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Energy Consumption, Gross Domestic Product, Foreign Direct Investment and CO2 Emission in Malaysia

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Abstract

This paper aims to study the relationship between energy consumption, gross domestic product (GDP), foreign direct investment (FDI) and CO2 emission in Malaysia. In our study, we used the Vector Error Correction (VEC) framework by initially looking at the long run and short run relationship between these variables via the Johansen cointegration technique. Yearly data during the thirty seven-year period (from 1971 to 2007) has been collected from World Bank and tested. The finding provides evidence for the existence of a longrun relationship between these variables for the period. The result also shows that there is a uni-directional causality from energy consumption to GDP and FDI.

Keywords: Energy consumption, GDP, FDI and CO2 emission

1.0 Introduction

In the last two decades, the issue of global warming and climate change has been discussed worldwide and the threat of these environmental problems has been increasing from year to year. Malaysia in particular, is a developing country that has been implementing industrial policy since 1970s through its New Economic Policy. Malaysia favors industrialization to become a fully developed nation by the year 2020. In the early stages of this policy, Malaysia set an uncomplicated industrial policy to attract foreign companies to invest in Malaysia or to collaborate with local entrepreneurs to set up their companies here. As a result, Malaysia has gained numerous investors and industries have expanded massively. However, this massive development and rapid industrialization require constant monitoring especially on the environment and economy. Given such a close link between the variables, currently there is a strong argument for the need to examine the current development and to set up the developing indicators that will integrate economic activity and environmental change in Malaysia.

The concept of sustainable development argues that the economic prosperity should also be accompanied by environmental ‘prosperity’. Malaysian government do recognize the importance of this concept by protecting the environment (natural resources) from depletion and pollution. The rapid industrial development is generating a large quantity of both hazardous and non-hazardous waste which need to be properly treated and disposed off. Among the steps taken to curb this problem is the enactment of laws to protect the environment and human health from being exposed to toxic chemicals.

Malaysia, according to an international environment index of 133 countries produced by international scientists and researchers from Yale and Columbia universities in US, has been ranked the ninth best in the world at tackling domestic and global environmental problems. The main reason is that Malaysia practice good governance. While Malaysia had been criticised on the deforestation of its tropical forest and on the encroachment on its wildlife precious habitat, the country had also made tremendous progress in the preservation of' its natural resources.

Controlling CO2 emission has been a key concern for environmentalists to minimize the problem of climate change. Due to this, the Prime Minister of Malaysia, Datuk Seri Najib Tun Razak in the United Nation Climate Change Conference 2009, has announced that Malaysia will reduce its CO2 emission by 40% in year 2020 as compared to its 2005 CO2 emission. Taking cue of this statement, this paper will try to show the relationship between energy consumption, Gross Domestic Product (GDP), Foreign Direct Investment (FDI) and CO2 emisssion in Malaysia. The data retrieved from World Bank will then be tested.

2.0 Literature Review

In the last ten years, many researches have been done to analyse the relationship between the said variables. Lean and Smith (2010) found that there is a long-run unidirectional Granger causality running from electricity consumption and emissions to economic growth. The results also showed a unidirectional Granger causality running from emissions to electricity consumption in the short-run. The causality results also support the argument that economic growth exerts a causal influence on growth of energy use and growth of pollution in the long run. The results also pointed out a unidirectional causality running from growth of energy use to output growth in the short run (Ang, 2007).

There is also a study that shows the existence of bidirectional Granger causality between CO2 emissions and commercial energy consumption (Ferda, 2009). Pao and Tsai (2010) have also revealed that in the long-run, energy consumption has a positive and statistically significant impact on emissions. In 2011 they also found that there exists a unidirectional causality from energy consumption to emissions and from GDP to FDI in the short-run. There is also bidirectional long-run Granger causality between emissions and FDI, along with unidirectional causality from energy consumption and real output, respectively, to emissions/FDI. Sharma (2011) added two more variables in her finding, trade openness and urbanisation. In her study, she found out that that trade openness, per capita GDP, and energy consumption, proxied by per capita electric power consumption and per capita total primary energy consumption, have positive effects on CO_2 emissions. Urbanisation is found to have a negative impact on CO_2 emissions in high income, middle income, and low income countries. Globally, only GDP per capita and per capita total primary energy consumption are found to be statistically significant determinants of CO_2 emission, while urbanisation, trade openness, and per capita electric power consumption have negative effects on the CO_2 emissions. Ozturk and Acaravci (2010) argued that although the main source of carbon dioxide emissions is energy consumption, the other most interesting result is that there was no evidence of a causal relationship between carbon emissions and energy consumption. In addition, there was no evidence of a causal relationship between carbon emissions and employment ratio in Turkey.

