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The Impact of Economic Growth Towards Environmental Degradation: The Evidence from Heckscher-Ohlin Theory and Environmental Kuznets Curve Hypothesis

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ABSTRACT

In this paper, researcher intend to investigate the relationship between economic growth and environmental degradation using Ordinary Least Square (OLS), the proxy used for environmental degradation is carbon dioxide emission (CO_2). In this investigation, there are 102 countries chosen ranging from 1995 until 2014. To determine whether there are significant different between countries, researcher put extra effort by considering whether there is significant difference between the factor endowment towards the environmental degradation, whereby, the effort of segregating the data into two groups will help us to identify the significance different between K and L abundant. The empirical result revealed that there is no significant difference between factor endowment towards the environment degradation.

INTRODUCTION

Environment condition such as climate change which caused global warming have called for more attention and discussion of global environmental issues because of its intense threat to the world (Saboori, Sulaiman, & Mohd, 2012). Similar study by Acaravci and Ozturk (2010) stated that it has also been the subject of intense research in investigating the relationship between economic growth and environmental pollution. Therefore, environment degradation is an on-going

condition that needs attention. Henceforth, this research will investigate the impacts of economic growth towards the environmental degradation; the proxy being carbon dioxide emission as it is the main contributor to air pollution according to Intergovernmental Panel on Climate Change (2010), and the proxy for economic growth is GDP Per capita as other previous studies (Boopen & Vinesh, 2011; Acaravci & Ozturk, 2010) also used the GDP Per Capita as one of the main variable that affect the environment degradation. As what have been highlighted by the Environmental Kuznets Curve, there will be turning point between GDP per capita towards environmental degradation. Therefore, the researchers concern on whether the turning point exist with different factor endowment such as K-abundant, L-abundant and overall?

In addition, inconsistent relationship between economic growth and carbon dioxide emission based on previous studies that revealed that there are a positive (Mikayilov, Galeotti & Hasanov (2018), negative (Magazinno, 2016; Kasperowicz, 2015) and bidirectional and unidirectional causality (Nasir & Rehman, 2011; Pao & Tsai, 2011) relationship between these two variables and the issues on environmental degradation itself have arose question among researcher, therefore, in this research, the researcher would like to test whether the turning point of EKC are consistent based from different factor endowment? The main objective of this study is to determine the relationship between economic growth towards environmental degradation in K-abundant, L-abundant and overall.

LITERATURE REVIEW

According to Cederborg and Snöbohm (2016), since determining the relationship between economic growth and environment is a new topic in economics, therefore, there are not many theories existed yet on this area of research. However, the most popular theory is the EKC theory which shows an inverted U-shaped curve. Environmental pollution and economic growth are two variables that cannot be separated currently because as a nation wants to improve their economic growth, they would eventually pollute the environment.

It was highlighted that the objective of this study is to determine whether different factor abundance of a nation will support or not support the Environmental Kuzents Curve hypothesis. The theory of Heckscher-Ohlin is used in this study to determine which country is under a capital abundant nation and which is under a labour abundant nation. Past researches (Acaravci & Ozturk, 2010; Aye & Edoja, 2017, Narayan, Saboori & Soleymani, 2015) were conducted to shows the relationship between environmental pollution end economic growth, the environmental pollutant that is mainly studied on is carbon dioxide emission.

The carbon dioxide can either be emitted from factories or vehicles. A study by Roca, Padilla, Farré and Galetto (2001) have done a research between economic growth and atmospheric pollution in Spain for a period from 1973 until 1996 and found a contradicting finding whereby the relationship between carbon dioxide emission per capita and GDP per capita does not support the hypothesis of Environmental Kuznets Curve. It means that the emission of carbon dioxide continues to rise as they increase their economic growth. In addition, there is another study that does not support the hypothesis of Environmental Kuznets Curve, Boopen and Vinesh (2011) found out that the relationship between carbon dioxide and economic growth also does not support the environmental kuznet curve. Their study used rigorous econometrics analysis, the result shows that the carbon dioxide emission is closely related to the GDP time path. However, there was no inverted U-shaped obtained, thus, it means it does not follow the environmental kuznet curve.

