The Effect of Green Taxation and Economic Growth on Environment Hazards: The Case of Malaysia

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ABSTRACT
This paper explores how carbon taxation and economic growth affect environment hazards in Malaysia using time series data over the period of 1974-2010. We applied cointegration and causality approaches to determine long term and the direction of causal relationship between these variables. Based on the results, we found the cointegration relationship between the variables. Furthermore, we noted that Kuznets' theory i.e. inverted-U shaped curve between economic growth and CO_2 emissions is valid for Malaysia but the carbon taxation policy is ineffective to control CO_2 emissions. The causality analysis revealed that there is bidirectional relationship is found between carbon tax and CO_2 emissions. Economic growth Granger causes CO_2 emissions and carbon tax is Granger cause of economic growth. To enhance the awareness on pollution issues governments should rely on alternative instruments, which may give benefit not only to taxpayers but also to reduce pollution, which is the pivotal issue to be tackle globally.
Keywords: economic growth, environment hazards,

1. Introduction

Since the late 1980s, the state of the environment has been one of the most important issues facing by the society. One of the main causes is the industrial civilization that has produced a lot of damage. In addition, economic losses from natural disasters such as extreme weather-related events keep increasing at an alarming rate. With the countries racing to achieve the development status economy, the new pollution has come from the internal combustion engine, power stations and even chlorofluorocarbons (CFCs). Thus, more developed a country is the higher environmental damage that is done for the purpose of development. Realizing the importance of this issue, there has been an increasing attention given to combat the environmental hazards. Pressure groups likewise have been campaigning vigorously for environmental quality. Climate change, water, energy and pollution are among the most pressing concerns for humanity either at a national or global level. On the government perspective, the establishment of the Kyoto Protocol in 1997 by the United Nations Framework Convention on Climate Change (UNFCCC) has exerted various efforts to reduce their CO_2 emissions. Thus to support the effort to protect the environment, Malaysia ratified Kyoto Protocol on 4 Sept 2002.

However it is worth highlighting that Malaysia has enacted Petroleum Taxation in 1967 where it is imposed on income from the winning of petroleum. Specifically winning of petroleum refers to any mineral oil or relative hydrocarbon and natural gas existing in its natural condition and casing head petroleum spirit. Years later, Malaysia has introduced the 1974 Environmental Quality Act to show their concern to protect the environmental quality. Although this tax was initially imposed to gain revenue, it can also be seen as the first step by Malaysian government to embark in tackling the environmental issues. Globally countries are looking at the best way to show their concern on environmental hazard, which has been caused by development activities. This comes to the imposition of carbon tax, green tax, energy tax and petroleum tax. For instance, a carbon tax is imposed on the carbon content of goods or directly on the emissions of greenhouse gases which is one of the alternatives to abate the level of pollution produce by the industries (Dong and Whalley, 2012). In addition carbon tax is paid on consumption of energy products such as fuel or on each fossil fuel extracted (Baranzini et al. 2000; Davis and

Killian, 2011; Lin and Li, 2011). These taxes despite having different names but it have been introduced for the purpose to overcome the negative impact resulting from the use of non-environmental products and services.

Supporting this, based on the Environmental Kuznets curve (EKC), as per capita income rises, environmental destruction increases. After the achievements of a critical level of economic growth, the country will become more aware of environmental protection. This is the case for developed country where the moment, the country has achieved the developed status; it will become more concerned about environmental issues. The earliest wave of research in this area has focused on the nexus between carbon emissions and economic growth, providing conflicting results; in favor of EKC and some against EKC theory (Shahbaz et al. 2012a, 2103a, 2013b, 2013c, Shahbaz and Jam, 2013; Tiwari et al. 2013; Narayan et al. 2010; Mehrara, 2005; Soytas and Sari, 2009). However it is difficult to pinpoint the direction of a relationship that is, whether the influence proceeds from economic growth to carbon emissions or the reverse, or in both directions. Tiwari (2011) establishes four sets of testable hypothesis that has been proven from past research as presented in Table-1.

[Insert Table-1 here]

Based on selected literature listed on Table-1, the direction of the relationship is varying where there is no uniformity in the direction of the relationship. However what can we agree on, there is strong relationship that exists between carbon emissions and economic growth. Given the profound relationship between carbon emissions and economic growth, it comes to the efficient tools that can be implemented by the government to reduce pollution problems. On one hand, imposing taxation on carbon is said as one of the most efficient tools to combat environmental problems. On other hand, the idea of imposing carbon taxation to economic activities may be opposed by the state government. For instance when the government needs to fulfill the requirements for a sustainable forest management and other environmental and ecological restrictions on logging companies, they might reluctant to do this as this may result in lower revenues from them (Saleem, 2005). However, study on investigating the validity of this relationship is still scarce as most of the studies as mentioned earlier focus on analyzing the relationship between carbon emissions and economic growth. Thus, this opens a channel of research in examining whether imposing tax will have significant impact on carbon emissions. As a result it will later affect the growth performance. Some scholars (Liang et al. 2007; Lin and Li, 2011; Conefrey et al. 2013) believed that carbon taxes imposed by the government have a significant effect on emissions reduction although the impact might be minimal. This shows that taxes imposed on economic activities that lead to environmental risk gives awareness where taxpayers may find alternative ways to dispose the waste from the companies. As the carbon tax is seen as the solution to combat emissions' problem, it also has a negative impact on the economy.

