TECHMIND RESEARCH
ISSN: 2292-1648
International Journal of Management Excellence
Volume 6 No. 1 December 2015

# $CO_2$ Emission, Energy Consumption and Economic Development in Malaysia

Hamizah bt Muhyidin[1], Md. Khaled Saifullah[2*], Yap Su Fei[3]
[1,2&3]Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia.
hamizahmuhyidin@gmail.com[1]
ronykhaled@gmail.com[2]
g2yss@um.edu.my[3]

* Corresponding author

**Abstract-** *Environmental awareness and its relation to the development of economy have garnered increased attention in recent years. This study analyzes the long-run relationship between environment degradation, economic growth, total energy consumption and industrial production index growth in Malaysia from year 1970 to 2012. The time series data are estimated using Johansen and Julies Cointegration test and VECM Granger causality test. The empirical analysis suggests a long-run cointegration relationship between all series. Granger causality analysis indicates strong evidence of uni-directional Granger causality running from economic growth and industrial production index growth to total energy consumption in the long-run. Also, the result shows evidence of a bi-directional Granger causality between total energy consumption and $CO_2$ emission. This situation suggests that a pollution abatement policies and higher investment to control for $CO_2$ emission will not jeopardize the economic sustainability and industry output in the long run. This study suggests that previous policies should be complimented with increasing the efficiency of energy use by employing a fuel balancing strategies and promoting the use of renewable energy resources like bio-fuel, solar energy and wind.*

**Keywords-** *Energy economics; CO2 Emission; Environment Degradation; Economic Development.*

## 1. INTRODUCTION

Environmental awareness and its relation to the development of economy have garnered increased attention in recent years. Generally, the relations between these two factors are interdependent and they run in both ways. For example, the development of economy may have a great impact on environment (i.e pollution, depleting resources) while in the long run, any environmental changes may also have a great impact on the economy. As Malaysia began to rise economically, the relation between its economic growth and the demand and supply of energy are becoming stronger. The energy sector of Malaysia is mostly dependent on fuel with 55% of its total energy demands are met by petroleum products, electricity with 21% and natural gas at 20% (MEIH, 2011). However, consumption of non-renewable fuels is declining, which contribute to a higher greenhouse gas emission (GHG) with emission generated from carbon as the most significant of anthropogenic GHG. $CO_2$ emission is accountable for more than half of the effect to the greenhouse effect level or that has contributed significantly on the increase of global warming and climate changes (Saboori and Sulaiman, 2013)[16].

Therefore, this situation poses the question whether Malaysia is able to continue developing while maintaining its environmental condition (resources security, $CO_2$ emission). In recent years, the Malaysian government has been developing greener energy policies to curb the problem of depleting resources and pollution in the country (Azlina and Mustapha, 2012)[4]. However, to control the $CO_2$ emission while sustaining the economic growth, it is crucial to have a better grasp on the long-run relationship and the causality between the income of a country, its environmental degradation and energy used by the population of the specified country.

An economy-specified study is preferable to a cross-sectional study due to the complexity of the economic conditions of each country and its environment (Ang, 2008)[1]. A cross-sectional study would only provide the general assessment of how each variable are connected to each other while an in-depth study of a specific country would suggest a more comprehensive answers to issue at hand, thus providing more information for developing policy accordingly. While Malaysia is continuously growing economically, it does not automatically translate to greater effort in maintaining the environment condition as what have been seen in developed country. Since the theoretical literature on pollution emission, energy consumption and economic development has been establish for Malaysia, this study would include industrial production growth index (IPI) as well. Basically, it is argued that industry (manufacturing, electricity and mining) demands the most energy in Malaysia and thus

produces the most toxic emission. Also, according to the data released by Malaysia's department of statistics (2011), the IPI represents close to 40% of Malaysia's total economy. This study aims to explore the long-run relationship between $CO_2$ emissions, income of the country, total energy consumption and industrial production index growth in Malaysia.

## 2. LITERATURE REVIEW

Over the years, Malaysia has shown a rapid economic development. The nation grows annually at the rate of 7.26% during the period before the financial crisis (1961 to 1997). Following the subsequent years up to the Asian financial crisis (1999 to 2008), the nation experienced an increase of 5.55% for its average growth rate annually. The average annual growth rate for year 2010 and 2011 were 8% and 5% respectively. In conjunction with economic development, Malaysia's energy consumption increased from 41,475 (kt) in 2010 to 43,433 (kt) in 2011 (MEIH, 2011).

