

# Disclosing the Relationship among CO<sub>2</sub> Emissions, Energy Consumption, Economic Growth and Bilateral Trade between Singapore and Malaysia: An Econometric Analysis

H. A. Bekhet, T. Yasmin

**Abstract**—The aim of this paper is to examine the relationship among CO<sub>2</sub> per capita emissions, energy consumption, economic growth and bilateral trade between Singapore and Malaysia for the 1970-2011 period. ARDL model and Granger causality tests are employed for the analysis. Results of bound F-statistics suggest that long-run relationship exists between CO<sub>2</sub> per capita (PCO<sub>2</sub>) and its determinants. The EKC hypothesis is not supported in Malaysia. Carbon emissions are mainly determined by energy consumption in the short and long run while, exports to Singapore is a significant variable in explaining PCO<sub>2</sub> emissions in Malaysia in long-run. Furthermore, we find a unidirectional causal relationship running from economic growth to PCO<sub>2</sub> emissions.

**Keywords**—ADRL Bound Test, Bilateral trade, CO<sub>2</sub> emission, Environmental Kuznets Curve, Energy consumption, Malaysia.

## I. INTRODUCTION

THE increasing threat of global warming and climate change has called for more attention and discussion of global environmental issues. There is projection of substantial increase in temperature by the end of the 21st century. It is virtually certain that increases in the frequency and magnitude of daily temperature extremes and decreases in cold extremes will occur in the 21st century at the global scale [1]. The “manmade” greenhouse effect is caused by the addition of greenhouse gases (GHG), especially carbon dioxide (CO<sub>2</sub>). They are emitted mostly when fossil fuels, such as petroleum, coal and natural gas are burned. Global carbon dioxide emissions are set to rise again in 2012 to new record, largely as a result of the economic growth. Around 200 countries gathered in Doha, Qatar to discuss and agree a global deal climate agreement by 2015 on cutting carbon emissions [2].

It is very important to save the environment through the efficiency of energy management and consumption from the environmental preservation point of view. Developing countries like Malaysia has emerged as a robust economy and a paragon of success for the East-Asian region. Since 1957, the resource rich nation has successfully prosecuted a policy of enviable economic growth. Malaysia boasts of being among the emerging nations with the highest rates of economic growth. Due to rapid economic transformation, government has promoted the strategy to reduce the amount of energy consumption as well as to reduce CO<sub>2</sub> emission through energy efficiency in order to protect environmental issues as stated in the 10th Malaysia Plan [3]. Therefore, Malaysia has

agreed to reduce the carbon dioxide by up to 40 percent by year 2020 in comparison to 2005 level even though Malaysia is non-annex 1 in the Kyoto Protocol but it is encourage in reducing the CO<sub>2</sub> emission.

Fig. 1 shows the trend of the CO<sub>2</sub> emissions per capita and GDP per capita in Malaysian economy for the 1970-2010 period. Both variables are showing the upward trend.

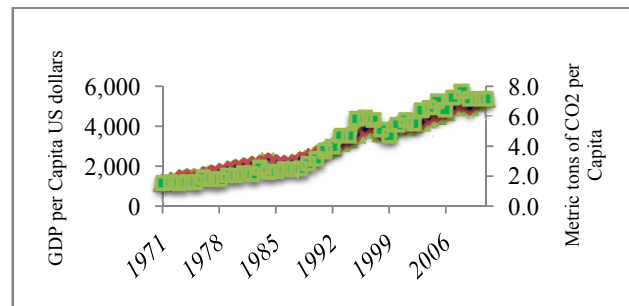


Fig. 1 Malaysian PCO<sub>2</sub> and GDP per capita for the 1970-2010 period [4]

The incredible economic growth of Malaysia, over the past three decades, is mainly attributed to its impressive industrial growth. Energy Information Administration (EIA) has analyzed that carbon dioxide emissions in Malaysia have increased by 221% since year 1990 to 2004 [5]. Fossil fuels contribute more than half of the total CO<sub>2</sub> increment. This growth rate is among the 30 biggest greenhouse gas emitters. Reference [6] has discussed that, while as a ratified the Kyoto Protocol, Malaysia put efforts to change the rapid growth in emissions. According to the Climate Change Performance Index report, Malaysia is rated as contributor of CO<sub>2</sub> with 49.2 scores [7]. Above all, Malaysia is an open economy which also heavily depends on external trade to achieve its economic growth. It has explained that external trade has been a catalyst in the development of the Malaysian economy contributing significantly to the Gross Domestic Product (GDP) where in 1971, the total merchandise trade to the GDP was 73 percent. It increased further by 187 percent in 2000 and recorded 142 percent in 2009 [8].

