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Energy Consumption in Various Sectors, Output and Carbon Dioxide Emission in Malaysia

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ABSTRACT

The issue on the linkage among energy consumption, output and environmental degradation has come to the fore and merited attention from policy makers. The importance of energy consumption in generating economic activities remains indisputable. However, the use of energy is claimed to be detrimental to the environment. Therefore, this study aims to investigate the linkage among energy consumption in several sectors, sectorial output and carbon dioxide emission in Malaysia. Data from 1990 to 2014 were analysed using the panel data analysis. Results show that a rise in output can reduce environmental degradation in Malaysia. However, the use of energy can degrade environmental quality. The inevitable and substantial use of energy types in the industrial and transportation sectors can trigger environmental woes. Therefore, these findings are vital to shed light on the issue and help policy makers formulate policies.

Keywords: Energy, Output, Carbon Dioxide Emission

1. INTRODUCTION

Energy consumption has been widely discussed among previous studies. This is because energy consumption is one of the primary determinants of national output, other than labour and capital. Cassim *et al*. (2004) believed that national outputs are severely dependent on energy. All countries need to ensure energy supply is sufficient to generate economic activities. Therefore, an exhaustion of energy can be a stumbling block to higher economic growth. However, it becomes more complex when several studies proposed policies to reduce energy consumption. Ighadoro (2010) argued that any reduction in energy consumption can serve an obstacle to the macroeconomic goals, particularly, higher economic growth.

Economic sectors such as agriculture, services, transportation and industry also hinge on energy. The absence of energy might cripple all the sectors. Transportation consumes a whopping amount of oil to operate the sector. Oil is also inevitably consumed in the agriculture sector to produce output. The

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industrial sector requires various energy types such as oil, gas and electricity to churn out manufactured goods.

Despite the vital importance of energy in economy, its' consumption is worth a control. The inexorable consumption of energy can have deleterious effects on the environment. The emission of harmful carbon dioxide in the air is rooted in energy consumption. Environmental degradation intensifies as more energy is consumed. Akin (2014) believed that the environmental policies, Kyoto Protocol for example, can reduce its impact on the environment. Lin and Lin (2011) explored the effects of energy use on economic growth and the environment, and thus inferred that environmental policies need to be formulated. The policies can ensure sustainable development as the environment is protected. The consumption of low quality energy such as coal should be limited to avert environmental degradation (Wei, *et al*., 2009). Humans' live are in jeopardy as a result of energy consumption.

A large number of studies were interested to investigate the relationship among energy use, economic growth and carbon dioxide emission. However, the studies did not provide consistent findings and the issue on energy consumption still merit attention. Most previous studies also did not explore the relationship among energy use, economic growth and carbon dioxide emission in various sectors. Therefore, this study aims to investigate the linkage among energy consumption, economic growth and carbon dioxide emission in various sectors in Malaysia.

Sectors such as transportation, industrial and agriculture use various energy types. However, their patterns of energy consumption are different from each other. Therefore, the contribution of energy consumption to carbon dioxide emission also might be different. Table 1 shows the final energy demand in various sectors (ktoe) from 2009 to 2014. In Malaysia, the industrial sector consumed the largest amount of energy, while the agricultural sector consumed the smallest amount of energy. All sectors in Malaysia exhibited an increasing trend in energy demand.

Table 1: Final Energy Demand in Various Sectors (ktoe)

Year	**Final Energy Demand in various Sectors (ktoe)**		
	Industrial	**Transport**	**Agriculture**
2009	14312	16119	211
2010	12928	16828	1074
2011	12100	17070	916
2012	13919	19757	1053
2013	13496	22357	1051
2014	13162	24327	1045

2. LITERATURE REVIEW

Several previous studies employed the panel data analysis to examine the relationship among energy consumption, economic growth and carbon dioxide emission in various countries (Azomahou *et al*., 2006; Stolyarova, 2009). Based on the empirical analysis by Cherniwchan (2012) and the data, from 1970 to 2000, collected from 157 countries, the findings showed that output in the industrial sector can be harmful to the environment. Asici (2011) also investigated the linkage between economic growth and carbon dioxide emission from 1970 to 2008 in 213 countries including high- and middle-income countries. The panel data analysis was employed and the results showed that higher per capita income can have detrimental impacts on the environment. However, the impact is larger in high-income countries compared to that in middle income-income countries.