3.0 Methodology

The method of analysis includes time series econometric technique of unit root test, Cointegration, and Granger causality test.

3.1 Unit root test

A type of stochastic process that has received a great deal of attention and scrutiny by time series analysts is the so-called stationary stochastic process. Stochastic process is a collection of random variables ordered in time (Damodar, 2003). It is well known that a stationary time series is one whose mean,variance and autocorrelation function do not change over time (Charter, 2008 & Koop, 2008).Time series analysis is about the identification, estimation and diagnostic checking of stationary time series. There are many tests for determining whether a series is stationary or non stationary. The most popular one is the Dickey-Fuller test-Unit root test (1979) and Philip Perron (1988). Non stationary time series can be transformed to stationary time series by differencing them one or more times. Normally we cannot reject the null hypothesis of unit root in any of the series above. As a result, we should run a co integration test in order to see if the series are cointegrated.

3.2 Cointegration test

If they have cointegration, there will exist stable long-run equilibrium in the model because if cointegrated, all variables move together to single equilibrium. This study does not include Vector Error Correction Model (VECM), Variance Decomposition and Impulse Respond Analysis that measure the accelerate and decelerate of momentum to equilibrium point.

3.3 Testing For Cointegration

A number of methods for testing cointegration have been proposed in the literature. Gujarati (2003) considers three comparatively simple methods: (1) the DF or ADF unit root test on the residuals estimated from the cointegrating regression, (2) the cointegrating Durbin-Watson (CRDW) and (3) the Engle-Granger or Augmented Engle-Granger test (1987). The test for cointergration described in this study is based on test developed by Johansen (1988) and Johansen and Juselius (1990). A test of cointegration is a test to determine whether or not there is a long run relationship between the variables as hypothesized by economic theory. To implement the Johansen's co integration test, the Vector Error Correction Method (VECM) is estimated. To determine the number of cointergrating rank ,we use the likelihood ratio (LR) trace test statistic that are Trace and Max Eigen Value statistic. For easy understanding, if both test statistic (Trace and Max Eigen Value) are more than critical values (1 or 5%

significant level), it will reject Ho which means there is co integration with at least one factor (exist long-run relationship).

3.4 Granger Causality test

The Granger Causality Test is based on the fact that the future cannot affect the past. A test is made to show whether lagged values significantly explain the variables. If both variables are integrated at level stage or I(0), Granger Causality Test should have been used. This test is valid only in the short-term determination. The requirements to proceed with Granger causality test are:

a) The variables must stationary at I(0), if the variables not stationary at I(O) but stationary at I(1) (after first difference), we can proceed to Granger or I(1).
b) There must exist one co integration factor in co integration test.
c) Residual is uncorrelated (no autocorrelation) with zero means and exist constant variance (homoscedastic).

4.0 Results and Findings

4.1 Unit Root Test Results

This study employed Augmented Dickey-Fuller test (ADF test) in order to test the presence of unit root. The results show that there are all acceptance of H_0 in the series at levels. Hence, the series can be concluded as non-stationary, since their ADF test results fail to reject the null hypothesis. Therefore, it is essential to continue ADF test for all series in first difference. The results of this second test are that all series are now stationary. As the results tend to propose non-stationarity in levels of the variables but stationarity in their first differences, this study is proceeded by coping that the variables belong to the I(1) process (refer table 1). To reduce the residual, we convert the data into logarithm form and then put into the E-views 7 software.

Table 1: Unit Root Tests for Energy, CO2, GDP and FDI

Variable	**ADF**	
	Level	First difference
LENERGY	-2.5479	-7.5246***
LCO2	-0.2855	-7.0749***
LGDP	-1.8745	-5.0099***
LRFDI	-2.4512	-7.8944***

*, ** and *** indicate 10%, 5% and 1% level of significance, respectively

4.2 Cointegration Test Result

Before we proceed with cointegration test, we have done the VAR lag order selection criteria to get the lag value that we can use. The lag value is very important because we must specify the lag value when we do the cointegration test. The results show that we need to use lag 1 in our analysis.

