THE LINKAGE BETWEEN CARBON DIOXIDE EMISSIONS, ENERGY USE AND ECONOMIC GROWTH IN MALAYSIA

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ABSTRACT: *The aim of the study is to know the linkages between carbon dioxide emissions (CO_2), energy use and economic growth (GDP) in Malaysia. Annual data has been used in this study. The result of Unit Root test shows that all the variables are stationary at first difference. Based on the causality relationship between three variables, the short-run causal relationship had been recognised in this study; a unidirectional causality running from energy use to carbon dioxide and from energy use to economic growth (GDP) and a bidirectional causality running between carbon dioxide and economic growth (GDP). Some policies had been recommended as for solution to Malaysian and as a springboard for researcher to further the study on economic growth, energy use and carbon dioxide.*

KEYWORDS: *Carbon Dioxide, Emission, Energy, Growth*

1.0 INTRODUCTION

Why the excessive concern with "economic growth"? Why does it matter to the environment? Under specify economic theory, the rate of living growth standard comprise of three broad categories; the progress of science and productive knowledge, the growth of individual skill and incentives (Jovanovic, 2000).

There are two different perspectives of growth; the ecology side and the economic side. From the ecological side, the growth refers to the growth in the population of a species. The normal pattern is that populations grow until some feature of their environment, perhaps a predator or a limited food supply, brings that growth to a halt or pushes it into reverse (Anderson, 1991). In economics, 'economic growth' can be defined as an increase of gross national product or gross domestic product (GDP). The term of 'growth' in economics basically refers to the growth rate of the composition of output between industry, agriculture, and services between polluting and non-polluting sector; between resource depleting and converting activities and so on (Anderson, 1991).

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1.1 Historical Background

Based on the Neo-classical growth theory, it is possible to do a reasonable job of explaining the broad pattern of economic change across countries, by looking at it through the lens of an aggregate production function. The aggregate production function relates the total output of an economy to the aggregate amounts of labor, human capital and physical capital in the economy and some simple measure of the level of technology in the economy as a whole (Banerjee & Duflo, 2004).

According to the Solow model, there are several economic growth stylised facts have been established. First, little growth in per capita output before the Industrial Revolution: population growth as a sign to technological advancement rather than output growth. Second, there has rapid growth in output and standard of living since the industrial revolution. Per capita income growth is not only an indicator of welfare but the dramatic increase in life expectation.

Despite the benefits of high and stable economic growth, many fail to take note of the negative externality this causes in the form of environmental degradation. Senior Researcher of Centre for International Climate and Environmental Research (CICERO) claims that the industrial revolution (1750-1850) still impacts the present natural environment. The increased energy use and unconstrained worker exploitation in factories, abysmal housing and hygienic standards aggravates socio-environmental problems such as infections, respiratory problems, poisoning and workplace accidents in the expanding urban slums.

1.2 Environmental Kuznet Curve

The recipient of the third Nobel Prize in economics, Simon Kuznet has developed a hypothesis of Environmental Kuznet Curve established the relationship between income and the use of natural resources or the environmental quality that being described by an inverted U-shaped relationship (Shafik & Bandyopadhyay; cited by Kamogawa & Shirota, 2011). Based on the EKC, initially as per capita income raises the environment degradation, but after achievement of a critical level of economic growth, it tends to fell down. This is means an environmental degradation is unavoidable in the initial stage economic development and therefore has to be tolerated until the inversion effects kick in. As increase in economic growth will increase the demand for environmental quality as the possible energy saving heightens the awareness among the people regarding the harmful impact of environmental pollution (Tiwari, 2011).

When a county begins industrialization, the scale effect will take place and pollution increases which is indicates the environmental decay initially. Further along the trajectory, firms switching to less-polluting industries results in the composition effect, which levels the rate of pollution. The composition effect occurs at the transition of turning point. Finally, the technique effect comes into play when mature companies invest in pollution abatement equipment and technology, which reduces pollution.

U-shaped relationship results from interaction of several effects such as consumer demand for environmental quality and des-industrialization and development of new and more efficient technologies. But the EKC does not occur. This is meant the EKC does not show perspective of short-run turning point. This EKC hypothesis suggest that the pollution will appear to harm the environment in initially but it will improve as economic growth because the increase of the sense of environmental quality. The economic growth has been promoted as a method of improving the environment.

