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Article

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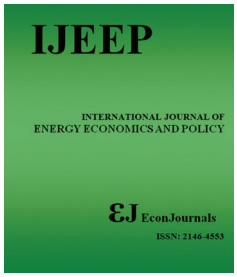

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The Influences of Economic Indicators on Environmental Pollution in Malaysia

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ABSTRACT

This study aims to investigate the relationship between environmental degradation (ecological footprint) and economic indicators such as gross domestic product (GDP), financial liberalisation, energy consumption, urbanisation, and trade openness in Malaysia. The use of financial liberalisation is driven by the factor that majority of the previous studies focused on financial development that has a narrow definition. Autoregressive distributed lag model and Granger causality test has been used to identify the relationship between the variables from 1978 to 2013. The result shows that environmental Kuznets curve model does not apply in Malaysia due to the U-shape relationship between financial liberalisation and ecological footprint. Positive relationships are identified between GDP, trade openness, energy consumption and ecological footprint. The results of the study suggest that Malaysia should improve its energy efficiency and focus more on its environmental well-being while increasing its GDP.

Keywords: Financial Liberalisation, Ecological Footprint, Malaysia
JEL Classifications: Q5, P28, O16, G18, P34, P43

1. INTRODUCTION

Financial liberalisation can bring many advantages to the country but at the same time, its negative side effects are often neglected due to the attractive advantages it offers (Ang and McKibbin, 2007). In order to maximise the benefits of financial liberalisation, we should not neglect the negative effects followed by the benefits brought by it. Among all of the negative consequences brought by financial liberalisation, the effects on the environment have been widely studied by researchers in recent years (Abbasi and Riaz, 2016; Lu and Chen, 2017; Ulucak and Bilgili, 2018; Gokmenoglu et al., 2015).

Financial liberalisation Malaysia was initiated by the Malaysian Government in the 1970sin response to the pressures of globalisation (Ang and McKibbin, 2007). The gross domestic product (GDP) and economic performance of Malaysia can be improved with the help of the increase in capital inflow followed by the practice of the liberalisation of the financial market (Atici, 2012). Furthermore, financial liberalisation plays an important role in attracting Foreign Direct Investment (FDI) that allow for the introduction of newer and more advanced technologies to Malaysia that will spur economic development.

In addition, a majority of the research that have been conducted have focussed on the relationship between financial development and environmental degradation (Lu and Chen, 2017; Charfeddine, 2017; Charfeddine and Mrabet, 2017; Rafindadi and Ozturk, 2016). However, the literature is scant and limited on the relationship between financial liberalisation and environmental degradation. Hence, this research is carried out to ensure a better understanding of the effects of financial liberalisation on environmental degradation in Malaysia.

Many researchers have studied the relationship between financial development and its effects on institutional reforms as it has the potential to affect the economy and environment (Kaminsky and Schmukler, 2003). According to Kaminsky and Schmukler (2003),

the use of financial liberalisation that has a wider perspective as compared to financial development will ensure that the results to be more comprehensive. Therefore, by examining financial liberalisation, a clearer and more holistic view can be formed as it includes all of the aspects and indicators of financial development namely broad money, domestic credit provided by the banking sector, and so forth.

2. REVIEW OF THE LITERATURE

The Malaysian government has implemented a number of policies over the past few years to encourage the liberalisation of the financial sector. These include the freeing of the base lending rate from Malaysia's central bank, the liberalisation of exchange controls, the separation of the Kuala Lumber stock exchange from stock exchange of Singapore as an independent stock market, reduction in the role of the government so that the private sectors have more control of the financial market in order to contribute to Malaysia's economic growth and establishing many financial institutions to further Malaysia's financial liberalisation (Khoon, 2007).

Furthermore, financial liberalisation brings a lot of benefits to the country such as the increase in capital inflow, free capital movement, allocation of resources to the most productive uses and the improvement in efficiency of the financial sector (Broner and Ventura, 2010). Therefore, it is clear that these advantages can increase the country's economic growth and welfare. However, these advantages might bring negative consequences to Malaysia's environmental quality.

Despite the advantages and disadvantages brought by financial liberalisation, the relationship between financial liberalisation and environmental degradation is unclear as there are limited studies that examined the relationship between these two variables. Chinn and Ito (2006; 2008) have developed a comprehensive index to measure financial liberalisation, specifically looking at the openness of cross-border financial transactions for a large number of developing and developed countries including Malaysia. Therefore, this research is motivated to identify the effects of financial liberalisation and environmental pollution in Malaysia. By having a better understanding of this relationship, this study would be able to provide important policy implications for the government and key financial institutions in Malaysia to address the environmental concerns that threaten the health and well-being of the public.