However, the main objective of the current study is to fill the gap in the energy literature by examining the equilibrium relationship between CO<sub>2</sub> per capita emissions and GDP per

capita, bilateral trade and energy consumption in Malaysia. Single country studies help policy making authorities in making comprehensive policy to control environmental degradation. In addition, the present research has taken into account bilateral trade between Singapore and Malaysia for its impact on environmental pollution. The selection of Singapore economy is due to the largest export partner of Malaysia. Department of Statistics Malaysia (DOSM) revealed that Malaysia's comprises around 49.4% share of total exports with Singapore [9] (see Fig. 2).

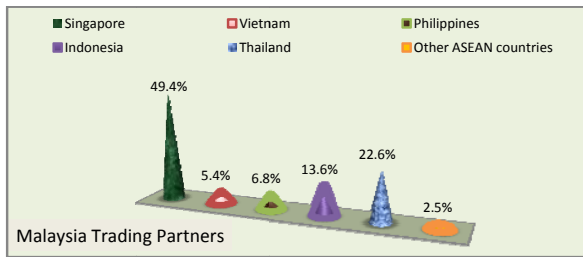


Fig. 2 Malaysia's trade with ASEAN countries for January 2012 [9]

In particular, the paper is motivated by the need to add more variables like energy consumption and trade in findings by [10]. They have suggested that the result will be more extensive by adding some other variables.

The rest of the paper proceeds as follows: Section II describes the past studies and is followed by a discussion of data and model in Section III. Section IV yields analyses of results. Finally, conclusion and policy implications are outlined in Section V.

## II. LITERATURE REVIEW

Reference [11], in 1971, Nobel Prize winner, postulated that income inequality first rises and then falls with economic growth. Ever since, the Environmental Kuznets Curve (EKC) hypothesis has become an independent research issue which has provoked a large body of theoretical and empirical literature. An inverted U-shape relationship between economic growth and environmental degradation is described by the EKC in which, environmental degradation increases with economic growth, reaches its maximum level and decreases when the economy reaches the given critical high level of income. Many related studies to EKC are available as [12]-[20].

There is another strand of literature which shows the energy consumption dependence on economic growth. One of the crucial elements for continuous economic growth is energy consumption. This highlights the importance of the link between energy consumption and economic growth. The relationship of energy consumption and economic growth has been investigated extensively as well in different countries. For example, the study by [21] for the US, [22] for Taiwan and Korea, [23] for Pakistan, [24] for EU countries, [25] for 17 African countries, [26] for six Gulf Cooperation countries, [27] for Soviet Union, [28], [29] for Malaysia, [30] for South America and [31] for Pakistan.

Trade openness is another variable which poised effect in generating CO<sub>2</sub> emission. It also provides a way for mobilizing factors of production freely between countries. Actually, movement of factors of production may also move dirty industries from home countries to developing economies where laws and regulations about the environment is just a formality. For example, it has documented that trade openness harms the environmental quality [32], [33]. Furthermore, it has also investigated that there is a link between trade and CO<sub>2</sub> emissions in Pakistan. They found a positive relationship between both of them [34]. Reference [35] added trade openness to explore the relationship between economic growth, CO<sub>2</sub> emissions and energy consumption in Turkey. Moreover, there was debate about the trade openness and its impacts on Chinese economy [36]. Their result showed that trade openness is one of the main contributors to economic growth while income raises the level of CO<sub>2</sub> emissions.

## III. DATA AND ECONOMETRIC MODEL

Annual time series data for the (1971-2011) period were utilized in this study. The details of variables are given in Table I:

TABLE I  
VARIABLES DETAILS

Variables	Units	Sources
CO <sub>2</sub> per capita (PCO <sub>2</sub> )	Metric tons per capita	[4]
GDP per capita (Y)	US dollars (constant 2000=100)	[4]
Exports to Singapore (EXS)	US dollars (constant 2000=100)	[37]
Imports from Singapore (IMS)	US dollars (constant 2000=100)	[37]
Energy Consumption (EU)	Kg of oil equivalent	[4]