The results of cointegration test (Trace and Maximum Eigenvalue) can be seen as follow:

Table 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.568788	47.87163	47.85613	0.0498
At most 1	0.244038	18.43122	29.79707	0.5343
At most 2	0.195742	8.639471	15.49471	0.3998
At most 3	0.028591	1.015253	3.841466	0.3136

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.568788	29.44041	27.58434	0.0286
At most 1	0.244038	9.791746	21.13162	0.7639
At most 2	0.195742	7.624218	14.26460	0.4182
At most 3	0.028591	1.015253	3.841466	0.3136

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The results for both test shows that there exist 1 cointegrating equation at 5% significant level, but we do not know which variables are affecting each other. So we can proceed to perform VECM to see the direction. The result of VECM are as follow:

Table 3

Error Correction:	D(LCO2)	D(LENERGY)	D(LGDP)	D(LRFDI)
CointEq1	-0.195331	-0.329521	0.129872	1.886469
	(0.16351)	(0.11473)	(0.06666)	(1.04243)
	[-1.19460]	[-2.87208]	[1.94841]	[1.80968]
D(LCO2(-1))	-0.068359	-0.045224	0.079887	-1.088721
	(0.24655)	(0.17300)	(0.10051)	(1.57185)
	[-0.27726]	[-0.26140]	[0.79483]	[-0.69263]
D(LENERGY(-1))	0.004115	-0.039853	-0.209006	-2.826572
	(0.24904)	(0.17474)	(0.10152)	(1.58768)
	[0.01653]	[-0.22806]	[-2.05877]	[-1.78031]
D(LGDP(-1))	-0.007280	0.213854	0.178861	2.873661
	(0.50657)	(0.35545)	(0.20650)	(3.22950)
	[-0.01437]	[0.60165]	[0.86615]	[0.88982]
D(LRFDI(-1))	0.034843	0.007914	0.009488	-0.234626

	(0.03106)	(0.02179)	(0.01266)	(0.19802)
	[1.12179]	[0.36310]	[0.74932]	[-1.18486]
C	0.070405	0.062856	0.060380	0.183045
	(0.03224)	(0.02262)	(0.01314)	(0.20553)
	[2.18386]	[2.77861]	[4.59434]	[0.89059]

The results show that CO2, GDP and real FDI have a long run effect towards energy consumption. This is because the value of the t statistic is bigger than 2 for energy consumption.

4.3 Causality Test Result

We carry out the test for all variables and come out with the following results:

Table 4

VEC Granger Causality/Block Exogeneity Wald Tests

Included observations: 35

Dependent variable: D(LCO2)

Excluded	Chi-sq	df	Prob.
D(LENERGY)	0.000273	1	0.9868
D(LGDP)	0.000207	1	0.9885
D(LRFDI)	1.258406	1	0.2620
All	1.466888	3	0.6899

Dependent variable: D(LENERGY)

Excluded	Chi-sq	df	Prob.
D(LCO2)	0.068332	1	0.7938
D(LGDP)	0.361980	1	0.5474
D(LRFDI)	0.131840	1	0.7165
All	0.786459	3	0.8527

Dependent variable: D(LGDP)

Excluded	Chi-sq	df	Prob.
D(LCO2)	0.631758	1	0.4267
D(LENERGY)	4.238537	1	0.0395
D(LRFDI)	0.561476	1	0.4537
All	4.773924	3	0.1891

Dependent variable: D(LRFDI)

Excluded	Chi-sq	df	Prob.
D(LCO2)	0.479743	1	0.4885
D(LENERGY)	3.169507	1	0.0750
D(LGDP)	0.791773	1	0.3736
All	5.389065	3	0.1454

From the table above, we can conclude that in the short-run, energy consumption will Granger cause GDP and it is significant at 5% level. Energy consumption may also affect real FDI but at 10% significance level.

5.0 Conclusion

The results depict that in both long and short run, there is a relationship between the selected variables. GDP, FDI and CO2 emission are the contributors towards energy consumption in the long run. This is quite true because if the economy is growing, more energy will be used. For example, if FDI increases, new factories will be built in Malaysia, thus the energy consumption will increase. An increase in CO2 emisssion will lead to an increase in temperature. This will also cause energy consumption increase since we will be depending more on airconditioner to decrease the temperature.