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TIME SERIES ANALYSIS OF THE IMPACT OF CONSUMPTION AND ENERGY USE ON ENVIRONMENTAL DEGRADATION: EVIDENCE FROM MALAYSIA

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The purpose of this study is to explore the long-run relationships and short-run dynamic interactions between environmental degradation (proxied by carbon dioxide, CO_2 emissions) and the independent variables of consumption (proxied by income level or gross domestic product, GDP per capita) and energy use in Malaysia over the period 1971 to 2008, using time-series analysis. The multivariate cointegration methodology is applied in this study to establish the possible causal relations between the variables concerned. The cointegration test and the vector error correction model display the evidence of a positive long-run relationship between consumption and environmental degradation while energy use is negatively related to environmental degradation. The long-term elasticity coefficients of the exploratory variables on environmental degradation display relationships that are theoretically grounded. There is evidence that consumption and energy use have a dominant influence in forecasting environmental degradation variance through further innovation analysis using variance decompositions. The study concludes with an examination of policy implications of the findings.

Keywords: consumption, environmental degradation, CO_2 emissions, energy, policy implications

INTRODUCTION

Globalisation has brought about changes in the production and consumption patterns in many societies, especially societies that are affluent. Nowadays, it is quite common to see an unlimited number of goods and wide ranging services being provided to consumers who are spoilt for choice. However, the over-indulging behaviour of consumers and over-zealous conduct of producers, who are out to make the best out of the demands and maximise profits do come with attendant problems to our environment. In Ger's view (1997: 112) the "consumption and production patterns of affluent countries are responsible for most transboundary problems, such as ozone layer depletion, ocean pollution, and chemicalization of the habitat."

There is widespread concern that the current production and consumption patterns will have long-lasting effects on the environment such as global warming characterised by rising temperatures and drastic climatic changes. A recent analysis by Hansen and Karl (2013) of the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration respectively indicates that 2012 has been recorded as one of the ten hottest years in history based on average global temperatures. The effects of global warming can be devastating and heat waves, drought, ozone layer depletion, storms, floods and rising sea levels can cause massive economic damage to agriculture and infrastructure.

The past few decades have witnessed rapid economic growth especially in developing nations, such as China, India and Russia. Economic development is often associated with higher energy consumption. However, unsustainable energy consumption triggered by rapid development creates environmental problems. For instance, increased energy consumption for fuel production can cause the greenhouse effect, which can further lead to other environmental disasters. The main cause of such problems, especially global warming is carbon dioxide (CO_2) emissions from the burning of fossil fuels (Davis and Caldeira, 2010). Hence, environmental problems such as global warming often affect the production of goods and services in a country or region. Additionally, unchecked consumer behaviour can also cause serious consequences to the environment and thus, many developing nations are concerned of the potential environmental damage that can be caused by incessant consumption spending.

Malaysia's current rapid growth and globalised economy have resulted in a high level of consumption which could potentially damage the environment as there is a higher demand for fossil fuels namely, crude oil, natural gas and coal as a source of energy. As posited by Azlina and Nik Hashim (2012), fossil fuels are the main cause of greenhouse gas emission (GHG). This raises an important concern on whether we can maintain current consumption patterns without causing damage to our environment.

Based on the discussion above, this study attempts to investigate the long-term relationship between consumption (proxied by gross domestic product, GDP per capita), energy consumption and environmental degradation (proxied by CO_2). The use of GDP per capita as a proxy for consumption stems from various macroeconomic models which maintain that private consumption for all nations is the main component of the GDP. At lower levels of income, the tendency to consume rises and therefore, it is safe to assume that for most nations, GDP is an accurate proxy for consumption.

Studies that have investigated the relationship between CO_2 emissions, income and energy consumption had reported conflicting results. This could be due to differences in the approaches and testing procedures that were employed. The approaches that are generally used in studies of this nature are simple log-linear models estimated by ordinary least squares (OLS), time-series analysis, cross-sectional analysis and panel data analysis.

