



Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets curve in Malaysia



Behnaz Saboori*, Jamalludin Sulaiman

Economics Programme, School of Social Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

HIGHLIGHTS

- We investigated the EKC hypothesis by using Malaysian energy aggregated and disaggregated data.
- It was found that the EKC is not supported, using the aggregated data (energy consumption).
- However using disaggregated energy data (oil, coal and electricity) there is evidence of EKC.
- Causality shows no causal relationship between economic growth and energy consumption in the short-run.
- Economic growth Granger causes energy consumption and energy consumption causes CO₂ emissions in long-run.

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ABSTRACT

This paper tests for the short and long-run relationship between economic growth, carbon dioxide (CO₂) emissions and energy consumption, using the Environmental Kuznets Curve (EKC) by employing both the aggregated and disaggregated energy consumption data in Malaysia for the period 1980–2009. The Autoregressive Distributed Lag (ARDL) methodology and Johansen–Juselius maximum likelihood approach were used to test the cointegration relationship; and the Granger causality test, based on the vector error correction model (VECM), to test for causality. The study does not support an inverted U-shaped relationship (EKC) when aggregated energy consumption data was used. When data was disaggregated based on different energy sources such as oil, coal, gas and electricity, the study does show evidences of the EKC hypothesis. The long-run Granger causality test shows that there is bi-directional causality between economic growth and CO₂ emissions, with coal, gas, electricity and oil consumption. This suggests that decreasing energy consumption such as coal, gas, electricity and oil appears to be an effective way to control CO₂ emissions but simultaneously will hinder economic growth. Thus suitable policies related to the efficient consumption of energy resources and consumption of renewable sources are required.

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1. Introduction

Nowadays, Greenhouse gases (GHG) and resulted global warming and climate change are well debated among scientists, researchers, head of states, government and policy makers. Carbon dioxide (CO₂) emissions as the most important anthropogenic GHGs, which are responsible for more than 60% of the greenhouse effect (Ozturk and Acaravci, 2010), significantly contribute to the increase in global temperatures and climate change (IPCC, 1996). The main part of the increase in CO₂ emissions can be attributed to

energy consumption especially, fossil fuels burning such as oil, gas and coal.

While conserving energy consumption may be the most direct way of managing the emissions problem, this reduction at the expense of economic growth may not be a desirable outcome (Lotfalipour et al., 2010). This is because of the significant relationship between economic growth, energy consumption and CO₂ emissions.

Malaysia, a high income developing country in South East Asia, experienced remarkable economic growth over the past three decades. Likewise other developing countries, energy played a significant role in boosting economic growth. Energy consumption in Malaysia increased by average annual growth rate of 6.76% in 2010 to settle at 72646 kilo tone of oil equivalent (ktoe) from 6093 ktoe in 1971 (world Bank, world development indicator).

* Corresponding author. Tel.: +601 7616 8939.

E-mail address: behnazsaboori@yahoo.com (B. Saboori).

The Four-Fuel Diversification policy in 1981 and the Five-Fuel Diversification policy in 2002 were introduced by Malaysian government to decrease the dependency of the country to oil as a main energy sources. As a result, the share of oil and petroleum products in primary energy supply declined from 75.55% in 1980 to 32% in 2010. Natural gas has become the main supplier of energy consumption (47.17%) followed by oil (32%), coal (18.87%) and hydropower (2.14%) in 2010.

Despite of the implementation of various energy related policies, Malaysia is still dependent on fossil fuels sources such as natural gas, coal and oil (Oh et al., 2010). With the growing energy demand in sustaining the country's economic growth in the future, it is inevitable that CO₂ emission will continue to increase, with fossil fuels as the main contributor in the energy supply and demand.

So far, the existing literatures utilized aggregate energy data to investigate the relationship between economic growth, energy consumption and CO₂ emissions. Since different sources of energy may have different impacts on economic growth and CO₂ emissions, the relationship between CO₂ emissions, disaggregate energy consumption and economic growth undoubtedly has significant implication for economic and environmental policies.

The aim of this study is to investigate the long-run and causal relationship between CO₂ emissions, economic growth and disaggregate energy consumption (oil, coal, electricity, and gas consumption) in Malaysia in order to minimize the aggregation bias problem. This may help policy makers in implementation of suitable policies to identify the effects of different type of energy sources on economic growth and CO₂ emissions.