A study by Saboori, Sulaiman and Mohd (2012) aimed to determine the long-run and causal relationship between economic growth and carbon dioxide emission in Malaysia for the year from 1980 until 2009. The result for this study was, they found out that there is a long run relationship between these two variables only when the carbon dioxide emission is the dependent variable. They also found out the existence of an inverted U-shaped relationship between carbon dioxide emission and economic growth, thus it supports the theory of environmental kuznet curve. On the contrary, Cederborg and Snöbohm (2016) research on the other hand disagree with the environmental kuznet curve of having a turning point which other studies claimed. They found out that the relationship between carbon dioxide and economic growth is positively correlated when they examine these two variables. However, it does not support the environmental kuznet curve hypothesis.

Previous empirical evidence from the study of Kasperowicz (2015) revealed that there are long-run negative relationship between GDP and environmental degradation. The primary reason for the inverse relationship is due to the low-carbon technologies. However, in short run, the relationship between GDP and carbon dioxide emission is positive because when the mass production is at a faster rate more energy is use hence, it can contribute to higher carbon dioxide emission. This paper was done in 18 EU Member countries and the chosen year was from 1995 until 2012.

A study by Narayan, Saboori and Soleymani (2015) whereby they were investigating the dynamic relationship between economic growth and carbon dioxide emission by doing a cross correlation test. They stated it is positive when current income is cross-correlated with past emission and negative when past income is cross-correlated with current emission. Thus, if this happen, it does follow the environmental kuznet curve hypothesis. Yet another similar previous research stated that different results were identified when they divide the nations to high and low growth regime. The relationship between economic growth and carbon dioxide emission is negative in low growth regime and positive in the high growth regime, this was a study by Aye and Edoja (2017).

DATA AND METHODOLOGY

The time period used in this panel data is 20 years ranging from 1995 to 2014. There are 102 countries involve under this investigation that will be segregated into L-abundant and K-abundant, the limitation for this study is, the countries are chosen based from the year of 2014 only since adding more years decreases the number of countries than usual. Since there is no predetermine set of rules on which are best to select the endowment factor, researcher select the physical unit approach whereby it can be estimated as follow:

$$\frac{TK}{TL} \tag{1}$$

Where TK and TL are total gross fixed capital formation (annual % growth) and labour force participation rate, total (% of total population ages 15 – 64) respectively. The three figures (Figures 1, 2 and 3) showed the environmental degradation by countries which were segregated by K-abundant, L-abundant and overall respectively.