According to APEC 2013 outlook, natural gas share in the industry is projected to be at least 35% of total industry demand followed by oil and electricity with 28% respectively. This value is projected to be in the year 2035 as it echoes the improvement in efficiencies within the industries as they become less dependent on energy. Meanwhile, the $CO_2$ emission from fossil fuel is projected to increase by 46% in the year 2035. The main sources of $CO_2$ emission would be energy generated by electricity with 33%, transportation with 24% and lastly the industry sector with 21%. This evidence necessitates a study on the long-run relationship and the causality between the country's total energy use by the population, industrial production index development, GDP growth and $CO_2$ emissions. The research on income, pollutant emission and total energy consumption has been widely acknowledged in recent years and thus categorized into three research classifications.

### 2.1 Income and Environmental Degradation

Grossman and Krueger in 1991 was the pioneer researchers set out to validate the U-shaped pattern that are claimed by the EKC hypothesis in the relationship between income and environment degradation over time. In 2006, Dinda collaborated with Coondoo to study the evidence of EKC over 88 countries using panel data analysis. Their study of Granger causality test found a weak evidence of two way relationship between pollutant emission and real income level.

Lee and Chang (2007) [11] argued the traditional panel data analysis method used by Dinda and Coodoo (2006)[7] as they re-investigated the data for stationarity. Their study provides important implication for future study involving $CO_2$ emission and GDP per capita modeling that do not have the same order of integration. A re-estimation of $CO_2$ emissions as a function of Malaysia economy are conducted by Mugableha (2013)[13]. The author employed the ARDL bound test for cointegration in the study. He suggested that Malaysia is an energy-dependent economy, as results from the long run cointegration analysis which shows that there exist a positive relationship from total energy use by the population to income development level in the country.

### 2.2 Income and Energy Consumption

It has been shown that income level and total energy consumption relationship are positively and closely related especially in developing economies. As the economy grows, the more energy it consumes.

Kraft and Kraft (1978)[9] tested the causality between GNP of U.S economies to total energy use by the population through the methodology described in Sim (1972)[18]. The author found that there is a one way causality from GNP per capita to total energy use by the population in the U.S economy. Yang (2000)[19] pioneered the test of causality through Granger method testing between real income development levels and disaggregate energy use by the population (electricity, coal, natural gas and oil). The study found a two way causality between aggregate energy use/one particular energy sources to real income development within the country.

As for Malaysian context, Shaari et.al (2012)[17] conducted the cointegration and causality test to examine the link between disaggregate energy resources of energy use by the population of Malaysia to income development level. Causality test estimated a unidirectional causality through Granger method testing from energy consumption of gas energy resources towards income level development thus any policies regarding utilization of gas consumption would negatively affect Malaysia's economy growth.

### 2.3 Income, Energy Consumption and Environmental Degradation

Richmond and Kaufman (2006)[15] shed some lights on the relationship between fuel consumption, income development level and emission of carbon dioxide for both OECD and non-OECD countries. Estimation of OECD data shows the evidence of turning point while estimation of non-OECD data indicates a positive relationship between the three variables without a turning point.

Industrial output are known to emit high level of pollution especially from developing countries. Chen (2009)[5] found a positive relationship between total energy use by the population and capital to the industrial production index growth. Ozkan and Ozkan (2012)[14] in their study of the long run period analysis between industrial production index growth and environmental degradation for Turkey economy found that $CO_2$ emission were mostly affected by a shock given to industrial production growth.

## 3. RESEARCH METHODS AND DATA SOURCE

This study adopts a similar method Islam et.al (2013)[9] used to describe the relationship between emissions of carbon dioxide (LE), income (LGDP), total energy

consumption within the country (LEC) and industrial production index growth (LIPI).

The data used in the study is from year 1970 to 2012 of Malaysian economy. All the variables were transformed into log-linear forms for the time series. This study follows four step. Firstly, this study tests the series for stationarity using Augmented Dickey-Fuller (ADF) test and Phillips – Perron (PP) test. Followed by Johansen and Juselius Cointegration tests to check for the existence of cointegrating equations. Thirdly, the Vector Error Correction Model (VECM) estimation analysis and finally, several specification test.

## 4. RESULT ANALYSIS AND DISCUSSION

Table I summarizes the results from unit root test of ADF and PP test. The results from both ADF and PP unit root test indicates that the series are non-stationary at level but become stationary after first differenced. These results indicate that the series are stationary and integrated of order 1, (I(1)) which are consistent to the result found by Azlina and Mustapha (2012), and Saboori and Sulaiman (2013)[16] for Malaysia.