Dritsaki C. and Dritsaki M. (2014) examined the linkage among energy consumption, economic growth and carbon dioxide emission in Greece, Spain and Portugal. The study employed the dynamic panel data approach and analysed data from 1960 to 2009. The findings revealed that s strong linkage between energy consumption and economic growth in Greece and Spain. However, using the panel causality test, the results showed that there is bidirectional relationship between the three variables in the short run and long run in all the countries.

Farhani and Rejeb (2012) examined the linkage among energy use, economic growth and environmental degradation in 15 MENA countries, using data from 1973 to 2008. The study employed the panel OLS, FMOLS and DOLS tests and the results suggested that a rise in economic growth can prompt higher energy consumption in the long run. In the short run, energy consumption can affect economic growth and carbon dioxide emission but without any feedback.

Li *et al*. (2011) examined the linkage among energy consumption, economic growth and carbon dioxide emission in China, using data ranging from 1985 to 2007. The study included 30 provinces in the mainland and divided into two groups: Eastern China and Western China. The study employed DOLS and the results indicated that there is a long-run relationship between economic growth and energy consumption in China. Apart from that, in the Eastern China, the results showed that energy consumption can have effects on the environment, while in the Western China; economic growth does not have any effect on the environment.

Alam and Huylenbroeck (2011) studied the relationship among energy consumption, economic growth and carbon dioxide emission in Bangladesh, The study used data from 1972 to 2006, and Autoregressive Distributed Lag (ARDL) model and the estimation of bi-variate vector error correction modelling (VECM) were employed. The results disclosed that energy supply can have a negative

effect on the economic growth, ensuing environmental degradation in Bangladesh.

3. METHODOLOGY AND FINDINGS

This study is to examine the linkage among energy consumption in various sectors, sectorial output and carbon dioxide emission in Malaysia. The data ranging from 1990 to 2014 were collected from various sectors (transportation, industrial and agriculture). The study employed the panel data analysis: panel co-integration and panel estimation. The panel unit root test, panel co-integration and panel estimation (FMOLS, DOLS, PMG and MG) were performed. The model specification is as follows:

$$\ln CO2_{it} = \beta_{1t} + \beta_2 \ln Y_{it} + \beta_4 \ln TE_{it} + \varepsilon_{it} \quad (1)$$

Where lnCO2 is carbon dioxide emission, lnY is sectorial output and lnTE is total energy consumption in various sectors. t is year, ε is error correction term, and β represents coefficient.

3.1 Panel Unit Root Results

This study employed the unit root test to see the stationarity of the data. The unit root test was based on ADF PP and LLC were used in this study. Table 2 shows the results of the panel unit toot test for the variables used. All the variables are not significant at level and therefore the null hypothesis is accepted. However, at first difference, the variables are significant; therefore the null hypothesis is rejected. The results suggest that the variables are non-stationary at level and stationary at first difference. Therefore, the panel co-integration test can be conducted.

Table 2: Unit Root Results

	Level			**First Difference**		
	LLC	**ADF**	**PP**	**LLC**	**ADF**	**PP**
Individual intercept without trends						
lnY	-2.09098**	4.95024	21.4789*	-7.57189*	45.1529*	51.8626*
lnTE	-2.24562**	9.87499	9.69155	-7.79057*	44.5163*	44.4655*
lnCO2	-1.65052*	7.34363	7.16354	-8.32550*	51.6092*	50.6603*
Individual intercept with trends						
lnY	-2.29340**	7.97819	15.4398*	-6.04697*	33.0953*	46.6386*
lnTE	0.14041	2.24250	2.17867	-7.90106*	39.1603*	38.4313*
lnCO2	-0.21775	3.43807	3.33828	-7.75645*	42.8955*	42.6662*

Note: * and ** denote significant level at 1% and 5%, respectively.

3.2 Panel Co-integration Results

The panel co-integration analysis was employed to see the co-integrated relationship among the variables. Table 3 shows the results of the panel co-integration test. Based on the results, it is learned that all the statistics except panel v-statistic are significant and therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. It suggests that there is a co-integrated relationship among energy consumption in various sectors, sectorial output and carbon dioxide emission. Next, the panel estimation will be performed to see the effects of energy consumption in various sectors and sectorial output on carbon dioxide emission in Malaysia.

