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Dynamic linkages among transport energy consumption, income and CO_2 emission in Malaysia

A.A. Azlina [a,*], Siong Hook Law [b,1], Nik Hashim Nik Mustapha [a,2]

[a] Department of Economics, Universiti Malaysia Terengganu (UMT), 21030 Kuala Terengganu, Terengganu, Malaysia
[b] Department of Economics, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

HIGHLIGHTS

- We examine the dynamic relationship among energy consumption in transportation sector, income and CO_2 and also attempts to validate the environmental Kuznet curve (EKC) hypothesis.
- We used a multivariate approach based on VECM.
- The inverted U-shape EKC hypothesis is not valid in the case of Malaysia.
- Uni-directional causality exists from emission to income, energy consumption and renewable energy use.
- Income Granger-causes energy consumption and renewable energy use, and both structural change and renewable energy use Granger-cause energy consumption in road transportation.

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ABSTRACT

This paper examines the dynamic relationship between income, energy use and carbon dioxide (CO_2) emissions in Malaysia using time-series data during 1975 to 2011. This study also attempts to validate the environmental Kuznet curve (EKC) hypothesis. Applying a multivariate model of income, energy consumption in the transportation sector, carbon emissions, structural change in the economy and renewable energy use, the empirical evidence confirmed that there is a long-run relationship between the variables as shown by the result of co-integration analysis. The results indicate that the inverted U-shape EKC hypothesis does not fully agree with the theory. The coefficient of squared GDP is not statistically different from zero. The time duration and the annual data used for the present study do not seem to strongly validate the existence of EKC hypothesis in the case of Malaysia. Causality test shows that the relationship between GDP and CO_2 is unidirectional. The Granger causality test results reveal that emissions Granger-cause income, energy consumption and renewable energy use. Moreover, we find that income Granger-causes energy consumption and renewable energy use, and both structural change and renewable energy use Granger-cause energy consumption in road transportation.

1. Introduction

The increasing threat of global warming and climate change has been one of the most urgent environmental problems in the last two decades. Among several pollutants that have been linked to climate change, energy consumption has been generally identified as a major contributor to environmental pollution. As a consequence, many empirical studies on the relationships between economic growth and environmental pollution as well as between economic growth and energy consumption have been conducted in developed and developing countries (see Ang, 2007; Zhang and Cheng, 2009; Menyah and Wolde-Rufael, 2010; Ozturk and Acaravci, 2010, Azlina and Nik Mustapha, 2012; among others). Economists and environmentalists have investigated this nexus of relationships because it has important implications from the theoretical, practical and policy points of view. For instance, if energy use is found to Granger-cause economic growth, it implies that growth requires energy and decreasing in energy use will possibly restrain economic development. Thus, the implementation of energy conservation policies may severely affect

* Corresponding author. Tel.: +60 9 668 4270; fax: +60 9 668 4237.
E-mail addresses: aqlina@umt.edu.my, nq1408@yahoo.com (A.A. Azlina), lawsh@upm.edu.my (S.H. Law), nhm06@umt.edu.my (N.H. Nik Mustapha).
[1] Tel.: +60 3 8946 7768; fax: +60 3 8948 6188.
[2] Tel.: +60 9 668 4856; fax: +60 9 668 4285.

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economic performance and retard economic growth. In contrast, if economic growth is found to Granger-cause energy use, it shows that energy conservation policies may be adopted without much concern for negative effects on economic growth. Likewise, if emission is found to Granger-cause economic growth, any policies that decrease CO_2 emissions will lead to a reduction in economic growth. On the other hand, if economic growth is found to Granger-cause emission, it may be possible to reduce emission without having a negative impact on economic growth.

As one of the most advanced developing countries in the Association of Southeast Asia Nation (ASEAN), Malaysia has experienced tremendous economic development in the last three decades. As Malaysia's economic activities globalise, there is a strong interactive connection between economic growth and energy consumption. The economic transition from agriculture to industry and then to services, has increasingly played an important role in the emerging growth in energy consumption. This process, which also known as the structural change in the economy, has also give a huge impact in the transportation sector. Transportation is one of the most energy intensive sectors in Malaysia. This sector has been regarded as the second largest energy user in the economy after industrial sector and they are responsible for approximately 40% of total energy consumption in Malaysia. Transportation activities are heavily dependent on the combustion of energy such as petroleum fuels, namely gasoline and diesel. Therefore, this sector contributes significantly to the greenhouse gas (GHG) emission. In addition, emissions from transportation are the fastest-growing source of CO_2 emissions, with the vast majority of projected increases expected to come from developing countries. Ong et al. (2012) highlighted that the transportation sector contributes to a growing share of total emissions. A recent empirical study by Chandran and Tang (2013) found that energy consumption in the road transportation sector significantly contributes to environmental pollution, particularly CO_2 emissions, in Malaysia. Therefore, it is important to investigate not only the impact of energy consumption in the transportation sector on pollutant emissions, but also the relationship between energy consumption, income and emission in Malaysia.