This study attempts to investigate the dynamics of consumption, energy use and environmental degradation in Malaysia over a period of 38 years from 1971 to 2008. Two time series graphs for the data on pollution (proxied by CO_2) and consumption (proxied by GDP) are shown in Figures 1 and 2 respectively. It can be seen that, as far as pollution and consumption are concerned, an upward trend exists over time. Figure 3, on the other hand, indicates that pollution has a direct link with levels of consumption, indicating the adequacy of using a linear specification. This concurs with Kuznets' hypothesis, which posits that the initial stages of economic growth are often marked by an increase in pollution levels. This study also uses the Vector Error Correction Model to analyse the impact of consumption expenditure on the environment. The results of the unit root tests show that all variables are non-stationary in levels, and stationary in first differences. The Johansen and Juselius (1990) cointegration analysis shows evidence of cointegration among the tested variables.

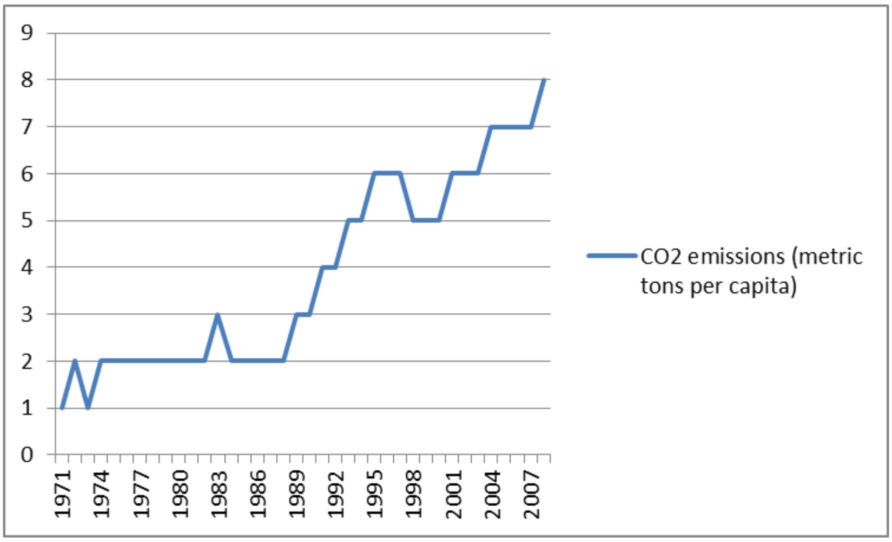

Figure 1: Time-series chart for pollution.
Source: World Bank (2012).

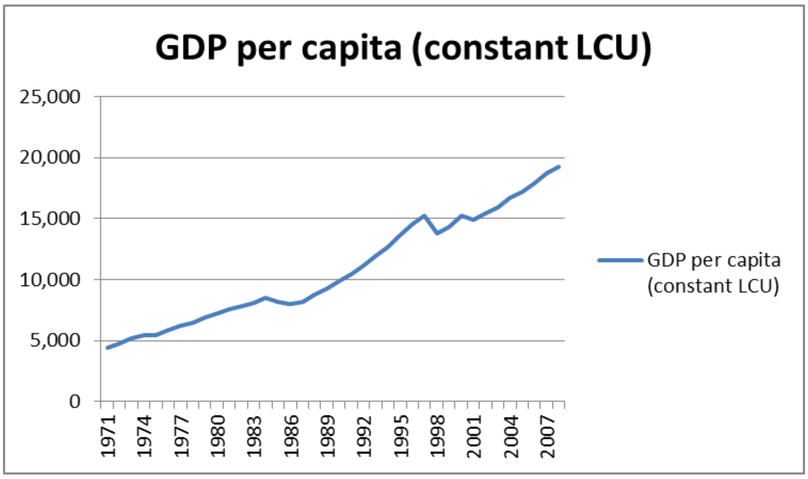

Figure 2: Time-series chart for consumption.
Source: World Bank (2012).