There are two types of relationship between financial liberalisation and environmental pollution namely the direct and indirect link. For the direct link, Tamazian and Rao (2010) found out that the practice of financial liberalisation will lead to environmental degradation if the institutional framework is weak. While for the indirect link between financial liberalisation and environmental pollution, Omri et al. (2015) concluded that financial liberalisation positively affects the trade openness in the country. Then, Rafindadi (2016) concluded that an increase in trade openness will negatively affect the environmental damage. Thus, financial liberalisation indirectly causes environmental degradation. Besides trade openness, Ranciere et al. (2006) explained that the increase in financial liberalisation level will increase the FDI of a country. Tamazian and Rao (2010) concluded that the increase in FDI will reduce the emission of carbon dioxide. Thus, it indirectly shows that financial liberalisation negatively affects carbon dioxide emission. Moreover, the practice of financial liberalisation in Korea and India that causes the increase in FDI also contribute to the innovative activities (Jalil and Feridun, 2011). Tamazian and Rao (2010) suggested that innovation is proven in reducing the environmental pollution. Thus, it indirectly shows that the increase in financial liberalisation level can reduce environmental pollution.

While for the indirect positive relationship between financial liberalisation and ecological footprint, Ranciere et al. (2006) concluded that financial liberalisation can directly affect financial development and strengthen it to achieve higher growth. Moreover, Al-Mulali et al. (2014) concluded that financial development positively affects environmental health in certain countries. Therefore, it proves that there is an indirect positive relationship between financial liberalisation and environmental pollution in low-income countries. Financial liberalisation not only leads to financial development but also improve the growth of the economics of a country (Ranciere et al., 2006). Their statement is supported by Kaminsky and Schmukler (2003) as they found out that the practices of financial development and financial liberalisation contribute to the growth of the economy. Additionally, Saidi and Hammami (2015) found a positive relationship between economic growth and energy consumption while Salahuddin et al. (2015) confirmed that there is a positive relationship between energy consumption and carbon dioxide emission. Therefore, it is clear that financial liberalisation indirectly leads to the increase of carbon dioxide emission.

3. METHODOLOGY

3.1. Environmental Kuznets Curve (EKC) Model

This study uses the EKC model which is first introduced by an economist named Simon Kuznets in the 1950s and 1960s. This model examines the relationship between economic development and environmental pollution. When the pollution indicators (ecological footprint) are plotted against economic development indicators (income or GDP), an inverted U-shaped curve will form (Kuznets, 1955).

In this study, the EKC model is modified by replacing GDP with financial liberalisation to identify the relationship between the financial liberalisation and ecological footprint in Malaysia. Financial liberalisation square will also be used to examine its future influences on ecological footprint in Malaysia.

3.2. Unit Root Test

The first step of the econometric analysis is to test the stationarity of the variables. According to Boutabba (2014), the result of F-statistics is invalid with the existence of I(2) variable. Therefore, unit root tests are needed to ensure the absence of I(2) variable and also to ensure the validity of the F-statistics. In this study, modified augmented Dickey-Fuller test is used.

The break dates are identified and dummy variables are created by using:

$$D_t(T_x)=1(t=T_x) \quad (1)$$

T_x represents the specified break date and the result will be 1 only on break date and 0 on the other dates. After identifying the breaks, the Innovational Outlier (IO) tests that assume the breaks occur gradually like the innovations are used.

For the IO tests, the general null hypothesis is shown as:

$$y_t=y_{t-1}+\beta+\varphi(L)(\theta D_t(T_x)+\gamma DU_t(T_x)+\epsilon_t) \quad (2)$$

The ϵ_t represents the independent and identically distributed innovations while the φ_t which is a lag polynomial that represents the stationary's dynamics and the invertible ARMA error process.

As for the alternative hypothesis, it is shown as:

$$y_t=\mu+\beta t+\varphi(L)(\theta DU_t(T_x)+\gamma DT_t(T_x)+\epsilon_t) \quad (3)$$

3.3. Autoregressive Distributed Lag Model (ARDL)

After performing the unit root test and ensure the absence of I(2) variable, ARDL cointegration method is used. The first stage of the ARDL cointegration method is bounds testing producer that is based on the F-test. Then, in order to identify the cointegration, F-statistics is compared with the critical values. Due to the fact that F-test has non-standard distribution, the two bounds of critical values for large sample size (500–100 observations) were suggested by Pesaran and Pesaran (1997) while Narayan and Narayan (2006) created the two bounds of critical values for the sample size which are as small as 30. ARDL can be utilised regardless of whether the lower bound assumes all variables are I(0) or the upper bound assumes they are all I(1) (Boutabba, 2014). According to Pesaran et al. (2001), if the result of F-statistic is larger than the upper critical value, then it means cointegration exists, *vice versa*. However, if the F-statistic falls within the two bounds of critical values, it means that the test is inconclusive.