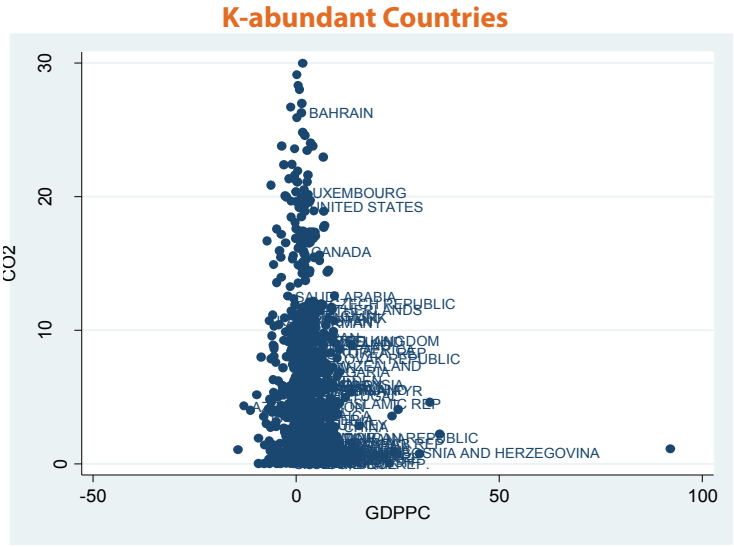

Figure 1 Environmental degradation in K-abundant nations

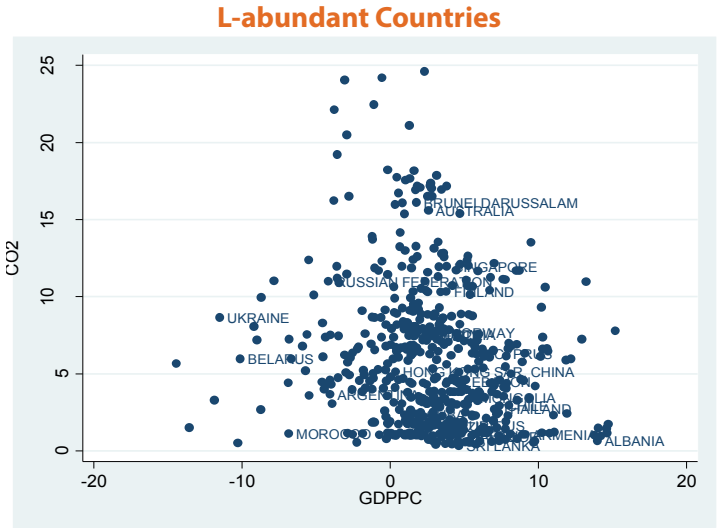

Figure 2 Environmental degradation by L-abundant nations

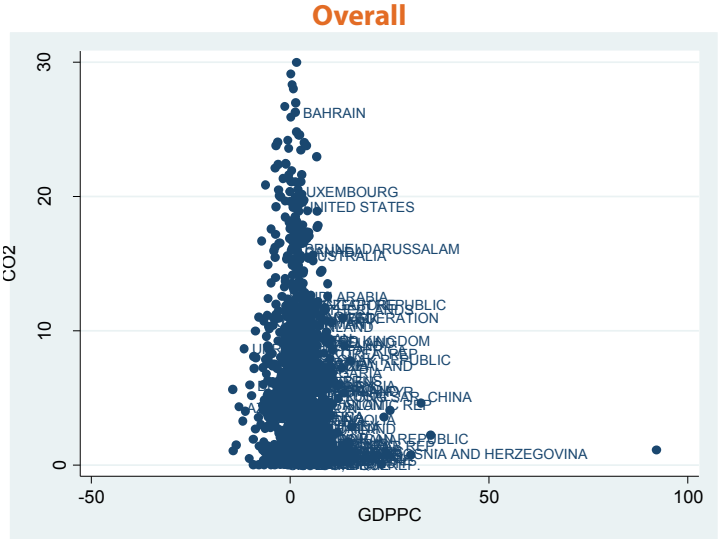

Figure 3 Environmental degradation for overall

According to Saboori, Sulaiman and Mohd (2012), EKC hypothesis can be specified in its general format as follows:

$$E = f(Y, Y^2, Z) \tag{2}$$

Based on the above equation, *E* represents and environmental indicator, *Y* is income and *Z* is other variables that can explain and affect environmental degradation. The dependent variable for this research is carbon dioxide emission, the independent variables consist of economic growth that is Gross Domestic Product, energy consumption, trade openness, and population. In this study, researcher identify the linear equation model to estimate the impact of carbon dioxide emission as follow:

$$E_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + Zn_{it} + \varepsilon \tag{3}$$

Where E_{it} represent carbon dioxide emission, Y_{it} is the Gross Domestic Product Per Capita, Y_{it}^2 is Gross Domestic Product Per Capita Squared, Zn_{it} is a vector that represent other factors such as energy consumption (Z_{1it}), trade openness as Z_{2it} and population as Z_{3it}, and finally ε is an error term. Since these variables each have a different measurement, therefore they need to be transformed into a natural logarithm.

RESULT AND FINDINGS

Table 1 revealed the result from unit root test of LLC, IPS and Breitung test. The result from the tests indicates that all the dependent variable is stationary at first order difference except for Gross Domestic Product Per capita and Population, whereby Gross Domestic Product Per capita is stationary at level and Population is stationary at second order difference.