Different approaches have been used to investigate the relationship between economic growth and CO<sub>2</sub> emissions. Reference [38] presents a comprehensive survey on the EKC literature and points out those factors as international trade, technological progress and demography may have an impact on CO<sub>2</sub> emissions. Based on these arguments, additionally, we also take into account trade and energy consumption. This article follows closely the methodology of the recent studies by [39], [40]. A log linear quadratic equation is specified to test the long-run relationship among PCO<sub>2</sub> emissions, energy consumption, economic growth and foreign trade in order to test the validity of the EKC hypothesis. The estimable econometric logarithm regression line is as follows in

$$LPCO_{2t} = \alpha_0 + \alpha_1 LY_t + \alpha_2 (LY_t)^2 + \alpha_3 LEX_t + \alpha_4 LIMS_t + \alpha_5 LEU_t + \varepsilon_t \quad (1)$$

where, t is the time period. While,  $\alpha_1 < 0$  and  $\alpha_2 > 0$  representing U-shaped relationship or if  $\alpha_1 > 0$  and  $\alpha_2 < 0$  indicate an inverted U-shaped relationship, hence the EKC. The expected sign of  $\alpha_3$  and  $\alpha_4$  is mixed depending on a level of a country in economic development stages. It is expected to be negative for developed countries as they specialize in clean and service intensive production and instead imports the pollution-intensive products from other countries with less

restrictive environmental protection laws. On the other hand, it may be positive in the case of developing countries as they are likely to be net exporter of pollution-intensive goods mentioned [41]. Since higher level of energy consumption leading to greater economic activity and stimulates CO<sub>2</sub> emissions, α<sub>5</sub> is expected to be positive.

Various methods are available in conducting the cointegration analysis, including the residual-based approach proposed by [42], the maximum likelihood-based approach discussed by [43], the fully modified OLS procedures of [44] and the recently developed approach, Autoregressive Distributed Lag (ARDL) suggested by [45]. ARDL for cointegration analysis has a number of attractive features over the other alternatives by [46]. First, the approach avoids endogeneity problems and inability to test hypotheses on the

estimated coefficients in the long-run associated with the [42]. Second, the short-run as well as the long-run effects of the independent variables on the dependent variable are assessed at the same time. Third, all variables are assumed to be endogenous. Forth the econometric methodology does not require establishing the order of integration of the variables (unit-root test). The approach is applicable regardless of whether the underlying regressors are *I*(0), *I*(1) or fractionally integrated and finally the methodology is popular in small samples as the case of the present study .

In current study ARDL bounds testing approach is employed to examine the long-run relationship among PCO<sub>2</sub> emissions, economic growth, trade between Singapore and Malaysia and energy consumption. However, in matrix basis, ARDL approach could be formulated as the following form

$$\begin{bmatrix} \Delta LPCO_{2t} \\ \Delta LY_t \\ \Delta (LY)_t^2 \\ \Delta LEX_t \\ \Delta LIMS_t \\ \Delta LEU_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} & \beta_{36} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} & \beta_{46} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} & \beta_{56} \\ \beta_{61} & \beta_{62} & \beta_{63} & \beta_{64} & \beta_{65} & \beta_{66} \end{bmatrix} \begin{bmatrix} \Delta LPCO_{2t-i} \\ \Delta LY_{t-i} \\ \Delta (LY)_{t-i}^2 \\ \Delta LEX_{t-i} \\ \Delta LIMS_{t-i} \\ \Delta LEU_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} & \alpha_{16} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} & \alpha_{26} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} & \alpha_{36} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} & \alpha_{46} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} & \alpha_{56} \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & \alpha_{66} \end{bmatrix} \begin{bmatrix} LPCO_{2t-1} \\ LY_{t-1} \\ (LY)_{t-1}^2 \\ LEX_{t-1} \\ LIMS_{t-1} \\ LEU_{t-1} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ \lambda_5 \\ \lambda_6 \end{bmatrix} \begin{bmatrix} ECM_{t-1} \\ ECM_{t-1} \\ ECM_{t-1} \\ ECM_{t-1} \\ ECM_{t-1} \\ ECM_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \end{bmatrix}$$

where, Δ is the first difference operator; α<sub>i</sub>(i =1, …, 6) represent intercept; β<sub>ji</sub>s (j,i = 1, …, 6) and n<sub>ji</sub>s (j,i = 1, …, 6) represent the short-run and long-run coefficients of the variables respectively; λ<sub>i</sub> (i= 1, …, 6) represents the coefficients of ECM<sub>t-1</sub> which used to link the long-run and short-run equilibrium of the variables at one period lagged; ε<sub>i</sub>s (i = 1, …, 6) represent the error terms.