The equation used for ARDL is shown:

$$LFP=df+\delta_0 LGDP_t+\delta_1 LFL_t+\delta_1 LUR_t+\delta_1 LEN_t+\delta_1 LTO_t+\delta_6+\delta_7 T+v_t \quad (4)$$

From the equation, *df* refers to the dummy of ecological footprint. *LFP* is the log of footprint measured in the global hectare (gha) per capita. LGDP is the log of the GDP measured in constant 2010 millions of US dollars. *LFL* is the log of the financial liberalisation; we utilized the country's degree of capital account openness introduced by Chinn and Ito (2006; 2008). The variables include binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report. LUR is the log of the urban population as an indicator of urbanisation. LEN is the total energy consumption measured in kilograms of oil equivalent while LTO is the trade openness measured in millions of 2005 constant US dollars. δ which is the Delta refers to the changes over time while t refers to the time from the year 1978 to the year 2013. Next, v_t refers to the residual matrix which is also known as white noise residuals. All of the data are obtained from the World Bank, Global Footprint Network and Chinn and Ito (2013) index series.

The data series for GDP per capita (constant 2010 US dollars) is measured by dividing the GDP with the midyear population. The GDP includes all products produced in the country and the taxes. As for financial liberalisation, the Chinn-Ito index which also known as KAOPEN is used. KAOPEN measures the openness of the capital account of a country and it is based on the dummy variables that show the restriction on financial transactions across the boundary in IMF's annual report on exchange arrangements and exchange restrictions (Chinn and Ito, 2006). For urbanisation, it refers to the total population in urban area. It is the population estimates extracted from the World Bank. For energy consumption, it is measured in kilograms of oil equivalent per capita. It includes all primary energy before transferring them to any other uses fuels. While for the trade openness, it is calculated by getting the sum of import and export of all goods and services measured in constant 2010 US dollars.

Furthermore, Equation (3) is reformed by adding in financial liberalisation square in order to check the robustness of the equation. The use of financial liberalisation square will be able to identify the future effect of the variable. Furthermore, the use of financial liberalisation square is a modification on the equation used by Shahbaz et al. (2015) who used financial development and financial development square to examine their relationship with the environmental degradation. Moreover, the existence of the EKC model in Malaysia can be tested with the addition of financial liberalisation square.

The new equation will be:

$$LFP=df+\delta_0 LGDP_t+\delta_1 LFL_t+\delta_2 LFL^2_t+\delta_3 LUR_t+\delta_4 LEN_t+\delta_5 LTO_t+\delta_6+\delta_7 T+v_t \quad (5)$$

In order to use the ARDL methodology, the error correction models (ECM) below were prepared:

$$\begin{aligned}\Delta LFP2_t = {} & \sum_{l=1}^{k} x_0 \Delta LGDP_{t-1} + \sum_{l=1}^{k} x_1 \Delta LFL_{t-1} + \sum_{l=1}^{k} LUR_{t-1} \\ & \sum_{l=1}^{k} LEN_{t-1} \sum_{l=1}^{k} LTO_{t-1} + \lambda_0 LCO2_{t-1} + \\ & \lambda_1 LGDP_{t-1} + \lambda_2 LFL_{t-1} + \lambda_3 LUR_{t-1} + \\ & \lambda_4 LEN_{t-1} + \lambda_5 LTO_{t-1} + \alpha_0 + \alpha_1 T + U_t\end{aligned} \quad (6)$$

The null hypothesis of no-cointegration $\lambda_0=\lambda_1=\lambda_2=\lambda_3=\lambda_4=\lambda_5$ is tested against the alternative hypothesis of $\lambda_0\neq\lambda_1\neq\lambda_2\neq\lambda_3\neq\lambda_4\neq\lambda_5$ in Equation (6).