Table 1 Summary of data for Lee, Levin and Chu (LLC), Breitung test and Im and Pesaran (IPS) test in 75 K-abundant, 27 L-abundant countries and overall (102 countries)

Countries		**K-Abundant countries**			**L-abundant countries**		**All Countries**	
Dependent Variable	**Panels**	**Test**	**T-statistic**	**P-value**	**T-statistic**	**P-value**	**T-statistic**	**P-value**
Carbon Dioxide Emission	Original Series	LLC Breitung IPS	0.401 3.340 4.386	0.656 0.100 1.000	−0.520 2.696 2.778	0.079 1.000 0.988	0.099 4.272 5.190	0.540 1.000 1.000
	1st Order Difference	LLC Breitung IPS	−14.973 −16.127 −18.354	0.000*** 0.000*** 0.000***	−7.659 −9.073 −10.554	0.000*** 0.000*** 0.000***	−16.768 −18.467 −21.169	0.000*** 0.000*** 0.000***
Independent Variables								
Gross Domestic Product Per capita	Original Series	LLC Breitung IPS	−12.685 −14.133 −14.121	0.000*** 0.000*** 0.000***	−3.629 −7.657 −7.772	0.000*** 0.000*** 0.000***	−12.825 −16.068 −16.107	0.000*** 0.000*** 0.000***
Gross Domestic Product Per capita	Original Series	LLC Breitung IPS	−12.685 −14.133 −14.121	0.000*** 0.000*** 0.000***	−3.629 −7.657 −7.772	0.000*** 0.000*** 0.000***	−12.825 −16.068 −16.107	0.000*** 0.000*** 0.000***
Energy Consumption	Original Series	LLC Breitung IPS	5.582 4.993 5.582	0.843 1.000 1.000	-0.066 2.937 1.316	0.474 0.998 0.906	0.859 5.782 5.463	0.805 1.000 1.000
	1st Order Difference	LLC Breitung IPS	−13.048 −16.274 −18.377	0.000*** 0.000*** 0.000***	−7.187 −7.986 −10.957	0.000*** 0.000*** 0.000***	−14.896 −17.901 −21.395	0.000*** 0.000*** 0.000***

Trade Openness	Original Series	LLC Breitung IPS	−4.384 0.452 −0.048	0.000*** 0.674 0.481	−5.393 −0.812 −1.400	0.000*** 0.209 0.081	−6.615 −0.028 −0.761	0.000*** 0.489 0.223
	1st Order Difference	LLC Breitung IPS	−15.960 −16.983 −17.842	0.000*** 0.000*** 0.000***	−10.957 −10.951 −10.903	0.000*** 0.000*** 0.000***	−19.315 −20.178 −20.909	0.000*** 0.000*** 0.000***
Population	Original Series	LLC Breitung IPS	1.848 27.852 6.966	0.968 1.000 1.000	8.039 15.405 1.058	1.000 1.000 0.855	5.555 31.829 6.518	1.000 1.000 1.000
	1st Order Difference	LLC Breitung IPS	−15.708 9.001 2.745	0.000*** 0.997 1.000	−7.681 5.670 1.139	0.000*** 0.873 1.000	−17.623 10.636 2.940	0.000*** 1.000 0.998
	2nd Order Difference	LLC Breitung IPS	−22.976 −3.484 −6.255	0.000*** 0.000*** 0.000***	−11.427 −0.589 −4.375	0.000*** 0.000*** 0.278	−25.523 −3.237 −7.615	0.000*** 0.001*** 0.000***

Notes: ***, ** and * denote significance level at 1%, 5% and 10% respectively.

After the tests to check the stationarity of each variable, the estimated equation for K-abundant, L-abundant and overall country is as follow:

$$dLnCO_2 = LnGDPPC + dLnENERGY + dLnTRADE + d2LnPOP + \varepsilon \quad (4)$$

Regression Analysis

H_0: There is no significant relationship between economic growth, energy consumption, trade openness and population towards carbon dioxide emission.

H_1: There is a significant relationship between economic growth, energy consumption, trade openness and population towards carbon dioxide emission.