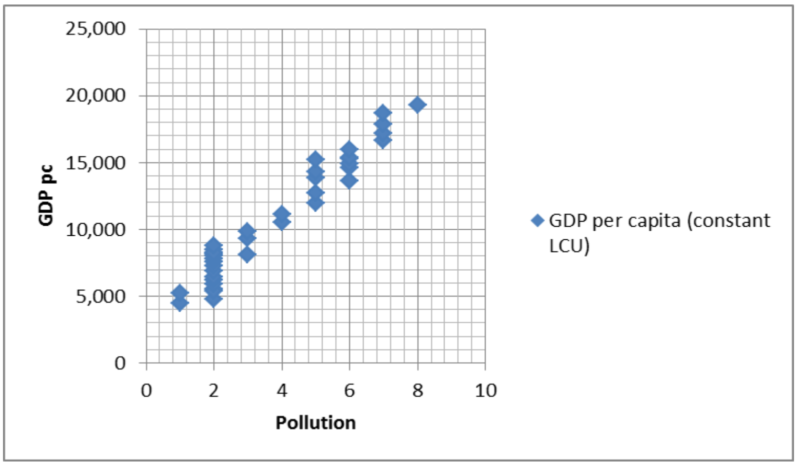

Figure 3: Scatter plot for pollution-consumption.
Source: World Bank (2012).

This study has some similarities with Ang (2008) who analysed data that covered 28 years from 1971 to 1999. In this study, we analysed data from a longer period of time, covering an additional nine years from 2000 to 2008. This augurs well for this study as there was a significant rise in carbon emission during this period as indicated in Figure 1. As clarified earlier, the increase in pollution levels can be attributed to the country's fast-paced development in the beginning this century, made worse by environment-hazard practices such as open burning. In addition, this study also examines the impact of consumption and energy use on pollution and the dynamic properties of the system through the generalised variance decomposition analysis to display the explanatory power or relative importance of each variable in accounting for fluctuations in other variables which Ang's (2008) study did not cover.

LITERATURE REVIEW

Scholars have claimed that globalisation has brought an onslaught of materialistic goods and services to consumers. The assertion by Ozanne, Hill and Wright (1998: 185) exemplifies this observation "Open any glossy magazine, and see pictures of sumptuous foods, beautiful people, glamorous fashions, and possessions too many to mention. Turn to any television channel, and an unending series of consumption images pulse before the eyes." The main problem with the continued increase in consumption is the damage it causes to the global environmental.

Many parties such as marketers, advertisers and the mass media have all contributed to the development of a generation of consumers with materialistic attitudes and desires and a ferocious appetite for branded goods. Hence, we can note that consumers from emerging economies are emulating western consumption patterns, fuelled by expensive advertisement and promotion blitz by multinational corporations (MNC) that market well-known global brands. It appears that the purchasing decisions of present-day consumers are often dictated by status-consciousness and brand loyalty and hence consumers, on the whole, do not realise that MNCs' revenues frequently exceed the GDP of entire countries. The MNCs wield ample economic power that is used to "force" governments of less developed and developing countries to allow profitable business ventures, at the expense of the environment.

Among the studies that have investigated the impact of consumption on environmental degradation are Jorgenson (2003), Adrangi, Dhanda and Hill (2004), Brulle and Young (2007), and Peters et al. (2007). Findings of these studies draw our attention to the possible fact that our uncontrolled and continued use of resources would eventually cause a scarcity of resources that will mark the beginning of the collapse of modern societies.

Many scholars (such as Dasgupta et al., 2002; Yandle, Vijayaraghavan and Bhattarai, 2002; Song, Zheng and Tong, 2008; Lean and Smyth, 2010; Shahbaz, Lean and Shabbir, 2012) have concurred with Kuznets' theory, which states that as income increases in the initial stages of economic growth, pollution also rises. In essence, there is an inverted U-shaped relationship between pollution and per capita income.

Behnaz, Jamalludin and Saidatulakmal (2012) who utilised the Auto Regressive Distributed Lag (ARDL) methodology found the Environmental Kuznets Curve (EKC) hypothesis applicable to the Malaysian setting. Similarly, Tiwari, Shahbaz and Hye (2013), in their study on the role of coal consumption in India using the ARDL methodology, concur with the EKC hypothesis findings of previous studies.