3.4. Granger Causality Test

After calculating the coefficients of the variables, Granger causality test is carried out. The Granger causality test is often used because of its ability to identify and detect the causal relationship among the variables. In general, the Granger causality test is used to find out whether a variable (x) is caused by another variable (y). Moreover, it is also used to find out that whether the addition of the past values of x can explain how much of variable y. X is said to Granger cause y when the past value of

x successfully affects the present value of variable *y* (Engle and Granger, 1987).

Granger causality test is used in this research to identify the causal relationship between all of the variables, especially financial liberalisation and environmental pollution. In order to perform the Granger causality test, a panel vector ECM (VECM) is needed (Engle and Granger, 1987). F statistics are used so that the short-run causal relationship can be tested by using VECM. On the other hand, the long run causal relationship is identified by using error-correction term. Moreover, Engle and Granger (1987) introduced two steps to find out the relationship between variables for both short-run and long-run. Firstly, the long-run parameters in equation (5) are estimated in order to obtain the residuals of the deviation from equilibrium (Farhani et al., 2014). Then, the estimation of the parameters of short-run adjustment is made. The functional forms of the baseline model are shown:

$$\Delta \ln FP_{2t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln UR_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln EN_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{7}$$

$$\Delta \ln \text{[illegible]}_{t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{8}$$

$$\Delta \ln FL_{t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln UR_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln EN_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{9}$$

$$\Delta \ln UR_{t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \alpha \Delta \ln UR_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln EN_{t-i} + \sum_{i=1}^{k} \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{10}$$

$$\Delta \ln EN_{t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln UR_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln EN_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{11}$$

$$\Delta \ln TO_{t} = \alpha \text{ [illegible]} \sum_{i=1}^{k} \text{ [illegible]} \ln \text{[illegible]}_{2t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} \sum_{i=1}^{k} \alpha \ln \text{[illegible]}_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln UR_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln EN_{t-i} + \sum_{i=1}^{k} \alpha \Delta \ln \text{[illegible]}_{t-i} + \alpha \quad + \alpha \text{[illegible]}_{t-1} + \text{[illegible]}_{1} \tag{12}$$

According to Engle and Granger (1987), the F-test was used to examine the short-run Granger causality. However, the t-test for the coefficient of ECT is used to identify the long-run Granger causality. A significant ECT coefficient means that present values are affected and determined by the previous equilibrium errors (Engle and Granger, 1987).

4. RESULTS AND DISCUSSIONS

The first step is to examine the stationarity of the variables by using the unit root test. Thus, the structural break dates are identified before running the ARDL test. For instance, the structural break date of 1998 for ecological footprint occurs mainly because of the after effect of the Asian financial crisis that occurred between July 1997 and mid-January 1998. Moreover, the structural break in 2001 can be best explained by the world economic slowdown that affected Malaysia during that period. Then, the results obtained are used to create dummies. However, in order to improve the accuracy of the results, only the dummies of financial liberalisation are used. The results of the unit root test are presented in Table 1.

After confirming the structural break dates, the ARDL method is carried out to identify the coefficients of the variables and also the cointegration among the variables. Table 2 shows the short-run results of the ARDL test for both the base equation and the new equation that included the financial liberalisation square.

Table 1: Unit root test

Variable	T-statistics	Break year
FP	−7.669305***	1990, 1998, 2001,2008
GDP	−5.143691***	1990, 1991, 1997, 2009
E	−7.508976***	1990, 1991, 1997, 2000
KA	−6.452317***	1992, 1993, 2008, 2010, 2012
T	−4.782433**	1992, 2000, 2007, 2011
U	−8.189749***	1991, 1992, 2000
KA^2	−8.147607***	1992, 1993, 1995

***, ** and * signify significance at the 1%, 5% and 10% levels respectively. The critical values for the T-statistics at first difference are −4.949133, −4.443649 and −4.193627 at the 1%, 5% and 10% levels respectively

Table 2: Short-run coefficients

Independent variables	Equation 4	Equation 5
KA (financial liberalisation)	−0.0319 (0.2107)	−0.0456 (0.0642)
GDP	1.6518 (0.0004)	1.6155 (0.0000)
T (trade openness)	0.7515 (0.0052)	−0.4609 (0.0599)
U (urbanisation)	−3.1381 (0.2712)	7.5074 (0.2921)
E (energy consumption)	0.3389 (0.1793)	−0.6851 (0.0070)
KA^2 (square of financial liberalisation)	-	0.0329 (0.0399)
DF (dummy of ecological footprint)	−0.0097 (0.8133)	0.0226 (0.5747)
ECM	−1.232 (0.0017)	−1.8902 (0.0000)