Table 2 Regression analysis result and diagnostic checks for pooled OLS

Variables	**Pooled OLS**									
	K-Abundant Countries			**L-Abundant Countries**			**All country**			
	Coefficient		**P-value**	**Coefficient**		**P-value**	**Coefficient**		**P-value**	
Gross Domestic Product Per Capita	**0.005**	**0.002**	**0.029****	**0.003**	**0.004**	**0.394**	**0.005**	**0.002**	**0.023****	
Gross Domestic Product Per Capita Squared	Omitted due to multicollinearity									
Energy Consumption	0.923	0.042	0.000***	0.801	0.062	0.000***	0.885	0.035	0.000***	
Trade Openness	0.062	0.024	0.009***	−0.023	0.046	0.611	0.044	0.021	0.037**	
Population	1.377	1.100	0.211	−0.833	0.987	0.399	0.104	0.732	0.887	
CONS	−0.003	0.003	0.329	0.001	0.006	0.885	−0.002	0.003	0.453	
R^2	0.282			0.264			0.274			0.274
PROB (F-STATISTICS)	0.000			0.000			0.000			0.000
BREUSH PAGAN LM	1.000			1.000			1.000			1.000
WOOLDRIDGE	0.408			0.638			0.416			0.416
MODIFIED WALD	0.000			0.000			0.000			0.000
VIF	1.010			1.010			1.010			1.010

Notes: ***, ** and * denote significance level at 1%, 5% and 10% respectively.

The result in Table 2 shows the regression analysis for both K-abundant and L-abundant countries as well as overall. Firstly, in order to determine whether the regression model can be directly regress through pooled OLS or Hausman test needed, Breush Pagan Lagrarian Multiplier is used to determine which tests, either pooled OLS or Hausman test, are suitable to run the regression model (Breush & Pagan, 1979). Based on Table 1 the BPLM test is 1.000 in both K and L abundant countries, and also as for both groups of country combined, if the p-value is less than 0.05, null hypothesis is rejected, hence, the regression model need to go through the Hausman test to determine whether the regression analysis is under a fixed or random effect, and if the p-value is more than 0.05, the regression model can be pooled with pooled OLS, the observed result showed that the regression can be pooled with pooled OLS. The result for the K-abundant countries shows that Gross Domestic Product Per capita, Energy consumption, Trade Openness and Population have a positive relationship with environmental degradation. Nonetheless, only Population has an insignificant relationship with environmental degradation. The regression result for K-abundant countries is almost similar with a study by Saidi and Hammami (2015), the difference is their study does not include the variable Trade Openness. On the other hand, the result is completely different for L-abundant countries, whereby, only Gross Domestic Product Per capita and Energy Consumption have a positive relationship while Trade Openness and Population have a negative relationship with environmental degradation, not only that, the result in L-abundant showed only Energy consumption has a significant relationship with environmental degradation, this outcome is similar to the study by Ahmad et al. (2016), they found out that both trade and population have a negative relationship with CO_2 emission. The result for overall (all country) showed that all the variable has a positive relationship with environmental degradation, but Population has an insignificant impact, while the other three remaining variables (Gross Domestic Product Per capita, Energy consumption and Trade Openness) are significant. The result for the combined groups of country is the same with a research by Aye and Edoja (2017) except that their result showed that population exert a significant impact towards CO_2 emission. The R^2 can help explain the effects of the independent variables towards the dependent variable, in the K-abundant nations the R^2 is 28.2% while in the L-abundant nations, it is 26.4%. The R^2 for all country is 27.4%. In addition, all three-regression showed that the estimation is fit because the probability F-statistic is less than 0.05. The diagnostic check was done to determine whether the regression contents heteroscedasticity, autocorrelation and multicollinearity. Table 2 shows that both groups of country and overall countries only suffers the problem of heteroscedasticity, hence, to treat this problem, the regression model will be run under a robust data analysis. The result is shown in Table 3:

Table 3 Regression analysis result and diagnostic checks for robust

Variables	Pooled OLS (Robust)								
	K-abundant			L-abundant			All country		
	Coefficient		P-value	Coefficient		P-value	Coefficient		P-value
Gross Domestic Product Per Capita	0.005	0.002	0.019**	0.003	0.003	0.348	0.005	0.002	0.015**
Gross Domestic Product Per Capita Squared	Omitted due to multicollinearity								
Energy Consumption	0.923	0.060	0.000***	0.801	0.130	0.000***	0.885	0.059	0.000***
Trade Openness	0.062	0.034	0.067*	−0.023	0.051	0.643	0.044	0.029	0.131
Population	1.376	0.834	0.099*	−0.833	2.652	0.754	0.104	1.612	0.948
CONS	−0.002	0.003	0.312	0.001	0.005	0.860	−0.002	0.003	0.424
R^2	0.2820			0.2640			0.2739		
PROB (F-STATISTICS)	0.000			0.000			0.000		

Notes: ***, ** and * denote significance level at 1%, 5% and 10% respectively.