There have also been many studies that have tested the nexus of output-energy and output-environmental degradation. Chebbi (2009) found that CO_2 emissions and energy consumption are positively related in the long run. This is supported by the results of a study by Mouez and Zaghdoud (2010) in Tunisia, which has many similarities with Malaysia. It is difficult to pinpoint whether energy consumption drives economic growth or the other way around, as both can be simultaneously determined. Bidirectional co-integration effects were found between total energy consumption and economic performance (Belke, Dobnik and Dreger, 2011; Loganathan and Thirunaukarasu, 2010).

Several studies (such as Kraft and Kraft, 1978; Al-Iriani, 2006; Huang, Hwang and Yang, 2008; Ang, 2008) indicate that there is causality from economic growth to energy consumption growth. Others such as Lee and Chang (2008) who studied 16 Asian countries; Narayan and Smyth (2008) who covered the G-7 countries and Apergis and Payne (2009) who researched 6 Central American countries, argue that causality ran from energy consumption to economic growth. Chandran and Chor (2013) used granger causality test and found evidence of a bidirectional causality between economic growth and coal consumption in China for both the short and long-run. However, as far as India is concerned, only a unidirectional Granger causality existed and it ran from economic growth to coal consumption.

Studies have shown that greater usage of energy leads to higher volumes of pollutants. Ang (2008) indicated that pollution and energy use were positively related to output in the long-run, while Nemat (1994) and Holtz-Eakin and Selden (1995) found that pollutant emissions were increasing monotonically with income levels. In a study done on the ASEAN-5 economies, Lean and Smyth (2010) confirmed the existence of a non-linear relationship between emissions and real output, consistent with the EKC.

The assumption that the governments in developing countries are equally committed and effective in controlling pollution further justifies Kuznets' inverted U income-pollution relationship. There is a general consensus that institutions in developing countries are weaker and more prone to graft than in developed countries. As such, the corrupt behaviour of authorities may, among other things, result in the approval of projects that are not environmentally friendly. This has been established in Lopez and Mitra's study (2000), which showed pollution levels have been observed to be above the ordinary levels due to corrupt behaviour.

In terms of efficiency of energy consumption, it is interesting to note that some countries able to keep their CO_2 emissions at proportionately lower levels although their level of consumption is high. In a study covering the Middle East and North Africa, Ramanathan (2005) discovered that countries had varying degrees of emission efficiency as a result of the differences in terms of the size of its operating scale. Besides the GDP size, the severity of emission is also driven by how well the countries manage usage efficiency. This begs the question of whether a long-term relationship exists between energy use and the level of consumption or national income. The most appropriate test to determine this would be to explore this relationship amongst major oil producing countries as conducted by Sari and Soytas (2008) who found that cointegration between the variables occurred only for Saudi Arabia whereas none was found in other major oil producing countries (Indonesia, Algeria, Nigeria and Venezuela). As evidenced in the literature, the link between consumption and environmental degradation is inconclusive and as such, there is ample room for further research in this areas to acquire a greater understanding of the output-energy and output-environmental degradation nexus.

DATA AND METHODOLOGY

Data

Annual time series data of the variables of carbon emissions (CO_2), gross domestic product per capita (GDPC) and energy use (EC) from 1971 to 2008 was used for Malaysia. The data was obtained from the World Development Indicator, to examine the influence of consumption and energy use on environmental degradation.

Environmental degradation is proxied by carbon emission (CO_2) data, while consumption is proxied by GDPC. The use of GDPC as a proxy for consumption is supported by the findings of Adrangi, Dhanda and Hill (2004) on the accuracy of GDPC as a proxy for consumption.

Model Specification

The model for CO_2 emissions is written in the following form:

$$ln(CO_2) = \beta_0 + \beta_1 ln(GDP)_t + \beta_2 ln(EC)_t + e_t \qquad (1)$$

where CO_2 is CO_2 emissions (metric tons per capita), GDP is real GDP per capita (constant LCU) and EC is energy use (kg of oil equivalent per capita).