Liang et al. (2007) and Lin and Li (2011) point out that the impact of carbon tax may depend on the economic conditions of an economy. For instance, analyzing the impact of carbon tax on CO_2 emissions in Denmark, Finland, Sweden, Netherlands and Norway they found that carbon tax significantly affects economic growth in Finland, but it's not significant in other countries. This may cause by different impacts of carbon taxes in different countries mainly come from policy approach and different rates imposed. Developed economies such as Australia are struggling to reduce global emissions by imposing carbon taxes. However the effect is seemed too small as many developing countries have ignored the environmental protection in order to achieve their aim to become developed economies (Dong and Whalley, 2012). Further carbon tax is, seems, become a burden specifically to developing countries. This is when the tax is imposed will increase the cost of development and this might lead to distortion of economic growth. Furthermore, Kiuila and Markandya (2009) and Zhou et al. (2011) report that a carbon tax is able to produce positive impact when the tax is designed to shift the burden from labor force or household income to environmental pollution. However the imposition of carbon tax might have a direct impact on the economy and growth of all countries should be followed by higher CO_2 emissions as a result from more production industries and household consumption. Since the aim of carbon tax to reduce CO_2 emissions, it is noted that this will distort economic growth. But this is not the case where the negative impact on economic growth from carbon tax is not obvious for the reason that the tax revenue is put into an economic system that can offset economic growth loss to some extent. Supporting these results, Löfgren and Nordblom (2010) based on the survey conducted in Sweden suggest that using CO_2 tax as an important climate policy will be more politically feasible and legitimate when the focus is given to the climate change problem.

In light of the above discussion, this study aims to examine the impact of carbon tax on carbon emissions and economic growth in Malaysia for the period of 1976 until 2010. This study contributes to the literature by focusing on the discussion of issues, which has not been touched in previous studies specifically in Malaysia. The central idea is that the imposition of carbon seems vital for the government as an alternative way of the collection of taxation as well as to combat environmental problems. Further the imposition of carbon tax also seems to affect the growth of the country.

The balance of study is organized as following: section-2 describes the model construction and methodological framework, the results and their discussion is explained in section-3 and section-4 presents conclusion and policy implications.

2. Model Construction and Methodological Framework

The data used in study are annual observations covering the period of 1976 to 2010 obtained from two data sources. The carbon dioxide emissions (CO_2) data are extracted from World Development Indicators. Meanwhile, carbon tax (CTAx) and GDP per capita measured at constant 2005 prices has been obtained from the Department of Statistics. The functional relationship is as shown in Eq. 1:

$$CO_{2t}=f(CTax_t, GDP_t, GDP_t^2) \quad (1)$$

Where CO_2 is referring to environmental hazards in (kt), CTax is carbon tax proxy to green taxation, GDP is proxy for economic growth and GDP^2 is GDP squared. All data are measured in Ringgit and transformed to logarithm formations as shown in Eq. 2:

$$lnCO_{2t}=\beta_1+ \beta_2 lnCTax_t + \beta_3 lnGDP_t + \beta_4 lnGDP_t^2 + \mu_t \quad (2)$$

[Insert Fig-1 here]

Where $lnCO_2$ is the natural log of CO_2 emissions, $lnCTax_t$ is natural log of carbon tax, $lnGDP_t$ ($lnGDP_t^2$) is the natural log of real GDP per capita (natural log squared of real GDP per capita) and μ_t is a residual term assumed to be white noised.

2.1 Unit root tests

In this study we used Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski et al. (KPSS) low powerful unit root tests for the stationary level of each variable used. As can be seen from Fig. 1, the plots of CO_2, CTax and GDP appears that it may have structural breaks and indicate more reason to use endogenous powerful unit root tests with structural break(s). Besides that, in some circumstance, the traditional residual based unit root test can be biased and to reduce the biasness, structural breaks(s) unit root test is the best solution. First, we employed Zivot-Andrew (1992) with single unit root test to capture the time trend of the break date. Although, ZA unit root test able to capture single structural break but in our case we need more powerful and more breaks indications through the series. Therefore, the suitability test is Clement et al. (1998) or well known as CMR double mean shift breaks. The CMR test is able to capture double structural breaks in the mean value using innovative (IO) and additive outlier (AO) (Shahbaz, 2012). The null hypothesis for CMR is

$$H_O: x_t = x_{t-1} + a_1 DTB_{1t} + a_2 DTB_{2t} + \mu_t \quad (3)$$

$$H_1: x_t = u+ b_1 DU_{1t} + b_2 DTB_{2t} + \mu_t \quad (4)$$

Where, DTB_{1t} is the pulse variable equals 1 if $t=TB_{i+1}$ and zero otherwise; DU_{it}=1 if $TB_i<t$ (I =1, 2) and zero otherwise; and TB_1 and TB_2 is the modified means over the time periods.