**Table I: Unit Root Test**

| Variable | Augmented Dickey Fuller (ADF) | | Phillips-Perron (PP) | |
|---|---|---|---|---|
| | Level | | | |
| | Intercept | Intercept & Trend | Intercept | Intercept & Trend |
| LE | -0.6231 | -2.5471 | -0.5704 | -2.5642 |
| LGDP | -1.7232 | -2.6223 | -1.6685 | -2.6355 |
| LEC | -0.8414 | -1.7768 | -1.1501 | -1.8330 |
| LIPI | -2.0720 | 0.2314 | -2.1314 | 0.4135 |
| | First Differenced | | | |
| | Intercept | Intercept & Trend | Intercept | Intercept & Trend |
| DLE | -7.9313*** | -7.8122*** | -7.9313*** | -7.8122*** |
| DLGDP | -5.1422*** | -5.2440*** | -5.1736*** | -5.2721*** |
| DLEC | -6.6013*** | -6.6382*** | -6.7233*** | -8.1346*** |
| DLIPI | -6.0784*** | -6.9569*** | -6.0998*** | -6.9655*** |

Notes: (***) indicates 1% level of significance. The optimal lag length was automatically selected using Schwarz Info Criterion for ADF testing. Newest-West bandwidth automatically select bandwidth for PP testing.

Table II: Johansen Cointegration Tests

| Hypothesized No. of CE(s) | Trace Statistics | Maximum Eigenvalue |
|---|---|---|
| r=0 | 73.89942** (47.85613) | 42.11592** (27.58434) |
| r≤1 | 31.78350** (29.79707) | 18.98274 (21.13162) |
| r≤2 | 12.80076 (15.49471) | 9.95510 (14.26460) |
| r≤3 | 2.845659 (3.841466) | 2.845659 (3.841466) |

Notes: (**) indicates 5% level of significance. Values in parentheses indicate 95% critical value.

According to the maximum eigenvalue test (table II), there is evidence of at least one cointegrating equation among the four variables while according to the trace statistics test, there is evidence of at least two cointegrating equation among the four variables. The Johansen cointegration test suggests the existence of long-run cointegration relationship among all the series in this study. Since the findings indicate two different results, this study apply the two cointegration equations value derived from trace statistics test in the VECM estimation as proposed by Asari et.al (2011)[3].

The result of lagged error correction term (ECT) showed in table III, that the coefficients are negative for all four equations. However, results are only significant for energy consumption equation and $CO_2$ emission equation at 1 percent and 10 percent respectively. The strong evidence of long-run uni-directional Granger causality from income development level and industrial production index growth to total energy use by the population suggests that the energy consumption in Malaysia is stimulated by its economic growth and industrial production growth; thus contradicting the argument by Islam et.al (2013) that recent financial development has brought in technology that is causing a more efficient use of energy within industries. Therefore, policy for efficiency in energy use may be applied without risking Malaysia's economic growth and its industrial production growth.

Table III: Granger Causality Tests through VECM

| Dependent variable | Independent variables (causality sources) | | | | |
|---|---|---|---|---|---|
| | Short-run | | | | Long-run |
| | ΔLE | ΔLGDP | ΔLEC | ΔLIPI | ECT |
| ΔLE | - | 0.5803 | 0.2166 | 0.2305 | -0.2153* (-1.8703) |
| ΔLGDP | 0.7518 | - | 1.8748 | 0.6028 | -0.2074 (-1.6482) |
| ΔLEC | 2.1522 | 3.6189 | - | 5.3206* | -0.7293*** (-3.3145) |
| ΔLIPI | 1.2093 | 9.5692*** | 0.7407 | - | -0.0407 (-0.2488) |

Notes: (*), (**), (***) indicates 1%, 5% and 10% level of significance respectively. Values in parentheses indicate t-stat value.

Table IV: Directions of Granger causality

| Long-run Granger causality relationships flow | | |
|---|---|---|
| LGDP | ⟶ | LE |
| LEC | ⟷ | LE |
| LIPI | ⟶ | LE |
| LGDP | ⟶ | LEC |
| LIPI | ⟶ | LEC |

Notes: ( ⟶ )indicate uni-directional granger causality and ( ⟷ ) indicate bi-directional granger causality.

In short, there is a long-run bi-directional granger causality from total energy use by population in Malaysia to $CO_2$ emission and long-run uni-directional granger causality from income development level to $CO_2$ emission, industrial production index growth to $CO_2$ emission, GDP growth to total energy consumption and industrial production index growth to total energy use by the population. The relationship flows of Granger causality method test in the long run are summarized in following table IV.

The evidence of long-run uni-directional Granger causality from income development level and industrial production index growth to $CO_2$ emission suggest that $CO_2$ emission in Malaysia is influenced by the economic growth and industrial production growth in the long-run. Thus suggesting that any implementation of new environmental regulation on dirty industry may increase the environmental risk of hindering the economic growth of Malaysia.