Methodology

The augmented Dickey-fuller (ADF) and Phillips-Perron (PP) unit root tests were used to test for stationarity. Thereafter, the maximum likelihood approach to cointegration test developed by Johansen (1988) and Johansen and Juselius

(1990) or better known as the JJ Cointegration Test was used. It provides information pertaining to whether the set of non-stationary variables under consideration is tied together by the long-run equilibrium path. In denoting *X* as a vector of the variables under study, the JJ test is based on the following vector error correction (VECM) representation:

$$\Delta X_t = \alpha + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + ... + \Gamma_p \Delta X_{t-p} + \Pi X_{t-1} + u_t \quad (2)$$

where α is an $n \times 1$ vector of constant terms, Γ_i (i = 1, 2,.., *p*) and Π are $n \times n$ matrices of coefficients, *p* is the optimal lag order and *n* is the number of variables in the model. The JJ test is based on determining the rank of Π, which depends on the number of its characteristics root (eigenvalue) that differ from zero.

As the purpose of this study is to determine the causal direction between the variables in question, the following vector error correction models (VECM) are estimated as:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \Delta y_{t-i} + \sum_{i=1}^{k} \alpha_j \Delta x_{t-j} + \gamma_1 ecm_{t-1} + \varepsilon_{1t} \quad (3)$$

$$\Delta y_t = b_0 + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \sum_{i=1}^{k} \beta_j \Delta x_{t-j} + \gamma_2 ecm_{t-1} + \varepsilon_{2t} \quad (4)$$

where ecm_{t-1} is the lagged residual from the cointegration between y_t and x_t in level. Granger (1988) points out that based on Equation (2), the null hypothesis that x_t does not Granger cause y_t is rejected not only if the coefficients on the x_{t-j}, are jointly significantly different from zero, but also if the coefficient on ecm_{t-1} is significant.

The study also applies the multivariate cointegration methodology of Johansen (1988) and Johansen and Juselius (1990) to establish the possible causal relations between environmental degradation and the variables of consumption and energy use. The cointegration test and the vector error correction model are used to find out whether there is evidence of long-run relationships between environmental degradation and the variables of consumption and energy use.

The study further investigates the dynamic properties of the system through the generalised variance decomposition analysis based on the unrestricted VAR model, to establish whether or not the consumption and energy use display explanatory power in forecasting environmental degradation variance. In Tiwari's (2011) analysis, the structural VAR approach indicates that consumption of renewal energy source increases GDP and decreases CO_2 emissions. A positive shock on GDP was found to have a very high positive impact on the CO_2 emissions.

This study has also drawn ideas from Loganathan and Thirunaukarasu (2010) who used a combination of OLS-EG, DOLS, ARDL and ECM to identify the short-run elasticity between total energy consumption and economic performance for Malaysia. Belke, Dobnik and Dreger (2011) insights gained through their effort to distinguish the effects of the national and international developments as drivers of the long-run relationship are also pertinent to this study.

This study hopes to extend the existing literature by using econometric modelling with VECM and variance decomposition approaches to identify the short-run and long run relationship between consumption and environmental degradation through CO_2 emissions.

DISCUSSION OF FINDINGS

The econometric findings are discussed in this section, starting with the results of the Unit Root test, followed by the discussions of the results of Johansen's Cointegration Test. Thereafter, the Vector Error Correction model results are analysed and finally, the results of the further innovation analysis using Variance Decomposition is presented.

Unit Root Test Results (Order of Integration)

Since time series data was used, certain appropriate preliminary analysis was conducted. The first step needed was to validate the presence of Equation (2). If Equation (2) was found to be present, the next step would be to estimate the long-run relation as shown in Equation (2) by employing the Johansen-Juselius approach and the Vector Error Correction Model (VECM). The ADF and PP Unit Root tests were performed on a 38 years period data i.e. from 1971 to 2008 to check whether the three variables in equation (1) were stationary in level or in first-difference. The results of this test are shown in Table 1. The constant without trend and the constant, linear trend specification were included in this test equation. The lag length used is represented in the brackets as shown in Table 1. The order of integration of the relevant variables was determined prior to performing a cointegration test as only integrated variables of the same order could be co-integrated. The test for unit roots in the variables of the system was calculated through the Augmented Dickey-Fuller (ADF) test and further supported by the Phillips-Perron (PP) test as shown in Table 1 for both level and first-differenced series. Table 1 confirms the stationarity of the variables when they are first-differenced, that is, all variables used in this time series are $I(1)$.