2.2 The ARDL Bound testing

As we have decided to investigate the long-run relationship between CO_2, Ctax, GDP and GDP^2 with mixed stationarity indications, therefore the suitable estimation technique is autoregressive distributed lag (ARDL) proposed by Pesaran et al. (2001). The ARDL model used in this study is as follows:

$$\Delta lnCO_{2t} = \beta_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnCO_{2t-i} + \sum_{i=1}^{n} \alpha_2 \Delta lnCTax_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \alpha_3 lnGDP^2_{t-i} + \pi_1 lnCO_{2t-i} + \pi_2 lnCTax_{t-i} + \pi_3 lnGDP_{t-i} + \pi_4 lnGDP^2_{t-i} + \varepsilon_{1t} \quad (5)$$

$$\Delta lnCTax_t = \beta_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnCTax_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \alpha_3 lnGDP^2_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta lnCO_{2t-i} + \pi_1 lnCTax_{t-i} + \pi_2 lnGDP_{t-i} + \pi_3 lnGDP^2_{t-i} + \pi_4 lnCO_{2t-i} + \varepsilon_{2t} \quad (6)$$

$$\Delta lnGDP_t = \beta_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \alpha_2 lnGDP^2_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta lnCO_{2t-i} + \sum_{i=1}^{n} \alpha_4 \Delta lnCTax_{t-i} + \pi_1 lnGDP_{t-i} + \pi_2 lnGDP^2_{t-i} + \pi_3 lnCO_{2t-i} + \pi_4 lnCTax_{t-i} + \varepsilon_{3t} \quad (7)$$

$$\Delta lnGDP^2_t = \beta_0 + \sum_{i=1}^{n} \alpha_1 lnGDP^2_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta lnCO_{2t-i} + \sum_{i=1}^{n} \alpha_3 \Delta lnCTax_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta lnGDP_{t-i} + \pi_1 lnGDP^2_{t-i} + \pi_2 lnCO_{2t-i} + \pi_3 lnCTax_{t-i} + \pi_4 lnGDP_{t-i} + + \varepsilon_{4t} \quad (8)$$

The ARDL model is able to capture the long-run relationship among the variables based on F-statistics (bounds test), where the null hypothesis of level relationship is H_0: $\pi_1=\pi_2=\pi_3=\pi_4=0$; against the alternative hypothesis, where the H_1: $\pi_1\neq\pi_2\neq\pi_3\neq\pi_4\neq 0$. We have used Narayan (2005) critical values table to identify the long-run behavior of the variables, because the time frame of this study is quite small. As mentioned earlier, one of the main aims of this study is to identify structural breaks and therefore we include time trend series of structural break date based on the ZA unit root test into the ARDL estimation framework to capture the structural break effects in the long-run relationship among the variables. In the second part of the ARDL framework, we explore the short-run relationship with error correction term which indicates the speed of adjustment by employing the ARDL-ECM framework with all series integrated at I(1). To ensure the ARDL estimation model reliable, we applied the goodness of fit and diagnostic tests as well as the CUSUM and CUSUMsq diagrams.

2.3 The VECM Granger causality test

In this study we used Granger causality estimation based on the ARDL framework by carrying out the ARDL-ECM and the lagged conditions. By applying this framework, we are able to identify the long-run causality based on the error correction term and the short-run causality by conducting the joint *F*-statistic tests. If the error correction term t-ratios are statistically significant, this will meet the long-run causalities between the variables. Meanwhile, if the F-statistical identically significance, we apply the short-run Granger causality approach for the short run causal relationship between the variables. The ARDL-ECM models for Granger causality test in this study can be expressed as follows:

$$\begin{bmatrix} \Delta lnCO_{2t} \\ \Delta lnCTax_t \\ \Delta lnGDP_t \\ \Delta lnGDP^2_t \end{bmatrix} = \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} + \begin{bmatrix} \delta_{11,1} & \delta_{12,1} & \delta_{13,1} & \delta_{14,1} \\ \delta_{21,1} & \delta_{22,1} & \delta_{23,1} & \delta_{24,1} \\ \delta_{31,1} & \delta_{32,1} & \delta_{33,1} & \delta_{34,1} \\ \delta_{41,1} & \delta_{42,1} & \delta_{43,1} & \delta_{44,1} \end{bmatrix} \begin{bmatrix} \Delta lnCO_{2t-1} \\ \Delta lnCTax_{t-1} \\ \Delta lnGDP_{t-1} \\ \Delta lnGDP^2_{t-1} \end{bmatrix} + \cdots + \begin{bmatrix} \delta_{11,i} & \delta_{12,i} & \delta_{13,i} & \delta_{14,i} \\ \delta_{21,i} & \delta_{22,i} & \delta_{23,i} & \delta_{24,i} \\ \delta_{31,i} & \delta_{32,i} & \delta_{33,i} & \delta_{34,i} \\ \delta_{41,i} & \delta_{42,i} & \delta_{43,i} & \delta_{44,i} \end{bmatrix} \begin{bmatrix} \Delta lnCO_{2t-i} \\ \Delta lnCTax_{t-i} \\ \Delta lnGDP_{t-i} \\ \Delta lnGDP^2_{t-i} \end{bmatrix} + \begin{bmatrix} \varphi_1 \\ \varphi_2 \\ \varphi_3 \\ \varphi_4 \end{bmatrix} \times \eta_{t-1} + \begin{bmatrix} \mu_{1,t} \\ \mu_{2,t} \\ \mu_{3,t} \\ \mu_{4,t} \end{bmatrix} \quad (9)$$

In Eq. 9, Δ denotes the difference operator η_{t-1} is the lagged error correction term, $\mu_{1,t}$, $\mu_{2,t}$,$\mu_{3,t}$ and $\mu_{4,t}$ are serially independent random errors.

3. Empirical Findings and their Discussions

The primary test of time series analysis is the stationary identification because time series data naturally affected with classical linear regression assumption. Before conducting stationary tests, we have explored the basic statistics as shown through Table-2.

[Insert Table-2 here]

We apply cointegration approaches to examine the long run relationship between the variables. We note that our variables should be stationary at *I* (1) or *I* (0) or variables are integrated at (1) and *I* (0). If any variation is stationary at *I* (2) then computation of *F*-statistics would be useless. To ensure that our variables are integrated at *I*(1) or *I*(0), we have applied ADF and PP unit root tests. The results are reported in Table-3.

[Insert Table-3 here]

Table-3clearly shows that all the variables are stationary with I (1), although the PP test using without trend estimation techniques reject the null hypotheses at *I*(0) stage. In order to determine the stationary level as long as unknown structural break, we have also applied Zivot and Andrew (1992) and CMR (1998), which accommodate single unknown structural break stemming in the series. We find that all the variables have unique order of integration in the presence of structural break in the series. The results are shown in Table-4.

[Insert Table-3 here]
[Insert Table-4 here]
[Insert Table-5 here]

We applied the CMR unit root which accommodates two unknown structural breaks in the series. The results are reported in Table-5 and we find that the structural breaks suggested by the CMR unit root tests for IO except for CTax in IO are significant at the 5 percent level of significance. Nonetheless, the AO model that captures sudden changes in the mean of a series seems to be more appropriate for the variables since the results support the significance level at 5 percent for all variables. For carbon tax revenue the results show the breakpoint in the year 1997 and 2004. The results suggest that the 1997 Asian Financial Crisis does affect the tax revenue collection. To further the adoption of the Kyoto Protocol in 1997 by UNFCCC may also be the contributing factor. However increase in oil price and a new exploration activity in 2000 does not have a significant impact. Although the tax rate remains unchanged since 1998, stood at 38 percent, the carbon tax revenue collection has increased due to an increase in world crude oil prices. Few break points recorded in 1980's are in line with the transformation of Malaysia from a third world country with a young industrialized economy. Thus an urban-based economic growth has led to increase potential for pollution of the environment. In addition to the adoption of the Montreal Protocol in Malaysia in 1987 marked the beginning of a unique global effort to solve a shared environmental problem further lead to the dropped the ozone-depleting substances (ODS) consumption (United Nation, 2005). The CMR unit root test also reveals that all the series has a unique order of integration. This suggests applying the ARDL bounds testing cointegration to examine the long run relationship between the variables over the period of 1974-2010 in the case of Malaysia. The results are shown in Table-5. We have used critical bounds generated by Narayan, (2005) which are suitable for small data. We find that our computed F-statistic is greater than upper critical bound at 5 percent as we used CO_2 emissions and the carbon tax as dependent variables. This shows that there are two cointegrating vectors, which confirm the existence of the long run relationship between the variables.