1.3 Climate Change and Environmental Problem

A continuous increase in man-made greenhouse emissions will cause climate change of the last 100 years, eight of the warmest years on record have occurred in the last decade. Based on the result of climate model, current climate change could increase the number of environmental refugees six fold over the next 50 years to 150 million (Hargroves & Smith, 2005) . A report by the World Bank Analysis shows that Bangladesh would be the most suffered from this climate change, losing half of its vice production, the forced staple of its 140 million people. At current price, this would cost Bangladesh US$3.2 billion.

An island become 'lost' long before the water level covers the island: it is lost at the point where the rising water level enters the food-chain rendering traditional crops, such as Babai or Taro, breadfruit inedible. In Pacific Island of Tuvalu, increase salinity of forcing family to growth their root crops in metal buckets instead of the ground (Hargroves & Smith, 2005).

China with the world's biggest population, second largest economy by land measure, and the world's largest consumer of coal (energy) is at the heart of the environmental problem and environment is at the heart of the "energy" problem in China (Gallagher, 2010).

The Economic Instrument for Environmental Management Malaysia (2004) found three main types of environmental problems. First, the negative externalities incurred at the expense of the environment with the public suffering as a result. Second, the environmental problem happens when the material of damage being subsidized. Thirdly, the ones caused by factory operators due

Pollution (water, air and land) is another environmental problem affecting the quality of our natural habitat. According to Malaysia Environmental Health Country Profile, WTO (2005), about 53 percent of the total number of sources were from domestic sewage facilities followed by manufacturing industries (38 percent), pig farms (6 percent) and agro-based industries (3 percent). Johor had been identified with the highest effluent sources of 29.9 percent, followed by Selangor (26.5 percent), and Perak (10.2 percent). They estimated the number of water pollution sources for 2002 to be 13,540 comprising mainly of sewage treatment plants, agro-based industries, manufacturing industries and animal farms.

The expansion of manufacturing industries and reliance on private transport rather than public transport contribute to the air pollution, particularly in Kuala Lumpur, Petaling Jaya, Johore Bahru and Prai.

Tiwari (2011) argues that the main contributor of global warming, climate change and ozone depletion is carbon dioxide. Realizing this, several countries signed the Kyoto Protocol and agreed to meet the target that was set for an average of 5 percent below level by 2008 to 2012.

1.4 Pollution Emission and Energy Consumption

The integration of environment and economic activities is important to maintain the pace of economic growth. However, the exploitation of environmental natural resources causes environmental degradation and the waste of production pollution. In Indonesia and Malaysia, the burning of tropical rainforest to create space for palm trees to produce biodiesel and oil has been emitting a huge pulse of carbon that spreads to neighbouring countries causing adverse effects to health (Tharavi & Ramakrishnan, 2009; cited by Hooi & Smyth, 2009).

The largest growth in CO_2 emissions has come from the power generation and road transport sectors, with the industry households and the service sector. According to Energy Information Administration (2007), Malaysia is

among the highest contributor of Southeast Asian Countries after Singapore (457.1 million Btu) and Brunei (314.4 million Btu) with a per capita energy consumption of 106.3 million Btu.

2.0 SELECTED LITERATURE REVIEW

Aqeel and Butt (2001) found that economic growth causes total energy consumption and petroleum consumption, electric consumption cause economic growth energy consumption cause employment. They studied the data of Pakistan from 1955 to 1956 and from 1995 to 1996 and suggested that it would be for the government to introduce policies to substitute gas for oil and using oil as a energy source is more efficient.

Soytas and Sari (2003) in their study on energy consumption and GDP of the G-7 countries found long – run unidirectional causality running from energy consumption (LEC) to economic growth (LGDP) for Turkey, France, West Germany and Japan but a reverse causality running from LGDP to LEC for Italy and Korea and bidirectional causality for Argentina in long-run.