Table 3: Panel Co-integration Results

$\mathbf{CO2 = f(Y, TE)}$	
Statistics tests	**Statistics values**
Alternative hypothesis: common AR coefs. (within-dimension)	
Panel v-Statistic	0.933086
Panel rho-Statistic	-2.638547*
Panel PP-Statistic	-3.923538*
Panel ADF-Statistic	-3.942012*
Alternative hypothesis: individual AR coefs. (between-dimension)	
Group rho-Statistic	-2.238631**
Group PP-Statistic	-5.342424*
Group ADF-Statistic	-5.112494*

Note: * and ** denote significant level at 1% and 5%, respectively.

3.3 The Panel Estimation

The FMOLS, DOLS, PMG and MG tests were performed and the results were recorded in Table 4. The results were divided into two time dimension: short run and long run. In the long run, the results for FMOLS, DOLS, and PMG show that sectorial output and energy consumption can have some effects on carbon dioxide emission. The result of FMOLS test shows that the coefficient for sectorial output is 0.8 and the value is negative. It is significant at 1%. Therefore, a 1% increase in sectorial output can reduce carbon dioxide emission by 0.8%. The result of FMOLS shows that the coefficient for energy consumption is 0.97 and the value is positive. It is significant at 1%. Therefore, a 1% increase in energy consumption can increase carbon dioxide emission by 0.97%. In the short run, the result of PMG shows that sectorial output and energy consumption do not affect carbon dioxide emission.

Table 4: Short- and Long-Run Panel Estimation Results

Dependent variable: lnCO2					
			Long run		
Independent Variables	**FMOLS**	**DOLS**	**PMG**	**MG**	**Hausman Test**
lnY	-0.848219*	-0.064048*	-.061648*	-.0193361	0.9569
lnTE	.973008*	0.995580*	1.022013*	.9335397 *	
			Short run		
Independent Variables			**PMG**	**MG**	
lnY			.0941858	.0386914	
lnTE			-.0884833	-.1298929	
Constant			8.029028*	8.803717	
ECT			-.8689166*	-.9609415*	

Note: * denotes significant level at 1%.

Table 5 shows the results of short-run panel estimation for various sectors. The results show that output and energy consumption in the agricultural sector do not have any effect on carbon dioxide in Malaysia. In the industrial sector, output does not affect carbon dioxide emission but energy consumption does affect carbon dioxide emission. An increase in energy consumption can reduce carbon dioxide emission in the industrial sector. In the transportation sector, the results are different from that in the industrial sector, whereby, an increase in energy consumption can increase carbon dioxide emission simultaneously.

Table 5: Short-Run Panel Estimation Results for various sectors

Dependent Variable: lnCO2			
Independent variables	**Agriculture**	**Industrial**	**Transportation**
lnY	.0398062	-.0641873	.3069385
lnTE	-.0148152	-.6873262*	.4366916***
Constant	9.434379*	10.60497*	4.047735**
ECT	-1.005462*	-1.161619*	-.439669*

Note: *, **and *** denote significant level at 1%, 5%and 10%, respectively.

4. CONCLUSION

This study aims to investigate the linkage among energy consumption in various sectors, sectorial output and carbon dioxide emission in Malaysia, using data ranging from 1990 to 2014. The panel unit root, panel Pedroni co-integration, FMOLS, DOLS, PMG and MG were employed to achieve the objective of this study. The results reveal that in the long run, an increase in sectorial output can reduce the environmental degradation in Malaysia. The environmental regulations in Malaysia have resulted in the reduction in the environmental

degradation. It suggests that Malaysians are increasingly concerned about their environment. However a rise in energy consumption in Malaysia can have a deleterious effect on the environment in the long run. This happens because Malaysians still consume several energy types that can be detrimental to the environment such as oil and coal. However, in the short run, there is no effect of energy consumption in various sectors and sectorial output on the environment. In the specific sectors, output and energy consumption do not harm the environment. Nevertheless in the industrial and transportation sectors, energy consumption can be detrimental to the environment.

These findings are important to formulate policies on energy consumption. Energy consumption in the industrial and transportation sectors should be controlled in order to avert any environmental degradation. Firms in the sectors should use more renewable energy instead of non-renewable energy in order to conserve the environment.

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