This study examines the dynamic linkages among income, energy use and CO_2 emissions in the case of Malaysia using time-series analysis during 1975 to 2011.Given the continuous economic growth of Malaysia, it is interesting to analyse the relationship among these variables to understand the role of economic growth and energy use in a small open economy. With the aim of contributing to the research on the EKC hypothesis for CO_2 emissions, this study provides new evidence from Malaysia by focusing on energy consumption from the transportation sector. This approach is of interest given that the energy consumption in the transportation sector in Malaysia is increasing not only with economic growth but also with CO_2 emissions. Moreover, as reported by World Development Indicators (World Bank, 2014), the CO_2 emissions from the transportation sector as a percentage of total fuel combustion in Malaysia have been the highest of all manufacturing industries and construction since 2009. It is reported that CO_2 emissions from the transportation sector in 2009 and 2010 are 24% and 23%, respectively, while the CO_2 emissions from manufacturing industries and construction are 20% and 17% in 2009 and 2010, respectively. Thus, it is essential to understand the impact of energy use in transportation sectors on determining CO_2 emissions.

This study also focuses on two other variables that have not been considered by other researchers, particularly in the case of Malaysia. First, the structural changes in the economy proxied by the share of the industry sector in the total GDP attempt to measure the importance of economic structure in explaining CO_2 emissions. The share of the industry sector in the national income can be used to represent economic structure because the industry sector is a major energy-using sector in many countries (Chan and Lee, 1996). The structural change in the economy, which is reflected by a higher degree of industrialisation, tends to be associated with greater CO_2 emissions. Second, the renewable energy use variable is used. Due to the increasing concern over issues related to global warming and climate change, a number of developing economies have started to explore the use of renewable energy as an alternative to current energy sources. Strategically located between 1° and 7° north of the Equator, Malaysia is endowed with an abundance of natural resources for renewable energy exploitation. As one of the most rapidly developing ASEAN countries, Malaysia is in the midst of exploiting the use of renewable energy such as solar, wind, hydro and biomass power. A negative relationship between renewable energy and CO_2 emissions is expected as the higher renewable energy usage will lower the CO_2 emissions.

This study also fills the research gap in the literature by studying the dynamic linkages between the emissions–energy–growth nexus based on multivariate models, which not only deal with economic theory but also focus on other aspects that have been neglected in previous studies. The framework for the analysis is the economic interaction between energy consumption, economic growth, pollutant emissions, the structure of economy and renewable energy use. The Vector Error Correction Model (VECM) approach is employed which allows all these variables to be endogenous. Through the error correction term (ECT), the model opens up additional channels of causality which is traditionally ignored by the standard (VAR based) Granger causality tests. For example, it allows for both energy and GDP to have a causal relationship with a third endogenous variable, without restricting the direction of this relationship. This would explain the correlation between GDP and energy without implying that there is a causal relationship between the two. Another advantage of VECM approach is that it captures both short-run dynamics and long-run equilibrium. This allows a distinction to be made between short-run and long-run causality.

The results of this study are expected to be an important reference for the government of Malaysia to formulate long-term energy policies to ensure the long-term reliability and security of energy resources and environmental sustainability without having to jeopardise economic growth. The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 addresses the empirical model specification, a description of the data used in the empirical analysis and the econometric methodology. Section 4 reports the empirical results, and Section 5 discusses the policy implications of the findings and concludes the paper.

2. A brief literature review

There is a vast body of literature that empirically investigates the emissions–growth nexus in which this nexus is closely related to testing the validity of the environmental Kuznets curve (EKC) hypothesis. The EKC hypothesis argues that pollution increases initially as a country develops its industry and then declines after reaching a certain level of economic progress. That is, there is an inverted U-shaped relationship between economic growth and environmental degradation. There is also a large body of literature that considers the energy-growth nexus. This nexus suggests that economic growth is closely related to energy consumption because higher economic development requires more energy consumption, and more efficient energy use requires a higher level of economic development (Halicioglu, 2009). Recently,