The coefficients are presented while the parentheses show the probabilities. ECM: Error correction method

The result shows that the coefficients of financial liberalisation in both equations are negative and it means that the increase in financial liberalisation level will decrease the ecological footprint of Malaysia in the short-run. However, the base equation suggests that financial liberalisation does not have a significant impact on ecological footprint. After adding the financial liberalisation square, the probability value of 0.0642 shows that financial liberalisation significantly impacts ecological footprint in the short-run. Ranciere et al. (2006) and Tamazian and Rao (2010) supported this statement when they found out that the increase in financial liberalisation will increase the FDI and there is a negative relationship between FDI and ecological footprint. Malaysia is exposed to the green and environmentally-friendly technologies due to the practice of financial liberalisation that helps Malaysia to attract more foreign investors. Then, the practice of the green technologies will help to reduce the ecological footprint of Malaysia in the short-run. Hence, the Malaysian government should encourage financial liberalisation in order to adopt newer and environmentally-friendly technologies that can be used to reduce the ecological footprint of Malaysia.

For GDP, both equations suggest that GDP significantly affect ecological footprint in a positive way. This finding is supported by Mohapatra and Giri (2008) when they concluded that there is a positive relationship between GDP and ecological footprint in India due to the weak implementation of the policies. The same result is found by Ahmed and Qazi (2013) as they found out that GDP growth positively affect the emission of carbon dioxide in Mongolia. For Malaysia's case, the lack of strict regulation that focuses on the environmental health during the period of rapid GDP growth has increased the ecological footprint. Therefore, the current rules and regulations should be revised and the authority should enforce the rules in preserving the environmental health so that the ecological footprint can be reduced.

Additionally, for trade openness, the base equation shows a positive coefficient and it means that the increase in trade openness level will increase the ecological footprint of Malaysia. However, after the addition of financial liberalisation square, it suggests that the increase in trade openness level will decrease the ecological footprint of Malaysia. Both of the equations have the probability values of smaller than 0.1 and it suggests that trade openness significantly impact ecological footprint in the short-run. Fredik (2018) supported the positive relationship between trade openness and ecological foot print as they found out that the lack of awareness towards the importance of environmental health is one of the reasons that cause the increase in trade openness to increase the ecological footprint in China. While for the negative relationship between the variables, Dogan and Seker (2016) came out with the same conclusion as they concluded that trade openness decreases carbon emission in top countries that are listed in the Renewable Energy Country Attractiveness Index due to the implementation of new environmentally-friendly technologies.

For urbanisation, the negative coefficient in the base equation suggests that there is a negative relationship between urbanisation and ecological footprint of Malaysia. With the addition of financial liberalisation square, it shows that the increase in urbanisation level will increase the ecological footprint. This statement is supported by Andreas et al. (2018) as they concluded that the increase in urbanisation level and population growth will contribute to the higher ecological footprint in Austria. Li and Lin (2015) came out with the same conclusion that urbanisation increases the emission of carbon dioxide in 73 countries due to the lack of energy-saving policies. However, the probability values of higher than 0.1 in both of the equations show that there is no significant relationship between urbanisation and ecological footprint This is because urbanisation is a long-run process and its effects on the environmental damage can be hardly measured in the short-run.

Moreover, for energy consumption, the base equation suggests that energy consumption does not significantly impact ecological footprint while the new equation explains that energy consumption significantly affects ecological footprint in a negative way. This finding is supported by Charfeddine and Khediri (2016) as they suggested that increase in energy consumption decreases the emission of carbon dioxide in the United Arab Emirates due to the adoption of energy efficient technology. In Malaysia, the practice of energy efficient policies and the improvement in the use of renewable energy can help to reduce the ecological footprint in the short-run. Therefore, the knowledge and use of green and renewable energy should be encouraged among the different sectors to minimise the use of non-renewable energy that can pollute the environment.

The probability of 0.0399 of the financial liberalisation square suggests that financial liberalisation square significantly affects ecological footprint. Moreover, the positive coefficient of 0.0329 means that the increase in financial liberalisation level will lead to the increase of the ecological footprint in the future. The coefficients of financial liberalisation and financial liberalisation square that are negative and positive respectively suggest that the increase in financial liberalisation level will lead to the decrease of ecological foot print at the early stage. Then, in the middle stage, the increase in financial liberalisation will increase the ecological footprint. Thus, a U-shape graph is formed and it proves that EKC hypothesis does not apply to Malaysia in the short-run.