Meanwhile, the evidence of strong bi-directional causality between total energy use by the population and $CO_2$ emission in the long-run suggest that total energy usage is the main cause of carbon dioxide pollution in Malaysia. This implies that Malaysia is able to control environmental degradation by reducing the energy consumption especially energy consumption through fossil fuels. This particular information is imperative as more than 90% of primary energy supply in Malaysia are derived from fossil fuels (MEIH, 2012). Also, according to the Carbon Dioxide Information Analysis Centre report, the ratio of Malaysia's fossil-fuel $CO_2$ emissions ranking is among the highest globally (50 out of 216) and has been rapidly increasing throughout the years.

## 5. CONCLUSION

This study aims to investigate the long-run relationship between $CO_2$ emissions, income development level, total energy consumption within the country and industrial production index growth in Malaysia over the period of 1970 to 2012. The empirical result of the Johansen cointegration test shows that $CO_2$ emission, income development level, total energy usage within the country and industrial production index growth to be cointegrated thus indicating a long-run cointegrating relationship among all the series.

In facing the environmental degradation problem and challenges in the long run while sustaining its economic growth, exploiting more renewable resources within the country can be a possible option as well as improving the efficiency of energy use within the industry. However, policy suggestion based on the empirical result of this study should be interpreted with care. This is due to small sample size conducted in the analysis and thus the estimation result might not be robust enough to accommodate the existing green energy policy option by Malaysia.

## 6. REFERENCES

[1]. Ang, J. (2008), Economic Development, Pollutant Emissions And Energy Consumption In Malaysia, Journal of Policy Modelling, Vol.30, 2:271-278.

[2]. APEC (2013), Energy Demand and Supply and Outlook, Asia Pacific Energy Research Centre, 5th edition.

[3]. Asari, F.F.A.H. Baharuddin, N.S. Jusoh, N. Mohamad, M. Shamsudin, N. and Jusoff, K. (2011), A Vector Error Correction Model

(VECM) Approach in Explaining the Relationship between Interest Rate and Inflation towards Exchange Rate Volatility in Malaysia, World Applied Sciences, Vol.12: 49-56.

[4]. Azlina, A.A. and Mustapha, N.H.M (2012), Environmental Degradation, Economic Growth and Energy Consumption: Evidence of the Environmental Kuznets Curve in Malaysia, Energy Policy, Vol.60:892-905.

[5]. Chen, S. (2009), Engine or drag: can high-energy consumption and CO2 emission derive the sustainable development of Chinese industry, Front. Econ. China No.4:548–571.

[6]. Department of Statistics Malaysia, (2011), Index of Industrial Production, Putrajaya, Malaysia.

[7]. Dinda, S. and Coondoo, D. (2006), Income and Emission: A Panel Data-Based Cointegration Analysis, Ecological Economics, Vol.57:167-181.

[8]. Grossman, G.M. and Krueger, A.B. (1991), Environmental Impacts of the North American Free Trade Agreement, NBER, Working paper 3914.

[9]. Islam, F. Shahbaz, M. Ahmed, A.U. and Alam, M.M. (2013), Financial Development and Energy Consumption Nexus in Malaysia: A Multivariate Time Series Analysis, Economic Modelling, Vol.30:435–441.

[10]. Kraft, J. and Kraft, A. (1978), On the Relationship between Energy and GNP, Journal of Energy Development, Vol.3:401-403.

[11]. Lee, C. and Chang, C. (2007), Energy Consumption and GDP Revisited: A Panel Analysis of Developed and Developing Countries, Energy Economics, Vol.29, 6:1206–1223.

[12]. Malaysia Energy Information Hub (MEIH), http://meih.st.gov.my (visited on 20th December, 2014)

[13]. Mugableha, M.I. (2013), Analysing the CO2 Emissions Function in Malaysia Autoregressive Distributed Lag Approach, Procedia Economics and Finance, Vol.5:571 – 580.

[14]. Ozkan, F. and Ozkan, O. (2012), An Analysis of CO2 Emissions of Turkish Industries and Energy, Regional and Sectoral Economic Studies, Vol.12:2.

[15]. Richmond, A.K. and Kaufman, RK. (2006), Is There A Turning Point in the Relationship between Income and Energy Use and/or Carbon Emissions?, Ecological Economics, Vol.56, 2:176-189.

[16]. Saboori, B. and Sulaiman, J. (2013), CO2 Emissions, Energy Consumption and Economic Growth in Association of Southeast Asian Nations (ASEAN) Countries: A Cointegration Approach, Energy, Vol.55:813-822.

[17]. Shaari, M.S., Hussain, N.E. and Ismail, M.S. (2012), Relationship between Energy Consumption and Economic Growth: Empirical Evidence for Malaysia, Business System Review, Vol.2, 1:17-28.

[18]. Sims, C.A. (1972), Money, Income and Causality, The American Economic Review, Vol.62: 540-552.

[19]. Yang, HY. (2000), A Note on the Causal Relationship between Energy and GDP in Taiwan, Energy Economics, Vol.22, 309–317.