Nanthakumar and Subramaniam (2010) applied the ADF and PP Unit Root Test, ARDL bounds testing approach, Ordinary least Square Engel-Granger (OLS-EG), Dynamic Ordinary Least Square (DOLS), Error Correction Model (ECM) in their study on Malaysia case from 1971 to 2008. Their results showed a bidirectional co-integration effect between total energy consumption and Malaysia's economic performance with only about 57 percent speed of adjustment to reach long run equilibrium that caused by short run shocks in Malaysia's economic performance.

Aziz (2011) studied the linkages between energy consumption and economic growth in Malaysia indicates that there is a long run relationship between energy consumption and economic growth in Malaysia.

Hossain and Saeki (2011) studied the dynamic causal relationship between electricity consumption and economic growth for the panel of South Asian countries using time series from 1971 to 2007. They concluded that higher electricity consumption in South Asian raises the economic growth.

Shahbaz (2012) studied the relationship between economic growth financial development and CO_2 emissions in Portugal. The annual data from 1971 to 2009 using Zivot-Andrews unit root test and ARDL bound testing approach, showed that the variables were co-integrated for long run relationship and economic growth and energy intensity increase CO_2 emissions while financial development condenses it.

Chebbi and Boujelbene (2008) in their study on Tunisia, found the existence of two co-integrating vectors; first is positive linkage between output (GDP) and energy use (energy consumption) and second is carbon dioxide (CO_2) emissions are positively related in the long-run.

Hooi and Smyth (2009) studied the relationship between carbon dioxide emissions, electricity consumption and economic growth in ASEAN 1980 to 2006. They focussed on five countries in Asia which are most impacted by the rapid growth in economy respectively. They found that there is a statistically significant positive association between electricity consumption and carbon dioxide emissions and non-linear relationship between emission and real output consistent with the Environmental Kuznet Curve.

With the presence of trade activities, Ismail & Yunus (2012) found that there have long-run causalities among variables for Malaysia from 1971 to 2007.

Saboori, Sulaiman and Mohd (2012) studied on dynamic relationship among carbon dioxide (CO_2) emissions, economic growth and energy consumption and foreign based on Environmental Kuznet Curve hypothesis

in Indonesia from 1971 to 2007. By using ARDL approach, they found that the result do not support the EKC hypothesis. In the long-run, the foreign trader is the most significant variable in explaining CO_2 emissions in Indonesia followed by energy consumption and economic growth.

Amin, Ferdaus & Porna (2012) investigated the long run relationship among output, CO_2 emissions and energy use for Bangladesh between 1976 to 2007 by using multivariate vector error correction model. They detected unidirectional causal relationships running from RGDP to Energy Use and Energy Use to CO_2 Emissions, but no causal relationship between RGDP and CO_2 Emissions.

Farhani and Rejeb (2012) studied the 15 MENA countries found that in the short-run, there is no evidence of short-run running from economic growth and carbon dioxide to energy consumption. They also found that a short run causality running from energy consumption to economic growth and carbon dioxide emissions.

Ismail & Yunus (2012) found a unidirectional relationship between output, capital, energy use, labor and emissions for Bahrain using annual data between years 1980 to 2007.

Kareem *et*. al (2012) studied on energy consumption, pollutant emissions and economic growth based on China experience from 1971 to 2008. They found a unidirectional causality running from CO2 emissions to economic growth and a unidirectional causality running from industrialization to economic growth.

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3.0 METHODOLOGY

The World Bank annual time series data for carbon dioxide emissions (CO_2) per capita, energy use (EU) and economic growth, (GDP) from year 1971 to 2008 was used in the study.

3.1 Research Objective

The general objective is to determine the linkage between carbon dioxide emissions, energy use and economic growth in Malaysia. Specifically, we intend to determine the relationship between carbon dioxide emissions and energy use and economic growth in Malaysia as well between energy use and carbon dioxide emissions in Malaysia.

3.2 Statistical tests

Besides the standard Unit Root tests (Augmented Dickey-Fuller, i.e. ADF and Philips-Perron i.e. PP), we also conducted the Johansen-Juselius Cointegration Test and Granger Causality test.