Additionally, the probability values of both dummies are larger than 0.1 in both equations and it suggests that structural break does not significantly impact ecological footprint in the short-run. While for the ECM, the negative and statistically significant estimate

Table 3: Long-run coefficients

Independent variables	Equation 13	Equation 14
KA (financial liberalisation)	−0.0035 (0.8708)	−0.0241 (0.0625)
GDP	0.8994 (0.0034)	0.8547 (0.0000)
T (trade openness)	0.9275 (0.0055)	0.8576 (0.0000)
U (urbanisation)	−5.9729 (0.0053)	−5.0254 (0.0000)
E (energy consumption)	0.8524 (0.0355)	0.9061 (0.0007)
KA^2 (square of financial liberalisation)	-	0.0174 (0.0391)
DF (dummy of ecological footprint)	0.0284 (0.6544)	0.0120 (0.5641)

The coefficients are presented while the parentheses show the probabilities. GDP: Gross domestic product

in both equations supports the long-run relationship between the variables in Malaysia. The coefficients of −1.232 and −1.8902 in both equations respectively suggest that the short-run deviations from the equilibrium are corrected by 123.2% and 189.02% respectively towards the long-run equilibrium path every year.

Table 3 shows the long-run results of the ARDL test for both the base equation and the new equation that included the financial liberalisation square. The negative coefficients of financial liberalisation in both of the equations show that there is a negative relationship between financial liberalisation and ecological footprint. However, the base equation shows a probability value of 0.8708 and it means that financial liberalisation does not significantly impact ecological footprint in the long-run. Omri et al. (2015) and Rafindadi (2016) supported this result as they found out that there is a positive relationship between financial liberalisation and trade openness and the increase in trade openness level will lead to the reduction in carbon dioxide emission. In Malaysia, innovation in the financial sector is encouraged by financial liberalisation. Then, the innovation of the financial sector can help to reduce ecological footprint with environmentally-friendly practices. Therefore, it shows that there is a negative relationship between financial liberalisation and ecological footprint.

While for GDP, the positive coefficients of GDP in both of the equations also suggest that GDP positively affect ecological footprint. Ahmet and Sevil (2018) came out with the same conclusion as they concluded that there is a positive relationship between GDP and air pollution level in 87 different countries. Pao and Tsai (2011) supported the statement as they found out that the increase in GDP leads to the increase of air pollution level in BRIC. This situation is the same with Malaysia as the GDP per capita of Malaysia has increased from USD 2953.30 in the year 1978 to USD 10062.91 in the year 2013 (World Bank, 2018). In addition to that, the total ecological footprint in Malaysia has increased from 2.24 to 4.21 from the period of 1978–2013 (Global Footprint Network, 2018). As such, more priority should be given to the environment during the period of economic growth in order to minimise the negative effects brought by the excessive economic growth that might affect the environmental health of the county.

Furthermore, as for trade openness, the positive coefficients in both of the equations suggest that there is a positive relationship between trade openness and ecological footprint. Moreover, the probability values of smaller than 0.1 for both equations also suggest that trade openness significantly impact ecological footprint in the long-run. This finding is supported by Rasiah et al. (2018) as they found out that the increase in trade openness level will lead to higher environmental damages due to the increase in carbon emission. In Malaysia, at the early development stage, the increase in GDP often followed by the increase in carbon dioxide emission due to the lack of awareness regarding the importance of environmental health. In view of the negative consequences of trade openness to the ecological footprint, the authority should raise the awareness of public towards the environment so that Malaysia can enjoy the benefits gained from high trade openness level without polluting the environmental health.

For urbanisation, both equations show negative coefficients and they suggest that the increase in urbanisation will contribute to the reduction of the ecological footprint. This result is supported by the findings of Charfeddine and Khediri (2016) as they suggested that there is a negative relationship between urbanisation and carbon dioxide emission. In Malaysia, the authorities work on the planning of land usage in order to control and reduce the ecological footprint. Notably, the effective planning of land usage can prepare Malaysia for urbanisation that is more environmentally-friendly (Begum et al., 2009).

Nevertheless, as for energy consumption, both equations show that there is a positive relationship between energy consumption and ecological footprint. Shahbaz et al. (2015) supported this result as they found out that in Portugal, the increase in energy consumption leads to the increase in carbon dioxide emission. The same result is found in Malaysia as Malaysia relies heavily on fossil fuels for energy generation. Moreover, the inefficiency of energy consumption in Malaysia is one of the causes for the increase in its ecological footprint. As such, the government should encourage the use of green and renewable energy sources to reduce the dependency on the non-renewable energy that will pollute the environment. Hence, more research can be conducted in order to improve the energy consumption efficiency and this will then directly reduce the ecological footprint of Malaysia.