[Insert Table-6 here]

After discussing the existence of the long run relationship among CO_2 emissions and carbon tax and economic growth, we turn to investigate the marginal impact of carbon tax and economic growth in CO_2 emissions. The results are reported in Table-6. We find that a carbon tax has a positive impact on CO_2 emissions but it is statistically insignificant. This situation arises due to several factors; first, the tax here is imposed on companies that engaged in petroleum activities, whereas the major biggest producer of CO_2 comes from the manufacturing companies and secondly, the inability of the industries to reduce their dependency on petroleum products to other alternative source which is more environmental friendly. Finally, in order to move into the league of high-income economies, industries ignored the environmental risks and engaged with high pollution activities to achieve the target. The relationship between economic growth and CO_2 emissions is an inverted U-shaped curve. This shows that a 1 percent increase in economic growth is linked with a 13.94 percent rise in CO_2 emissions while the nonlinear term of GDP seems confirm the delinking of CO_2 emissions after the threshold level of GDP per capita. This finding is consistent with Saboori et al. (2012) who supported the existence EKC in the case of Malaysia.

[Insert Table-7 here]

In the short run (lower segment of Table-7), we find that a carbon tax has a positive impact on CO_2 emissions but it is still insignificant. The relationship between economic growth and CO_2 emissions is inverted U-shaped as linear and nonlinear terms of GDP have a positive and negative impact on CO_2 emissions and it is statistically significant at 1 percent and 5 percent levels of significance respectively. The estimate of the lagged error term (η_{t-1}) is negative (-0.49) and it is statistically significant at the 5 percent level. This validates our earlier established long run relationship between the variables. We may conclude that adjustment spend from short run to long run equilibrium path is 49 percent and it may consume almost 2 years to reach equilibrium path. The short model passes all diagnostic tests easily. We find no evidence of serial correlation as well as heteroskedisticity. The error term found to be normally distributed and functional form of the model is well organized.

[Insert Fig-2 here]

For the CUSUM test in Fig. 2, the test statistic is not outside the corridor. On the contrary, the CUSUM of squares test statistic is outside the corridor. Thus the null hypothesis of parameter stability is rejected at the 5 percent significance level showing the instability of the coefficients. We have also applied the ARDL-ECM Granger causality to examine the direction of causal relationships between carbon tax, economic growth and CO_2 emissions. It is recommended by Granger (1969) to apply the ECM Granger causality framework if variables are integrated at $I(1)$. There must be a causality at least from one direction if variables are cointegrated. The results are reported in Table-8. We find that carbon tax Granger causes CO_2 emissions and in return, CO_2 emissions Granger cause carbon tax in the long run. The unidirectional causality exists running from economic growth to CO_2 emissions. This finding is consistent with Saboori et al. (2012) in the case of Malaysia. In short run, economic growth GrangercausesCO_2 emissions. The neutral effect is found between a carbon tax and CO_2 emissions. The nonlinear term of GDP also Granger causes carbon tax.

[Insert Table-8 here]

4. Conclusion and Policy Implications

The Malaysian government has actively taken initiatives to promote the adoption of green technology as a part of a strategy for sustainable development. This effort has started since 1970's with the introduction of the Environmental Quality Act 1974 to protect the environment due to heavy agricultural activities for the country's development. Years later with the transformation from an agricultural based on manufacturing activities see more effort should be taken to combat the environmental problem. The global warming issues are now becoming the major concern where the numerous amount of research from various disciplines are focused on this global problem. Thus this paper provides an analysis of the impacts of carbon taxation and economic growth on carbon emission. We aim to examine whether the policies implemented by the government specifically through taxation affect the carbon emissions. Based on the outcomes, we can state that the imposition of carbon tax in Malaysia is not giving much impact on the carbon emissions reduction. This means that a carbon tax has no significant development in the growth of carbon emissions. This may be due to the structure of tax in Malaysia where companies will either be charged petroleum tax or company tax based on their core activities and there is no specific tax or policies to cater for carbon emissions. Thus the companies, which involved in activities that heavily produce carbon emissions, might not be imposed on petroleum tax.

Meanwhile, in 10th Malaysia Plan (2010-2015), the government has introduced 5 strategic pillars of new energy policy for Malaysia. The first strategy is energy pricing for petroleum products, natural gas, electricity and coal. The second strategy is related to supply side initiatives especially for imports of LNG and coal, renewable emphasized and the government also accepts nuclear as an option for electricity generation in future. Thirdly, is most likely related to energy efficiency measures in industrial, commercial, residential areas and transport industries. This is a great policy because these sectors are the largest consumer of energy in Malaysia and have high potential of CO_2 emission from electricity generation from resources. The fourth energy policy is towards stronger governance that can be emphasized by increasing the market disciplines for natural resources and electricity generation. This will guide industries and consumers in Malaysia to be more responsible and disciplines while dealing with non-renewable and renewable resources. The fifth new energy strategy is mostly related to manage of energy recourses by integrating and sequenced approach to achieve sustainable outcomes. As a conclusion, this new energy policy introduced through Tenth Malaysia Plan is a wonderful idea to reduce CO_2 emissions from energy generation in the future and this policy also able to guide industries and consumers the dynamic link between resources and environmental sustainability.