Table 1: ADF and PP Unit Root Tests

LEVEL	ADF		PP	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
LCO_2	–1.674452 (0)	–4.379551 (0)	–1.507568 [1]	–4.702793 [4]***
LGDP	–1.365293 (0)	–2.184544 (0)	–1.330345 [2]	–2.397939 [3]
LEC	–0.933340 (1)	–2.665706 (0)	–0.730847 [8]	–2.621410 [1]

1ST DIFFERENCE	ADF		PP	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
LCO_2	–13.37548 (0) ***	–13.12915 (0)***	–13.37548 [0]***	–13.12915 [1]***
LGDP	–5.041948 (0)***	–5.064201 (0)***	–4.998868 [2]***	–5.023425 [2]***
LEC	–7.470421 (0)***	–7.425852 (0)***	–7.699403 [5]***	–8.383731 [7]***

Note: *** and ** denotes significant at 1% and 5% significance level, respectively. The figure in parenthesis (…) represents optimum lag length selected based on Schwatz Info Criterion. The figure in bracket […] represents the Bandwidth used in the Phillips-Perron test selected based on Newey-West Bandwidth criterion.

Johansen-Juselius Cointegration Test Results

The Johansen-Juselius Cointegration Test was performed using non-correlated errors as the lag selection criterion. Since all variables in this time series are *I*(1), there is a likelihood of an equilibrium relationship between them. The cointegration test of Johansen (1988) and Johansen-Juselius (1990) was applied to investigate the presence of a long-run equilibrium relationship among the variables in study. Table 2 estimates the number of long run relationships that exist between environmental degradation (proxied by CO_2 emissions) and it determinants comprising consumer behaviour (proxied by GDP per capita) and energy consumption (EC). After performing the Johansen Cointegration Test, the Vector Error-correction Model (VECM) was estimated and the optimal lag length was obtained. A model with the optimum lag of 1 was chosen based on the Ljung-Box-Q statistics as the error terms of all equations in the system were found to be serially uncorrelated.

The results in Table 2 show that both the trace statistics as well as the maximum-eigenvalue statistics indicate the presence of a unique cointegrating vector at 1% level. Therefore, the empirical results suggest the presence of a long run cointegration relationship between environmental degradation (proxied by CO_2 emissions) and its determinants comprising of consumer behaviour (proxied by GDP per capita) and EC.

Table 2: Results from Johansen's Cointegration Test: Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

NULL	Test statistics		Critical value (5%)	
	Trace	Max eigenvalue	Trace	Max eigenvalue
r = 0	44.98541***	38.00977***	29.79707	21.13162
r ≤ 1	6.975635	6.599763	15.49471	14.26460
r ≤ 2	0.375872	0.375872	3.841466	3.841466

Note: *** denote significance at 1%. This table shows the results from Johansen's Cointegration Test for both Trace and Maximum Eigenvalue which shows the presence of cointegration for this system of variables.

Vector Error-Correction Model (VECM)

The vector error-correction model is used to capture the long-run equilibrium dynamics in the time series. Since there is evidence of cointegration, the dynamic relationships between the cointegrated variables can be studied using an error-correction model.

The cointegrating vector (normalised on the CO_2 emissions) representing the long-run relationship (with lag 1) is shown as follows:

$$\ln(CO_2)_t = -24.46877 + 5.388227 \ln(GDP)_t^{***} - 3.365872 \ln(EC)_t^{***} + e_t \quad (5)$$

t-stat [9.44280] [7.07742]

Note: *** denotes significant at 1%

The coefficients found in the normalised cointegrating vector in Equation (2) are long-term elasticity measures because the variables have undergone logarithmic transformation. Equation (2) shows that both LNGDP and LNEC are at 1% significance level. In the long run, there seems to be a positive and significant relationship between consumption (proxied by real GDP per capita) and environmental degradation (proxied by CO_2 emission), while energy consumption has a negative and significant impact on environmental degradation in Malaysia.