As for financial liberalisation square, the relationship between financial liberalisation square and ecological footprint is identified with the probability of smaller than 0.1. Since the coefficient of financial liberalisation square is positive, it means that the increase in financial liberalisation level will increase the ecological footprint in the future. Next, since the coefficients of financial liberalisation and financial liberalisation square are negative and positive respectively, it forms a U-shape graph and it means that the increase in financial liberalisation level will decrease the ecological footprint in the present but increase the ecological footprint in the future. Thus, it proves that the EKC model does not apply to Malaysia.

After identifying the coefficients of the variables, the Granger causality test is carried out to identify the long-run and short-run causal relationship among the variables. The result of the t-test of ECT shows the long-run causal relationship among the variables while the result of the F-statistics explains the short-run causal relationship among the variables.

As what can be seen from the result, for Equation 7, the coefficient of ECT is −0.9963 and the probability is 0.0040. Therefore, it means that GDP, energy consumption, financial liberalisation, trade openness and urbanisation Granger cause ecological footprint in the long run. Al-Mulali and Che Sab (2012) supported this result as they found out that there is a relationship between energy consumption, carbon dioxide emission, GDP growth and financial development. Notably, Malaysia relies heavily on energy consumption for the growth of different sectors in order to achieve high GDP growth. Thus, it will then contribute to the increase in the ecological footprint.

The same result is obtained for Equation 8 with the coefficient of ECT of −0.5986 and, the probability of 0.0036. This means that all of the variables Granger cause GDP in the long term. This result is the same with Farhani et al. (2014) as they found out that there is a relationship between carbon dioxide emission, GDP, energy consumption and trade in Tunisia. Under the 1984 National Agricultural Policy, the Malaysian government focused on the agriculture sector by absorbing the technologies acquired from trade openness in order to maximise farm income and increase the contribution of agriculture sector to national income. Therefore, it shows that there is a relationship between trade openness level, financial liberalisation, energy consumption and GDP.

While for Equation 9, ecological footprint, GDP, energy consumption, trade openness and urbanisation Granger cause financial liberalisation in the long run as the ECT has a coefficient of −0.3917 and probability of 0.0482. Jalil and Feridun (2011) and Tamazian and Rao (2010) supported this result as they found out that there is a relationship between economic growth, financial liberalisation, energy consumption and environmental pollution. In order to prepare Malaysia for the global financial environment that is constantly changing, the New Economic Policy has been introduced. NEP encourages financial liberalisation and trade openness so that Malaysia can adapt to the global financial environment that is changing rapidly. Therefore, the relationship between financial liberalisation and the other variables is proven.

While for Equation 11, the coefficient of the ECT is -0.9642 and the probability is 0.0006 and it means that all of the variables Granger cause energy consumption in the long run. According to Chandran and Tang (2013), they came out with the same conclusion as they found out that there is a relationship between income, energy consumption and carbon dioxide emission in ASEAN-5 which are Singapore, Malaysia, Thailand, Indonesia and Philippines. Under the Sixth Malaysia Plan, the usage of energy is given more focus. Malaysia government focused on improving the energy efficiency such as fuel substitution to ensure the growth of GDP and minimise the negative effects of energy consumption. Therefore, it shows that there is a relationship between other variables such as GDP and trade openness with energy consumption.

Next, for Equation 10, the coefficient of ECT of −0.0010 and the probability of 0.9636 shows that ecological footprint, financial liberalisation, GDP, energy consumption and trade openness do not Granger cause urbanisation in the long run. Lastly, for Equation 12, there is no evidence of Granger causal relationship among the variables in the long run due to the coefficient of ECT of −0.1275 and the probability of 0.2455.

5. CONCLUSION

In conclusion, bidirectional causalities are present between ecological footprint and GDP, ecological footprint and energy consumption, ecological footprint and financial liberalisation, GDP and energy consumption, GDP and financial liberalisation as well as energy consumption and financial liberalisation in the long run.

While for the short-run causal relationship, it shows that there is a short-run unidirectional causality from ecological footprint to trade openness due to the fact that the increase in pollution leads to high level of trade openness. The increase in the consumption of energy land can increase the productivity of a country and this will then encourage more international trade to achieve higher economic growth. Al-Mulali and Low (2014) supported the finding as they concluded that there is a positive relationship between trade variables and carbon dioxide emission.