However the empirical results suggest that economic growth in Malaysia affects carbon emissions. The results are consistent in both short run and long run. This support the Kuznets' theory where the more developed the country is the more concern given to combat the environmental pollution. However on reaching the developed status there is less concern given to environmental issues. Referring to our data, we can classify the data in three phases, which are 1970s, 1980s and 1990s onwards. In 1970s Malaysia was heavily relied on agriculture activities that emitted less carbon emissions. However, due to privatization and transformation to manufacturing activities there is an increase in carbon emissions production in the middle 1980s. Further with the closest aim to reach the developed nation in the 2020s, it is expected that the production of carbon emissions will increase to 180 million metric tons per year in 2010 as compared to only 14 million metric tons in 1974. Therefore, although the government has put much effort by introducing incentives to tackle the environmental issues, support from other parties such as companies and individual is vital. The more vigorous enforcement of existing regulations in order to keep pace with the anticipated growth in investments is crucial to cater for environmental problem. The government should also focus on being a facilitator that provides a platform to industries to play their role in carrying out special environmental and ecological campaigns, which will benefit both parties. In the recent years, the government has also played an important role by reducing import tax on green technology imported cars especially from Japan. This is a good indication, where the Malaysian government has a positive intention to reduce CO_2 emissions. However, it is hoped that once we achieve the developed nation status by 2020 our view on environmental issues will be changed accordingly.

Conversely, some of the previous studies argued about the contribution of these sectors on economic growth and its pressure on environmental sustainability. To overcome this puzzle, taxation policy on non-renewable resources such as petroleum, gas and coal should be revised. This can be emphasized through fiscal policies with carbon tax policies because the findings of this study not able to capture the contribution of taxation on CO_2 emissions. From our point of view, by utilizing carbon tax policy, the government able to sustained continuous economic growth with tax revenue with hoping more of industrial activities that have direct connection with environmental hazards. As a developing country, economic growth and CO_2emission is following the basic Kuznets theory. Basically, a carbon tax is one of the important policies choices to stimulate the realization of CO_2 in many developed and developing countries (Zhou et al. 2011). The positive impacts on economic growth from carbon tax revenue also should be discussed clearly based on the traditional Kuznets' theory. Basically, the impacts on tax revenue are directly related to the economic growth scenario, through the findings of this study. Therefore, if we introduced an environment taxation policy on non-renewable resources, conversely it will not able to drop CO_2 emissions. This is because approximately Malaysia is facing upward trend of Kuznets curve, where increase's in economic growth, will tend to increase CO_2 emission. Finally, as a conclusion, carbon tax policy is able to sustain the economic growth in Malaysia, but not able to reduce the environmental hazards cause by the high volume of industrial activities. Whatever the results indicate through this study, top priority to combat CO_2 emission in Malaysia is by introducing innovative green technology aspects of industrial, commercial, residential and transport industries. In the meantime, the government should play an important role with policy implication, especially in the urban areas to reduce energy use and the citizen must be more responsible to achieve a sustainable environment.

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Table-1: Selected literature on EKC indicators

Hypothesis	Author	Country	Period	Causality Direction
Growth	Lee and Chang [14]	Taiwan	1954-2003	CE/EC $\rightarrow$ EG
	Ang [15]	France	1960-2000	CE/EC $\rightarrow$ EG
	Ozturk and Acaravci [16]	Turkey	1968-2005	CE/EC $\rightarrow$ EG
	Binh [17]	Vietnam	1976-2010	CE/EC $\rightarrow$ EG
	Shahbaz et al. [8]	Turkey	1970-2010	CE/EC $\rightarrow$ EG
	Shahbaz et al. [7]	Romania	1980-2010	CE/EC $\rightarrow$ EG
Conservation	Fati et al. [18]	New Zealand, Australia, India, Indonesia, Philippines and Thailand	1960-1999	CE/EC $\leftarrow$ EG
	Tiwari [13]	India	1971-2005	CE/EC $\leftarrow$ EG
Feedback	Glasure [19]	South Korea	1961-1990	CE/EC $\leftrightarrow$ EG
	Jumbe [20]	Malawi	1970-1999	CE/EC $\leftrightarrow$ EG
	Yoo [21]	Korea	1970-2002	CE/EC $\leftrightarrow$ EG
	Shahbaz et al. [22]	Pakistan	1972-2011	CE/EC $\rightarrow$ EG
Neutral	Yu and Jin [23]	United States	1974-1990	No relationship
	Stern [24]	United States	1948-1994	No relationship

Notes: CE –carbon emission, EC – energy consumption and EG – economic growth

Table-2: Summary statistics of data (logarithm formation)