The positive relationship between consumption (proxied by real GDP per capita) and environmental degradation (proxied by CO_2 emission) are consistent with the empirical evidence of Tucker (1995); Adrangi, Dhanda and Hill, (2004); and Halicioglu (2009).

It is interesting to note that energy consumption in Malaysia has a negative relationship with CO_2 emissions. While this result contradicts with the findings of Ang (2007; 2009) and Jalil and Mahmud (2009), it is believed that when there is improved energy efficiency, this is likely to reduce CO_2 emissions as shown in our results. The plausible explanation for this puzzling relationship is the existence of safer patterns of production and consumption that does not pollute as much as before. Aside from this, national and global environment policies and cooperation between governments have provided a stronger push for improved energy efficiency and cleaner environment. Such policies include the imposition of green taxes on pollutants and subsidies for green companies, encouraging the use and further development of more sustainable energy technologies. It must also be noted that the estimated coefficients of the cointegrating vector shown above only represents the long-term relationship that exists and does not reflect the short-term dynamics that these variables could possibly share. In order to study the short-term dynamic relationships amongst the variables, the variance decompositions are generated based on the unrestricted VAR model.

Variance Decomposition

The study also investigated the dynamic properties of the system through the generalised variance decomposition analysis, which is presented and discussed in this subsection. The variance decomposition displays the explanatory power or relative importance of each variable in accounting for fluctuations in other variables. The study illustrates the contribution of the regressors in forecasting the variance of environmental degradation and of each other. Table 3 represents the results of the generalised variance decomposition at different time periods: one year (short term), five to eight years (medium to long term).

It can be seen that the bulk of the variations in the CO_2 emissions is attributed to its own variations. Even after 10 years, almost 98% of the variation in CO_2 emissions is explained by its own shock implying that it is relatively exogenous to other variables. However, it is imperative to note the insignificant role played by energy consumption and GDP per capita in forecasting the variance of CO_2 emissions. It can be seen that over the longer time horizon (10 years), energy consumption forecasts only approximately 1.632% of the variance of CO_2 emissions, whereas GDP per capita innovations do not seem to generate much fluctuation in CO_2 emissions.

Table 3 also shows that energy consumption is the most explained variable because almost 81% of its variance has been explained by innovations in the other variables. Almost 74% of variances in GDP per capita are explained by shocks in the other two variables. The results also point towards the dominant role of CO_2 emissions in generating fluctuations on GDP per capita. Any shocks to GDP per capita significantly impacted the forecast error variances of energy consumption in Malaysia.

Table 3: Generalised variance decomposition

Variance Decomposition of LCO_2:				
Period	S.E.	LCO_2	LGDP	LEC
1	0.148904	100.0000	0.000000	0.000000
2	0.186621	93.15505	1.387680	5.457271
3	0.243952	94.02599	1.003965	4.970046
4	0.286730	95.50663	0.797338	3.696031
5	0.325127	96.36135	0.694202	2.944449
6	0.360702	96.62497	0.856901	2.518132
7	0.396582	96.97993	0.811031	2.209035
8	0.428891	97.29177	0.746070	1.962158
9	0.458727	97.49114	0.728629	1.780236
10	0.487122	97.64514	0.723122	1.631741
Variance Decomposition of LGDP:				
Period	S.E.	LCO_2	LGDP	LEC
1	0.032161	20.80555	79.19445	0.000000
2	0.050891	46.03050	53.69089	0.278614
3	0.067982	61.01589	37.27972	1.704392
4	0.082363	63.83988	34.05952	2.100596
5	0.097031	65.66329	32.18501	2.151708
6	0.110382	67.89408	29.81029	2.295635
7	0.122429	69.26755	28.30694	2.425509
8	0.133643	69.99500	27.51093	2.494077
9	0.144233	70.65558	26.79839	2.546030
10	0.154127	71.20781	26.19514	2.597055
Variance Decomposition of LEC:				
Period	S.E.	LCO_2	LGDP	LEC
1	0.061736	3.242883	33.39232	63.36479
2	0.079407	6.805471	52.48888	40.70565
3	0.095836	13.11201	56.81340	30.07459
4	0.105316	18.06007	55.83147	26.10846
5	0.115450	20.60377	54.68971	24.70652
6	0.125366	21.76098	55.18784	23.05119
7	0.135328	23.11005	55.30318	21.58678
8	0.144149	24.37182	55.17886	20.44932

