu (2009) and Ozturk and Acaravci (2010) conclude that there is no inverted-U shaped relationship between income and CO_2 emissions in Turkey. In other words the empirical results are sensitive to the country/countries chosen, period of time considered, chosen estimation technique and the use of different control variables in the model.

Furthermore earlier empirical studies consider testing causality along with testing the cointegration to see if the long-run relationship between environmental degradation and economic