The bounds testing procedure is based on the joint F-statistic that is tested the null of no cointegration, H<sub>0</sub>: α<sub>ij</sub>=0, against the alternative of H<sub>1</sub>:α<sub>ij</sub> ≠ 0. The F-test is conducted to test the existing of long-run relationship among the variables. The critical values of the F-statistics in this test are available in [42]. There are two sets of critical values for a given significance level, with and without a time trend, at *I*(0) and the other at *I*(1), which are known as lower bounds (LCB) and upper bounds critical values (UCB) respectively. The decision rule is based on compare the calculated F-statistics with the critical values tabulated at statistical tables [45]. If the calculated F-statistics are greater than the upper bounds value, *I*(1), the null hypotheses (H<sub>0</sub> = 0), no co-integration, will be rejected. This means that the variables included in the models share long-run relationship. Conversely, if the calculated F-statistics fall below the lower bounds value, *I*(0), the null hypothesis (H<sub>0</sub> = 0), no co-integration, cannot be rejected. This means that the variables included in the models do not share long-run relationship among themselves. Moreover, if the calculated F-statistics fall in the range *I*(0) ≤ F value ≤ *I*(1) it means that the decisions are inconclusive to be either accept or reject the long-run relationship. Furthermore, in the final step, we obtain the short-run dynamic parameters by estimating ECM<sub>t-1</sub> associated with the short-run estimates. That gives the adjustment speed of the disequilibrium among

the variables [45]. However, it has suggested that if the co-integration exists among the variables in the long-run then, there must be either unidirectional or bidirectional causality among these variables [42].

Reference [45], [46] suggested testing the stability of estimated coefficients through cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ). In this study the stability tests are conducted to check the stability of the coefficient in estimated models.

IV. RESULTS ANALYSIS

Reference [47] has discussed that in time-series methodology, the regression results are likely to be spurious if the variables are non-stationary. On the other hand, it has postulated that if a time series is non-stationary, then the aim of forecasting would be cancelled out [48]. Thus, the ADF test was performed to detect the model’s stationary levels (see Table II). The results show that all the models are stationary at their first differences; hence, these models are *I*(1) for the 1970-2011 period. Therefore, since all the variables are stationary at *I*(1) which enables us to proceed with the rest of the economic model.

TABLE II  
ADF TEST

Variables	ADF I(0)	ADF I(1)	Order of Integration
LPCO <sub>2</sub>	-1.003914	-7.651692***	I (1)
LY	-1.555096	-5.462345***	I (1)
(LY) <sup>2</sup>	-1.160469	-5.615044***	I (1)
LEXS	-1.531534	-6.115679***	I (1)
LIMS	-1.703011	-6.424630***	I (1)
LEU	-0.795355	-6.658566***	I (1)

Note: \*\*\* is significant at 1%.

According to the selection of lag criteria the number of lag depends on the lowest values of HQ, SBC and AIC [49]. Also, could use LR test (sequential modified) as a primary determinant of how many lags to be included (see Table III).

TABLE III  
LAG SELECTION

Lag	AIC	SC	HQ
0	-7.089063	-6.835731	-6.997466
1	-16.04752	-14.27420*	-15.40634*
2	-16.28415*	-12.99083	-15.09339

Note: \* is significant at 10%.

The  $F$ -statistics of  $CO_2P$  model was obtained 4.78 which is higher than the upper bound critical value of 3.37 at 10% significant level and supports cointegration. The other variables shows inconclusive and no cointegration result in Table IV.

TABLE IV  
F-STATISTICS TEST

Models	F-statistics	Significant level	Critical value	
			Lower	Upper
$LCO_2P$	4.78***	10%	2.26	3.37
$LY$	1.53	5%	2.65	3.81
$(LY)^2$	1.68	1%	3.52	4.78
$LEXS$	1.85			
$LIMS$	2.21			
$LEU$	1.82			

Note: \*\*\* is significant at 1%.

The existence of cointegration among variables warrants the estimation of (1) by ARDL approach to get the long-run coefficients. The results are reported in Table V.

TABLE V  
LONG-RUN CO-EFFICIENTS

Regressor	Coefficient	P-value	T-value
$LY$	-4.56	0.117	-1.6103*
$(LY)^2$	0.23	0.155	1.4556*
$LEXS$	0.60	0.013	2.6318**
$LIMS$	-0.13	0.271	-1.1199*
$LEU$	1.24	0.028	2.2956**
$C$	3.15	0.739	0.3354

Note: \*, \*\* significant at 10% and 5%, respectively.

The negative and positive coefficient of  $LY$  and  $(LY)^2$  respectively, indicate the existence of a U-shape relationship between per capita  $CO_2$  emissions and per capita real GDP. This confirms that  $PCO_2$  emissions declines at initial level of economic growth then reaches a turning point and increases with the higher level of economic growth. The long-run elasticity of  $CO_2$  emissions with respect to energy consumption is 1.24 and significant at 1% level which implies that 1% increase in per capita energy consumption will lead to 1.24% increase in per capita  $CO_2$  emissions in the long run. This positive effect of per capita energy consumption on  $CO_2$  emissions is in line with earlier findings by [13], [36]. Similarly the coefficient of  $LEXS$  is 0.60 which is positive in sign and highly significant. It indicates that 1% increase in foreign trade will lead to 0.60% increases in per capita  $CO_2$

emissions. The positive long-run relationship between  $PCO_2$  emissions and trade openness is in line with [35], [40]. From the results it is apparent that the long-run effect of energy consumption on  $PCO_2$  emissions in Malaysia is more significant than trade openness. The estimated model also passes the diagnostic tests of functional form specification and normality. Moreover diagnostic test statistics do not suggest the presence of any serial correlation and heteroskedasticity.