(continued on next page)

Table 3: *(continued)*

Variance Decomposition of LEC:				
Period	S.E.	LCO_2	LGDP	LEC
9	0.152485	25.33855	55.04344	19.61801
10	0.160409	26.06753	54.97949	18.95298
Cholesky Ordering: LCO_2 LGDP LEC				

Note: Table 3 represents the results of the generalised variance decomposition ion at different time periods: 1 month, 6 months, 1 year (short term), 18 months and 2 years (medium to long term).

POLICY IMPLICATIONS

The findings of this study have important implications on issues related to sustainable development in the country. In essence, the government must put into place regulatory measures to stringently enforce green laws that will reduce carbon emission. The empirical evidence gathered in this study postulates that higher consumption is positively associated with worsening environmental degradation in the long run. Therefore, it is important for policy makers to take cognizance that higher consumption and income level inevitably leads to deteriorating environmental conditions. Therefore, policymakers should implement policies focusing on sustainable environmental management rather than attempt to reduce environmental degradation through legal regulation and restrictive taxation. In other words, environmental regulation shall not come at the expense of higher national income.

The most effective way to achieve the best of both worlds is via education. People in developed countries tend to have greater environmental awareness due to better education and subsequent awareness on the effects of human activities on the environment. Malaysian authorities must take the cue from developed nations to incorporate environmental education in the school curriculum. Additionally, technology, such as the state-of-art waste management systems should also be utilised to curb environmental degradation.

The rise in environmental degradation may only be confined to certain sectors of the economy. As such, imposing a blanket approach in taxation on all sectors in order to deter carbon emission may not be outright effective. Disaggregation of data on environmental degradation should be sector-based as the sectors that inflict greater environmental damage should be taxed more than those that do not inflict as much damage. This selective approach may deter the "culprits" and coerce them to undertake measures that will reduce pollution whilst the cleaner sectors will justifiably be rewarded for the efforts taken. However, the disaggregated data may not be easily available and the collection process may be time-consuming.

It is also hoped that the Malaysian government, in its hope to achieve a sustainable "high-income nation" status, further implements and extends green policies that will assist in achieving its vision of developed status in 2020. One step towards this would be for Malaysia's transition to become a circular economy. If the Malaysian government is serious about the environment and decides to pursue sustainable development goals, then the first step would be to significantly reduce energy consumption, especially coal, and accelerate the proportion of use of renewable energy.

CONCLUSION

This study explored whether environmental degradation (proxied by CO_2 emissions) in Malaysia could be explained by consumption (proxied by GDP per capita) and energy consumption. The study employed vector error-correction model to gather empirical evidence to support the notion that environmental degradation is cointegrated with a pair of independent variables; namely, GDP per capita and energy consumption. The empirical results suggest the presence of long-run equilibrium relations between these variables and environmental degradation. The results lend evidence on the existence of a positive relationship between environmental degradation and consumption and a negative relationship between environmental degradation and energy use.

The short-term dynamic relationships that exist amongst the variables were also analysed, by generating variance decompositions based on the unrestricted VAR model. The generalised variance decomposition analysis demonstrates the dominant influence of environmental degradation and energy consumption on the consumption variance in Malaysia. The results also show evidence of the dominant role of environmental degradation in generating fluctuations on consumption. On the other hand, shocks in consumption significantly impact the forecast error variances of energy consumption in Malaysia.

Based on the findings, it can be concluded that consumption patterns have caused a negative impact on the environmental in Malaysia. The findings of this study offer an insight into the damaging impact of uncontrolled consumerist lifestyle on the environment. Hence, understanding the key drivers behind Malaysia's growing consumption and its associated CO_2 emissions is critical for the development of its climate policies in the future.

The study has some limitations that can be addressed in future research on the area. Firstly, it only investigates the relationship between two independent variables and environmental degradation in Malaysia. Additional work can be done on data from different countries, include other important economic variables and/or utilise monthly data for its analysis.

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