The rest of the paper is structured as follows: Section 2 briefly describes energy context in Malaysia, Section 3 explains the previous studies, the proposed model and data are discussed in Section 4, methodology in Section 5, empirical results are presented in Section 6, discussion and policy implications are reported in Section 7 and the last section states the conclusions.

2. Malaysian context

Over the last three decades, Malaysia experienced a rapid economic growth. From 1961 to 1997 (before financial crisis) economic growth increased by an annual average growth rate of 7.26%. From 1999 to 2008 (before Asian financial crisis), Malaysia experienced 5.55% increased in its annual average growth rate.

Economic growth was higher than 7% and 5% in 2010 and 2011, respectively. In line with economic growth, energy use increased from 65,692 ktoe in 2009 to 78,298 ktoe in 2010 (0.2%). According to Ninth Malaysia Plan, 2006–2010, transportation sector is the first largest energy consumer (40.57%) in 2010 followed by industrial (31.16%), residential and commercial (16.76%), non-energy (8.9%) and agricultural sectors (2.59%).

Over time, a variety of energy related policies have been implemented by Malaysian government in order to promote sustainable economic growth, to promise energy supply and at the same time to consider environmental issues. In 1975 the national petroleum policy was implemented in order to efficient utilization of oil resources. In 1979, the National Energy Policy was implemented as the first serious policy with supply, utilization and environmental issues as the three main objectives. In 1980 the National Depletion Policy was implemented. The policy aimed to make the life time of oil and gas reserves longer. Later the diversification in energy consumption was introduced by Four-fuel Diversification Policy. The policy was aimed to make a balanced consumption of oil, gas, hydro and coal. This will decrease the country's dependency on a specific energy sources. In 2001 consumption of renewable energy sources was included to the energy mix of the country through implementation of the Five-fuel Diversification policy. The policy was aimed to increase the contribution of renewable energy to 5% of total energy mix by 2010.

Despite of the importance of fuel diversification in energy security and Malaysia's effort on fuel diversification through implementation of different policies, fossil fuels such as oil and gas are still the main contributor of energy mix in the country. In other word, fossil fuels are the main contributor of energy mix however their shares of energy mix have been changed over time (Fig. 1).

In 1978 total primary energy supply is 9310 ktoe in which oil contribute the largest share (75.42%) followed by gas (21.71%), hydro (2.62%) and coal (0.25). 10 years later in 1988, total primary supply doubled to settle at 18,051 ktoe. The share of oil in total energy supply decreased to 56.68% followed by gas (34.74%), hydro (7.14) and coal (1.44%). In 1998 total primary supply increased 100% to reach 36,446 ktoe. Oil is still the largest contributor to the energy supply. However its share decreased to 52.28%. The share of gas and coal increased to 39.92% and 4.75% in 1998, respectively. The share of oil consumption from total primary energy supply even decreased more to 42.36 and 31.94% in 2008 and 2010,

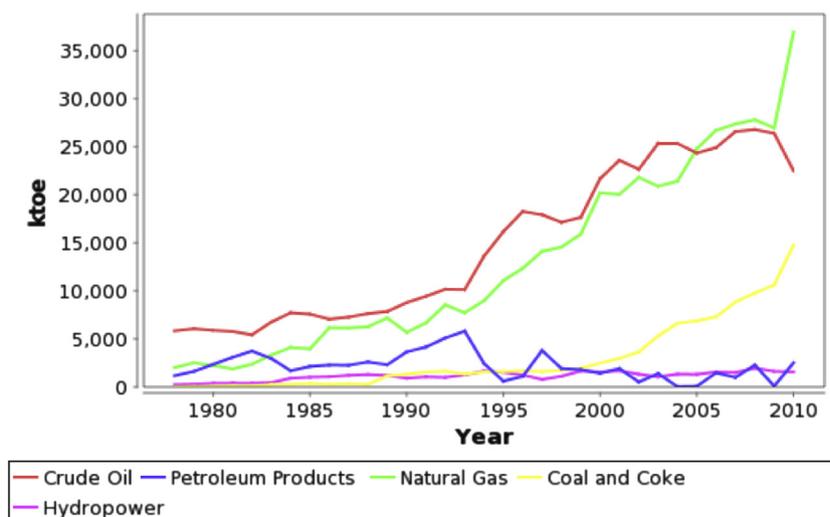


Fig. 1. Primary energy supply by fuel type. References: Malaysia Energy Information Hub, MEIH (<http://meih.st.gov.my/>)

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