The VECM will be estimated to assess the direction of causality between GDP, energy consumption andCO_2, the VECM equations take form:

$$\Delta GDP_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1i} \Delta EU_{t\,1} + \sum_{i=1}^{p} \delta_{1i} \Delta CO_{2t\,1} + \theta_{1,1} ECT_{1,t\ 1} + \varepsilon_{1t} \qquad [1]$$

$$\Delta EU_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i} \Delta GDP_{t\,1} + \sum_{i=1}^{p} \delta_{2i} \Delta CO_{2t\,1} + \theta_{2,1} ECT_{1,t\ 1} + \varepsilon_{2t} \qquad [2]$$

$$\Delta CO_{2t} = \alpha_3 + \sum_{i=1}^{p} \beta_{3i} \Delta GDP_{t-1} + \sum_{i=1}^{p} \delta_{3i} \Delta EU_{t-1} + \theta_{3,1} ECT_{1,t-1} + \varepsilon_{3t} \quad [3]$$

3.3 Selective Analysis and Findings

Table 1: Unit Root and Stationary Test

Variables	ADF		PP	
	t_μ	t_τ	τ_μ	τ_τ
	A: Level			
CO_2	-0.1603 (0)	-2.3380 (0)	0.1293 (4)	-2.1197 (1)
EU	1.3247 (1)	-2.7975 (0)	2.8686 (11)	-2.6186 (1)
GDP	1.1358 (0)	-1.5812 (0)	1.1594 (2)	-1.6530 (2)
	B:First Differences			
CO_2	-8.5356 (0)**	-8.6889 (0)**	-8.5356 (0)**	-8.5121 (1)**
EU	-8.4759 (0)**	-8.8529 (0)**	-8.6825 (3)**	-10.0385 (7)**
GDP	-5.1485 (0)**	-5.3181 (0)**	-5.1111 (2)**	-5.3233 (1)**

Note: t and τ statistics are for ADF and PP respectively. The subscript $_\mu$ in the model allows intercept and $_\tau$ allows for Trend and Intercept. Asterisks (**) indicate statistically significant at 5 percent . Figures in parenthesis indicate the lag lengths. The lag length for ADF is determined by automatic selection in Schwartz Info Criterion while PP test is determined by Newey-West Bandwitch using the lag selected by Akaike Info Criterion (AIC). Both ADF and PP tests are examines the null hypothesis of a unit root against the stationary alternative. Critical values for ADF and PP test are based on MacKinnon (1996) one-sided p-values. The CO2 indicates carbon dioxide emissions, EU indicates energy use and GDP indicates economic growth in Malaysia.

Table 2: Johansen-Juselius Cointegration Test

Null	Alternative	k = 3, r = 1			
		Λmax		Trace	
		Statistic	95% C.V	Statistic	95% C.V
r = 0	r = 1	23.8337*	20.97	33.2766*	29.68
r = 1	r = 2	7.3753	14.07	9.4429	15.41
r = 2	r = 3	2.0676	3.76	2.0676	3.76

Note: The k is the lag length and r is the number of cointegrating vectors. Chosen r: number of cointegrating vectors that are significant under both tests. Asterisks (*) denotes statistically at 5 percent level.

Table 3: Granger Causality Test

Dependent Variable	ΔCO_2	ΔEU	ΔGDP
	X^2-statistic (p-value)		
ΔCO_2	-	8.6876 (0.0337)**	10.9460 (0.0120)**
ΔEU	7.54495 (0.0564)	-	1.3597 (0.7150)
ΔGDP	15.1260 (0.0017)**	1.8278 (0.0031)**	-

Note: The X^2- statistics tests the joint significance of the lagged values of the independent variables and the significance of the error correction term(s). Figures in parenthesis are the p-values. Asterisks (**) indicate statistically significant at 5 percent.

Table 4: Equation of Least Squares (LS)

Variables	Equation

CO_2, EU	$CO_2 = 0.0031EU - 0.4208$
GDP, EU	$GDP = 6.5703EU + 1344.8490$
GDP, CO_2	$GDP = 2006.1720CO_2 + 2730.6280$
CO_2, GDP	$CO_2 = 0.0005GDP – 1.0058$

Based on the result all variables were rejected only for intercept test equation. For instance, at level test, the t-statistics of carbon dioxide (CO_2) for ADF test for both intercept and trend and intercept are -0.1603 and -2.3380 respectively. Both t-statistics are not stationary which is meant the t-statistic is smaller than critical value.