	$\ln CO_2$	$\ln Ctax$	$\ln GDP$	$\ln GDP^2$
Mean	4.25	22.02	26.11	682.45
Median	4.34	21.77	26.18	685.57
Maximum	5.20	24.02	27.05	731.72
Minimum	3.11	19.59	25.03	626.59
Std. dev.	0.67	1.074	0.62	32.82
Skewness	-0.26	0.188	-0.13	-0.11
Kurtosis	1.73	2.59	1.66	1.65

Table-3: Unit root tests results

Variables	Without trend		With intercept and trend	
	ADF	PP	ADF	PP
$\ln CO_2$	-1.24	-3.21**	-1.75	-1.56
$\Delta\ln CO_2$	-6.80*	-7.05*	-7.04*	-16.25*
$\ln Ctax$	-2.26	-2.34	-3.22	-3.23
$\Delta\ln CTax$	-6.65*	-6.66*	-6.63*	-6.63*
$\ln GDP$	-1.19	-1.16	-1.26	-1.42
$\Delta\ln GDP$	-5.18*	-5.19*	-5.44*	-5.45*
$\ln GDP^2$	-0.99	-0.96	-1.40	-1.58
$\Delta\ln GDP^2$	-5.25*	-5.26*	-5.43*	-5.44*

Notes: (*) and (**) indicate 1% and 5% significance level respectively

Table-4: ZA unit root tests with structural breaks

Variables	Level		First difference	
	Test value	Year of break (T_B)	Test value	Year of break (T_B)
lnCO_2	-2.14	1990	-5.40*	1990
ln*Ctax*	-3.81	1987	-6.78*	1997
ln*GDP*	-3.03	1991	-5.85*	1998
lnGDP^2	-3.95	1991	-5.92*	1998

Note: (*) indicates significant at the 1 % level

Table-5: CM Runit root test with first difference mean shifts

Variables	Innovative outliers (IO)			Additive outlier (AO)		
	t-statistic	$T_B(1)$	$T_B(2)$	*t*-statistic	$T_B(1)$	$T_B(2)$
lnCO_2	-3.81	1986	2000	5.73*	1987	2001
ln*Ctax*	-4.58	2000	2004	-6.20*	1997	2004
ln*GDP*	-3.87	1989	1997	-6.36*	1989	1996
lnGDP^2	-2.55	1990	2003	-7.95*	1990	2003

Note: (*) indicates 5% significance level respectively

Table-6: Lag Length Selection

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	161.9126	NA	1.09e-09	-9.2889	-9.1094	-9.2277
1	277.7949	197.6816*	3.08e-12*	-15.1644*	-14.2665*	-14.8582*
2	293.7182	23.4166	3.23e-12	-15.1598	-13.5437	-14.6087
3	304.0477	12.7599	5.04e-12	-14.8263	-12.4919	-14.0302

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table-7 : The ARDL Cointegration estimation results

Variables	lnCO^2	ln$CTax$	lnGDP	lnGDP^2
F-statistics	7.987**	8.348**	1.2331	4.958
Structural break	1990	1987	1991	1991
Critical values$^{\#}$	1 % level	5 % level	10 % level	
Lower bounds	7.527	5.387	4.477	
Upper bounds	8.803	6.437	5.420	
R^2	0.713	0.717	0.999	0.999
Adj-R^2	0.389	0.578	0.998	0.999
F-statistic	2.199***	5.158*	11.144*	22.446*

Note: (*) and (**) shows significant at 1%, 5% and 10% levels respectively. # Critical values bounds are from Narayan [39] with unrestricted intercept and unrestricted trend

Table-8: ECM-ARDL cointegration results

Dependent	AIC and SBC: ARDL(1,0,0,0)			
variable: CO_2	Coefficient	Standard error	t-statistics	p-value
Long run estimates				
ln$Ctax$	0.06	0.03	1.46	0.15
lnGDP	13.94*	4.20	3.31	0.00
lnGDP^2	-0.24*	0.08	-3.06	0.01
Short run estimates				
Δln$CTax$	0.03	0.02	1.38	0.17
ΔlnGDP	6.83*	2.41	2.81	0.00
ΔlnGDP^2	-0.12*	0.04	-2.68	0.01
ECT_{t-1}	-0.49*	0.12	-3.78	0.01
Panel C: Goodness of fit and diagnostic test statistics				
$\chi^2_{Serial}(1)$	0.01 (0.90)	$\chi^2_{Function}(1)$	0.10 (0.74)	
$\chi^2_{Hetero}(1)$	2.31 (0.13)	$\chi^2_{Normality}(2)$	0.03 (0.98)	

Notes: (*) and (**) indicate 1% and 5% significance levels respectively. Values in parenthesis are p-values.