Hence, once we establish the long-run relationships among the series models can make a progress for analyzing the short-run relationships. Furthermore, the  $ECM_{t-1}$  and short-run results are presented in Table VI. The short-run elasticity of  $PCO_2$  emissions, with respect to energy consumption, is 0.68. It is positive in sign and highly significant at 1% confidence level, indicating that for each 1% increase in per capita energy consumption, per capita  $CO_2$  emissions increase by 0.68%. The coefficient of imports from Singapore is negative and insignificant. It is -0.07, suggesting that the contribution of the imports to  $PCO_2$  emissions in the short-run is negligible in Malaysia during the estimated period while, the exports shows the positive value as 0.06. The statistical significance of  $ECM_{t-1}$  with an appropriate sign (-) is an indication of the speed towards the long-run equilibrium after dis-equilibrium in the short-run. However, the coefficient of  $ECM_{t-1}$  is fairly large, that is, -0.55. This indicates that any deviation from the long-run equilibrium between  $PCO_2$  and other variables is corrected about 55% for each period and it takes about 1.78 year (1 divided by the estimated coefficient of  $ECM_{t-1}$ ) in restoring to the long-run equilibrium level after disequilibrium in the short run.

TABLE VI  
SHORT-RUN AND ERROR CORRECTION TERMS COEFFICIENTS

Regressor	Coefficient	P-value	T-Statistic
$\Delta LY_{t-1}$	-1.23	0.457	-0.75311
$\Delta (LY)^2_{t-1}$	0.12	0.171	1.3994
$\Delta LEXS_{t-1}$	0.06	0.622	0.49804
$\Delta LIMS_{t-1}$	-0.07	0.303	-1.0467
$\Delta LEU_{t-1}$	0.68	0.002	3.3432**
$\Delta C$	1.72	0.738	0.33756
$ECT_{t-1}$	-0.55	0.001	-3.5853***

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

The Granger causality has also applied to check the direction of relationship among variables<sup>1</sup>. However, there is unidirectional causal relationship running from economic growth to  $PCO_2$  emissions in long-run. This result is consistent with in Tunisia [50], in Iran [51] and in Pakistan [52], the result also reveal the relationship between GDP per capita and  $CO_2$  per capita in short run.

To check the stability of the coefficients cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) techniques were employed. Graphically, these two statistics are plotted within two straight lines bounded by the 5% significance level. If any point lies beyond this 5% level, the null hypothesis of stable parameters is rejected. As can be seen from Figs. 3 and 4, the plots of CUSUM and CUSUMSQ

<sup>1</sup> Results are with researchers.

statistics are well within the critical bounds, support the stability of the coefficients in estimated model.