As the variables are stationary, the variables are considered to have same order of integration. According to Table 2, there is one co-integrating vector has emerged between carbon dioxide emissions, energy use and economic growth in Malaysia.

Based on the result in Table 3, a unidirectional causality running from energy use to carbon dioxide emissions with the X^2-statistic is 8.6876 and the p-value is 0.0337, a unidirectional causality running from energy use to economic growth with X^2-statustic is 1.8278 and the p-value is 0.0031 and a bidirectional causality between economic growth and carbon with 10.9460 (0.0120) and 15.1260 (0.0017) respectively. But there is no causality relationship running from carbon dioxide to energy use and from economic growth to energy use. So, there had four causality relationships between the variables occur in the short-run.

One co-integrating vector presence in the JJ test but after the variables had been tested in VECM Granger causality test, the variables were does not fulfil the three conditions of ECT. The three conditions of ECT are the coefficient must have a negative sign and less than 1 while the t-ratio should be more than 1.96 if 5 percent significant level is being used. But in VECM Granger causality test, the direction of causality in the long run cannot be detected.

Four causal relations were identified from the Granger Causality test. First, between CO_2 whereby a 1 percent increase in energy use causes a 0.0030 percent increase in the CO_2. Second, 1 percent increase in energy use leads the GDP to increase by 6.57 percent. Lastly, a bidirectional relationship between GDP and CO_2 with 1 percent increase in CO_2, to increase GDP by 2006.17 percent of and a 1 percent increase in GDP to increase CO_2 by 0.0005 percent.

A study of Farhani and Rejeb (2012) for MENA countries shows the same evidence of energy use cause to carbon dioxide in short run. Energy sources had been consumed mainly by four economic sectors consists of residential, commercial, transportation and industrial. Energy sources in Malaysia also consists of five key energy; oil, hydropower, gas, coal and renewable energy. But the emissions of carbon dioxide contributed mainly by oil, gas and coal since hydropower based on the circulation of water dam and renewable energy being worked out to be strengthened. The increase of energy use may lead to increase of carbon dioxide emissions.

The result in this study is contrary from the result of a study on CO_2 emissions, nuclear energy, renewable energy and economic growth by Menyah & Wolde-Rufael in United States (2010) which is they do not found a causality running between nuclear energy consumption and economic growth but parallel with the result of The result in this study is contrary from the result of a study on CO_2 emissions, nuclear energy, renewable energy and economic growth by Menyah & Wolde-Rufael in United States (2010) which is they do not found a causality running between nuclear energy consumption and economic growth but parallel with the result of Farhani & Rejeb (2012).

4.0 CONCLUDING REMARKS

The general objective of this study to determine the linkage between carbon dioxide, energy use and economic growth in Malaysia was successfully met.

Since the climate issues and environmental degradation problems is one of the biggest challenges faced by all, the Government should come out with policies that strike a good balance between growth targets and sustainable development. The National Green Technology Policies 2009 launched is a commitment to empower the low-carbon economy among Malaysians. The increase of global community awareness toward climate change and environmental degradation problems lead to investment of green technology in the form of cleaner, low-carbon transport and energy system.

The Government should also continue to promote renewable energy. This will reduce our dependency on imported energy products mostly from China, Indonesia and South Africa.

The most successful country in harmonizing the economic growth and environment is Germany. As a pioneer of green growth policies, Germany had succeed cutting down the CO_2 emissions by 23 percent in 2009 compared to 1990 level. In the period from 1990 to 2010, Germany renewable energy consumption increase fivefold and they leveraging the green technology to increase the number of employment and trigger the economy with aim to make energy policy as a key country's stimulator.

In general Malaysians in all walks of life must begin to realize the importance of efficient energy use, conservation and alternative energy sources available. It is our collective responsibility to care for the environment because we must eventually absorb the social costs attached to any misuse and abuse related to it. At the very least, we ought to learn from other economies the marginal benefits of consuming energy wisely.

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