Additionally, there is a short run-unidirectional causality from GDP to energy consumption and it means that the increase in production will directly increase the total energy consumption. In Malaysia, this relationship is proven true when energy consumption in Malaysia increases simultaneously with the rapid GDP growth rate. This result is identical with the result Rafindadi and Ozturk (2017) as they suggested that affluence has a positive impact on energy consumption in South Africa. Azam, Khan, Zaman and Ahmad (2015) supported the statement as they suggested that economic growth positively affects on energy consumption in Indonesia, Malaysia and Thailand.

While for financial liberalisation, short-run unidirectional causalities from financial liberalisation to ecological footprint, GDP and trade openness are identified. Financial liberalisation can help to increase the GDP and it increase trade openness level by encouraging more international trade. However, the high level of financial liberalisation will increase the consumption of natural resources and lead to the increase of ecological footprint. Tamazian and Rao (2010) agreed with the result as they concluded that financial liberalisation can lead to environmental degradation if the institutional framework is weak.

Additionally, there is a short run evidence of unidirectional causality from urbanisation to energy consumption. The urbanisation process will increase the concentration of firms and human resources. Moreover, the increase in the number of firms will increase the energy demand and consumption. This result is identical with the result Bass (2018) as they prove that urbanisation positively contribute to electricity consumption in Russia.

Last but not least, there is short run evidence of unidirectional causality from trade openness to ecological footprint. The increase in trade openness will encourage the authorities to increase the consumption of natural resources to meet the demand of high trade openness, resulting in higher ecological footprint. Abid (2016), came out with the same conclusion that the increase and trade

Table 4: Granger causality test

Variables	Direction of causality						
	Short run						Long Run
	FP	GDP	KA	U	E	T	ECT
FP	-	0.188501 (0.8298)	5.316069 (0.0358)	1.295270 (0.2692)	0.474007 (0.4987)	4.338382 (0.0510)	−0.996308 (0.0040)
GDP	0.873704 (0.3658)	-	4.770698 (0.0452)	2.227390 (0.1520)	0.024508 (0.8771)	0.462256 (0.5048)	−0.598598 (0.0036)
KA	1.693464 (0.2195)	−0.521311 (0.6085)	-	0.715325 (0.4082)	0.886839 (0.3570)	1.546414 (0.2387)	−0.391663 (0.0482)
U	2.481921 (0.1195)	0.000150 (0.9904)	2.610044 (0.1270)	-	0.000597 (0.9807)	2.701417 (0.1167)	−0.000969 (0.9636)
E	0.017486 (0.8967)	4.310927 (0.0295)	0.420005 (0.7917)	3.478609 (0.0777)	-	0.417454 (0.5259)	−0.964239 (0.0006)
T	2.754122 (0.0817)	0.550452 (0.4677)	3.861850 (0.0682)	1.045306 (0.3709)	1.789954 (0.1952)	-	−0.127512 (0.2455)

F-statistics are shown while the probability values are presented in parentheses

openness will increase the emission of carbon dioxide in Sub Saharan African countries (Table 4).

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

The main objective of this study is to investigate the effects of financial liberalisation on ecological footprint. The results showed that there is a U-shape relationship between financial liberalisation and ecological footprint in both the long run and short run. This therefore means that the EKC hypothesis does not apply in Malaysia. Furthermore, it also shows that there is a negative relationship between urbanisation and ecological footprint. Trade openness has a positive effect on ecological footprint in the long-run too. On the other hand, GDP and energy consumption positively affect ecological footprint in Malaysia.

Based on the results, the implementation of financial liberalisation will decrease the ecological footprint at the beginning stage and eventually increase the ecological footprint in Malaysia, the Malaysian government should encourage financial liberalisation and at the same time focus on minimising the negative effects brought by it. Moreover, the authorities must practice effective planning of land usage in order to encourage green and intelligent urbanisation so that the ecological footprint can be reduced. Additionally, in view of the potential threat of high trade openness level in increasing the ecological footprint, more rules and regulations of international trading should be enforced by the authorities. For instance, the import and export quota should be revised and the import and export duties must be revised too. Next, the rules and regulations regarding the conservation of the environment must be enforced so that more emphases are given to the environmental health. With the growing concern regarding the environmental problem, it helps to ensure that the increase in GDP will not be at the cost of environmental health. Last but not least, Malaysia should improve its energy efficiency by implementing green technologies as well as encouraging the use of renewable energy. The heavy reliance on fossil fuel should be replaced with renewable energy as fossil fuels are the main contributor to the greenhouse gases.

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