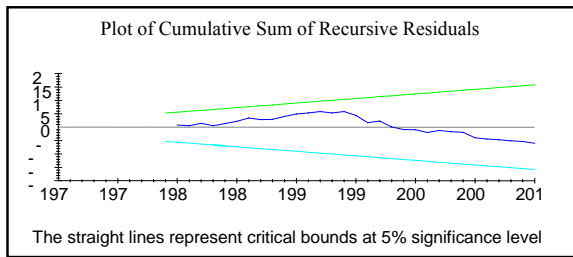


Fig. 3 Plot of cumulative sum of recursive residuals

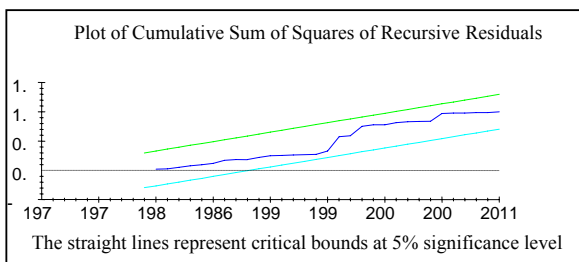


Fig. 4 Plot of cumulative sum squares of recursive residuals

#### V. CONCLUSION AND POLICY IMPLICATIONS

The current study investigated the dynamic relationship between carbon dioxide emissions and economic growth in Malaysia based on the EKC hypothesis for the period (1970–2011) by incorporating energy consumption and trade openness. Cointegration analysis was conducted using bounds testing approach developed by [45]. Negative and positive coefficient of  $\ln Y$  and  $(\ln Y)^2$  respectively, indicating a U-shape relationship between per capita CO<sub>2</sub> emissions and per capita real GDP. This confirms that CO<sub>2</sub> emissions declines at initial level of economic growth then reaches a turning point and increases with the higher level of economic growth. Therefore, the results do not support the EKC hypothesis. The elasticity of CO<sub>2</sub> emissions with respect to energy consumption is 1.2430 and 0.68 in the long and short-run respectively and highly significant. This implies that for each 1% increase in energy consumption per capita CO<sub>2</sub> emissions will rise by 1.24% in the long-run and 0.68% in the short-run. It implies that emission reduction policies and more investment in pollution abatement will not hurt economic growth and could be a feasible policy tool for Malaysia to achieve its sustainable development in the long-run. Carbon capture and storage, carbon emissions tax and carbon-trading scheme can be performed without much concern for long-run income. Of course, these policy tools should be accompanied by other possible strategies such as increasing plant efficiency, employing fuel balancing or fuel switching and making enhanced use of renewable energy. Government of Malaysia has promoted strategies with greater emphasis given to environmental considerations which address global warming and climate change. The coefficient of exports to Singapore is positive and significant in the long-run and short-run. This is

indicating that 1% increase in foreign trade will lead to 0.6% increases in per capita CO<sub>2</sub> emissions in the long-run while its contribution to CO<sub>2</sub> emissions is 0.06% in the short-run. Correctly signed and statistically significant coefficient of  $ECM_{t-1}$  supports the existence of cointegration among variables.

#### REFERENCES

- [1] Intergovernmental Panel on Climate Change (IPCC), "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation", Cambridge University Press, Cambridge, UK, 2012.
- [2] DOHA, "UN Climate Change Conference COP18-CMP8". 2012, Retrieved from ([http://unfccc.int/key\\_steps/doha\\_climate\\_gateway](http://unfccc.int/key_steps/doha_climate_gateway)).
- [3] Tenth Malaysia Plan, 2011-2015. Putrajaya, Malaysia: The Economic Planning Unit, Prime Minister's Department; 2010.
- [4] World Bank Indicators (2013), retrieved from: <http://data.worldbank.org/country/malaysia> (accessed on January 2013).
- [5] Energy Information Administration (EIA), "International Energy Annual Report 2005 – CO<sub>2</sub> World Carbon Dioxide Emissions from the Consumption of Coal", 2005, USA: Government of US. Retrieved from <http://www.eia.doe.gov>.
- [6] B. Liebman, "Malaysia leads the world in greenhouse gas emission growth rate", Curb Global Warming, 2007, Retrieved from: <http://curbglobalwarmingblog.Blogspot.com>.
- [7] J. Burck, C. Bals, and K. Bohnenberger, "Climate Change Performance Index 2012", Berlin, Germany, Available at: ([www.germanwatch.org/ccpi](http://www.germanwatch.org/ccpi)).
- [8] M. B. Yusoff, "Malaysian Bilateral Trade Relations and Economic Growth", *International Journal of Business and Society*, vol. 6, 2005, pp. 55-68.
- [9] Department of Statistics Malaysia (DOSM), Malaysia External Trade Statistics, 2012, Retrieved from: <http://www.statistics.gov.my/portal> (accessed on March 2013).
- [10] B. Saboori, J. Sulaiman, and S. Mohd, "Economic growth and CO<sub>2</sub> emissions in Malaysia: A cointegration analysis of the Environmental Kuznets Curve", *Energy Policy*, vol. 51, 2012, pp. 184–191.
- [11] S. Kuznets, "Economic growth and income inequality", *American Economic Review*, vol. 45, 1995, pp. 1–28.
- [12] U. Soytas, and R. Sari, "Energy consumption and GDP: causality relationship in G-7 countries and emerging markets", *Energy Economics*, vol. 25, 2003, pp. 33–37.
- [13] J. B. Ang, "Economic development, pollutant emissions and energy consumption in Malaysia", *Journal of Policy Modeling*, vol. 30, 2008, pp. 271–278.
- [14] C. C. Lee and J. D. Lee, "Income and CO<sub>2</sub> emissions: evidence from panel unit root and cointegration tests", *Energy Policy*, vol. 37, 2009, pp. 413–423.
- [15] P. K. Narayan, and S. Narayan, "Carbon dioxide emissions and economic growth: Panel data evidence from developing countries", *Energy Policy*, vol. 38, 2010, pp. 661–666.
- [16] I. Ozturk, and A. Acaravci, "CO<sub>2</sub> emissions, energy consumption and economic growth in Turkey", *Renewable and Sustainable Energy Reviews*, vol. 14, 2010, pp. 3220–3225.
- [17] S. S. Wang, D. Q. Zhou, P. Zhou and Q. W. Wang, "CO<sub>2</sub> emissions, energy consumption and economic growth in China: A panel data analysis", *Energy Policy*, vol. 39, 2011, pp. 4870–4875.
- [18] M. J. Alam, I. A. Begum, J. Buysse, S. Rahman, and G. V. Huynhbroeck, "Dynamic modeling of causal relationship between energy consumption, CO<sub>2</sub> emissions and economic growth in India", *Renewable and Sustainable Energy Review*, vol. 15, 2011, pp. 3243–3251.
- [19] H. A. Bekhet, and T. Yasmin, "Exploring EKC, trends of growth patterns and air pollutants concentration level in Malaysia: A Nemerow Index Approach", IOP Conf. Series: Earth and Environmental Science, vol. 16, 2013, pp. 1-4.
- [20] H.A. Bekhet, and T. Yasmin, "Economic Growth and Pollutant Emission In Malaysia: An Empirical Analysis of Environmental Kuznets Curve", 16<sup>th</sup> AFBE Conf., Putrajaya, Malaysia, 2012, pp. 370–387.
- [21] J. Kraft, and A. Kraft, "On the relationship between energy and GNP", *Journal of Energy Development*, vol. 3, 1978, pp. 401–403.