Table-9: Chow forecast test

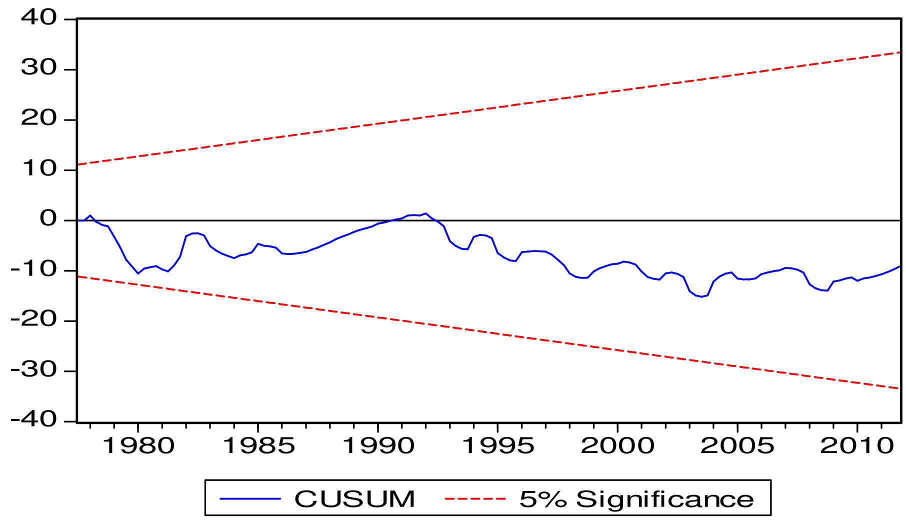
Length of period: 1980 until 2010		
	Statistics	p-value
F-statistic	2.728	0.450
Log likelihood ratio	155.373*	0.000

Notes: (*) and (**) indicate 1% and 5% significance levels respectively.

Table-10: Granger causality estimations under the ARDLapproach

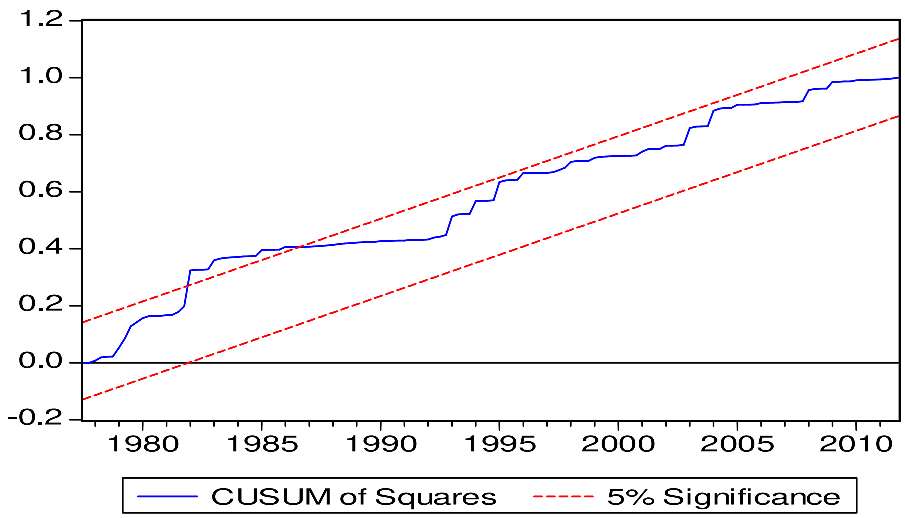
Dependent Variable	Weak causality (χ^2 statistics)					Strong causality(χ^2 statistics)			
	Short run Granger causality				Long run	$\Delta\ln CO_2$	$\Delta\ln CTax$	$\Delta\ln GDP$	$\Delta\ln GDP^2$
	$\Delta\ln CO_2$	$\Delta\ln CTax$	$\Delta\ln GDP$	$\Delta\ln GDP^2$	ECT_{t-1}	$\&ECT_{t-1}$	$\&ECT_{t-1}$	$\&ECT_{t-1}$	$\&ECT_{t-1}$
$\Delta\ln CO_2$	-	1.92	7.94	7.23	-0.49	-	14.39	15.07	15.08
		(0.16)	(0.01)*	(0.01)*	(-3.78)*		(0.00)*	(0.00)*	(0.00)*
$\Delta\ln CTax$	0.82	-	3.66	4.22	-0.32	4.15	-	4.10	8.51
	(0.36)		(0.06)	(0.04)**	(-2.38)**	(0.12)		(0.12)	(0.03)**
$\Delta\ln GDP$	0.13	0.86	-	8.18					
	(0.71)	(0.35)		(0.00)*					
$\Delta\ln GDP^2$	0.15	0.81	8.18	-					
	(0.69)	(0.36)	(0.00)*						

Notes: (*) and (**) indicate 1%, 5% and 10% significance level respectively.Values in parenthesis are p-values.



The straight lines represent critical bounds at 5% significance level

Fig. 1. Plot of cumulative sum of recursive residuals



The straight lines represent critical bounds at 5% significance level

Fig. 2. Plot of cumulative sum of squares of recursive residuals