- [22] A. M. M. Masih, and R. Masih, "On temporal causal relationship between energy consumption, real income and prices: some new evidence from Asian energy dependent NICs based on a multivariate cointegration vector error correction approach", *Journal of Policy Modeling*, vol. 19, 1997, pp. 417-440.
- [23] A. Aqeel, and M. S. Butt, "The relationship between energy consumption and economic growth in Pakistan", *Journal of Asia Pacific Development*, vol. 8, 2001, pp. 101-110.
- [24] U. Soytaş, and R. Sari, "Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member", *Ecological Economics*, vol. 68, 2009, pp. 1667-1675.
- [25] Wolde-Rufael, "Electricity consumption and economic growth: a time series experience for 17 African countries", *Energy Policy*, vol. 34, 2006, pp. 1106-1114.
- [26] M. Al-Iriani, "Energy-GDP relationship revisited: an example from GCC countries using panel causality", *Energy Policy*, vol. 34, 2006, pp. 3342-3350.
- [27] D. B. Reynolds and M. Kolodziej, "Former Soviet Union oil production and GDP decline: granger causality and the multi-cycle Hubbert curve", *Energy Economics*, vol. 30, 2008, pp. 271-289.
- [28] V. G. R. Chandran, S. Sharma, and K. Madhavan, "Electricity consumption-growth nexus: the case of Malaysia", *Energy*, vol. 38, 2009, pp. 606-612.
- [29] F. Islam, M. Shahbaz, A. U. Ahmed, and M. M. Alam, "Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis", *Economic Modelling*, vol. 30, 2013, pp. 435-441.
- [30] H. Yoo, and S. Y. Kwak, "Electricity consumption and economic growth in seven South American countries", *Energy Policy*, vol. 38, 2010, pp. 181-188.
- [31] M. Shahbaz, H. H. Lean, and M. S. Shabbir, "Environmental Kuznets Curve hypothesis in Pakistan: Co integration and Granger causality", *Renewable and Sustainable Energy Reviews*, vol. 16, 2012, pp. 2947-2953.
- [32] M. Feridun, F. S. Ayadi, and J. Balouga, "Impact of trade liberalization on the environment in developing countries: the case of Nigeria", *Journal of Developing Societies*, vol. 22, 2006, pp. 39-56.
- [33] W. Antweiler, R. B. Copeland and M. S. Taylor, "Is free trade good for the emissions: 1950-2050", *The Review of Economics and Statistics*, vol. 80, 2001, pp. 15-27.
- [34] S. Khalil and Z. Inam, "Is trade good for environment? a unit root co integration analysis?", *The Pakistan Development Review*, vol. 45, 2006, pp. 1187-1196.
- [35] F. Halicioglu, "An econometric study of CO<sub>2</sub> emissions, energy consumption, income and foreign trade in Turkey", *Energy Policy*, vol. 37, 2009, pp. 1156-1164.
- [36] A. Jalil, and S. F. Mahmud, "Environment Kuznets curve for CO<sub>2</sub> emissions: A co integration analysis for China", *Energy Policy*, vol. 37, 2009, pp. 5167-5172.
- [37] United Nations Commodity Trade Statistics Database (2013), retrieved from: <http://comtrade.un.org/db/> (accessed on February 2013).
- [38] S. Dinda, "Environmental Kuznets curve hypothesis: a survey", *Ecological Economics*, vol. 49, 2004, pp. 431-455.
- [39] J. B. Ang, "CO<sub>2</sub> emissions, energy consumption, and output in France", *Energy Policy*, vol. 35, 2007, pp. 4772-4778.
- [40] H. Iwata, K. Okada, and S. Samreth, "Empirical study on environmental Kuznets curve for CO<sub>2</sub> in France: the role of nuclear energy", *Energy Policy*, vol.38, 2010, pp. 4057-4063.
- [41] G. M. Grossman, and E. Helpman, "The politics of free-trade agreements", *American Economic Review*, vol. 85, 1995, pp. 667-690.
- [42] R. F. Engle, and C. W. J. Granger, "Co-integration and error-correction: representation, estimation and testing", *Econometrica*, vol. 55, 1987, pp. 251-276.
- [43] S. Johansen, and K. Juselius, "Maximum likelihood estimation and inference on cointegration with applications to the demand for money", *Oxford Bulletin of Economics and Statistics*, vol. 52, 1990, pp. 169-210.
- [44] P. Phillips, and B. Hansen, "Statistical inference in instrumental variables regression with I(1) process", *Review of Economic Studies*, vol. 57, 1990, pp. 99-125.
- [45] M. H. Pesaran, Y. Shin, and R. J. Smith, "Bound testing approaches to the analysis of level relationship", *Journal of Applied Econometrics*, vol. 16, 2001, pp. 289-326.
- [46] M. H. Pesaran, and Y. Shin, "An autoregressive distributed lag modeling approach to cointegration analysis", In: Strom, S. (Ed.), *Econometrics and Economic Theory in 20th Century: The Ragnar Frisch Centennial Symposium*. Cambridge University Press, Cambridge, 1999, Chapter 11.
- [47] C. Brooks, "Introductory Econometrics for Finance", 2nd Edition, *Cambridge University Press*, 2008, Chapter 3.
- [48] D. Gujarati, and D. Porter, *Basic Econometrics*. New York, NY: *McGraw-Hill Irwin*, 2009, Chapter 7.
- [49] C. W. Granger, "Some properties of time series data and their use in econometric model specification", *Journal of econometrics*, vol. 16, 1981, pp. 121-130.
- [50] M. Fodha, and O. Zaghoud, "Economic growth and pollutant emissions in Tunisia: an empirical analysis of the Environmental Kuznets Curve", *Energy Policy*, vol. 38, 2010, pp. 1150-1156.
- [51] M. R. Lotfalipour, M. A. Falahi, and M. Ashena, "Economic growth, CO<sub>2</sub> emissions, and fossil fuels consumption in Iran", *Energy*, vol. 35, 2010, pp. 5115-5120.
- [52] M. Nasir, and F. Rehman, "Environmental Kuznets Curve for carbon emissions in Pakistan: an empirical investigation", *Energy Policy*, vol. 39, 2011, pp. 1857-1864.



**H. A. Bekhet** is a professor in Quantitative analysis in applied economics. He is currently professor at the Graduate Business School (GBS), COGS. of Universiti Tenaga Nasional (UNITEN), Malaysia. He earned his PhD in Input-Output Methods from the University of Keele, England, UK, in 1991. He taught at Baghdad University from April 1991 to May 2003, Al-Zyatoonh University, Jordan from September 2003 to December 2007 and Joined UNITEN in July

2008 up to date.

He has already published more than 70 papers in peer-reviewed articles and five text books in mathematical economics, Econometrics, Quantitative analysis for business and Modeling & data analysis by SPSS. His teaching and research interests include the Mathematical Economics Models, Econometrics, and Input-Output Analysis. Other research interests include the Cost Benefit Analysis, Development Models, Time Series Analysis, and Energy Economics. His three published research articles are as below:

- [1] H. A. Bekhet, "Assessing Structural Changes in the Malaysian Economy: I-O Approach", *Economic Modeling*, vol. 30, 2013, pp. 126-135.
- [2] H. A. Bekhet, "Assessing Development Efficiency in Malaysian Economy: Input-Output Approach", *International Journal of Economics & Business Research (IJEER)*, vol.4, 2012, pp. 297-325.
- [3] H. A. Bekhet and A. Matar, "Co-integration and Causality Analysis between Stock Market Prices and Their Dterminates in Jordan." *Economic Modeling*, under process, Elsevier, 2013.

Prof. Hussain is the Editor-in-Chief of Journal of Advanced Social Research (JASR). He is the Member of Input-Output Association, IIOA, Vienna, Austria.