Table 3 shows that in K-abundant countries, all the variable has a positive significant impact towards CO_2 emission, in L-abundant nations, the result showed that Gross Domestic Product Per capita and Energy consumption have a positive relationship while Trade openness and Population do not, and only Energy consumption is significant. The result for both groups of country combined postulates that all the variables has a positive relationship with CO_2 emission, but only Gross Domestic Product Per capita and Energy consumption is significant. All three estimations are fit because the probability F-statistic is less than 0.05.

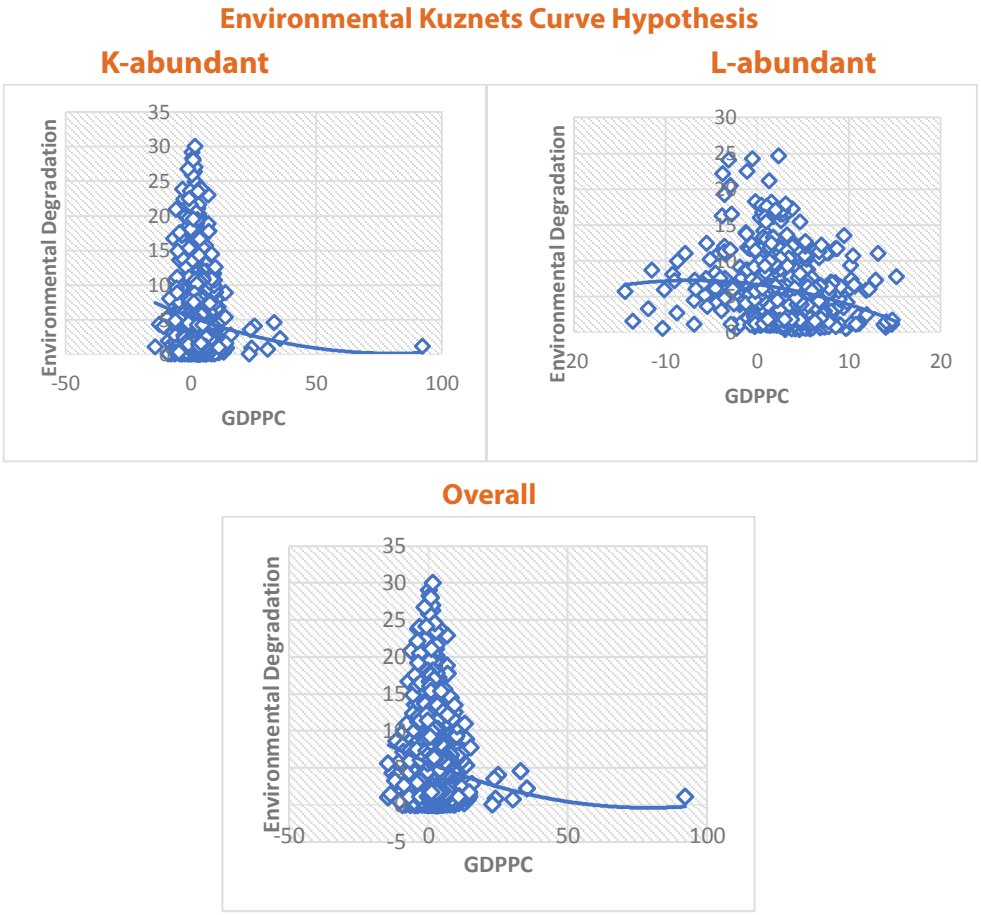

Figure 4 The scatter plot and polynomial trend lines for K-abundant, L-abundant and overall

Figure 4 postulated the result on Environmental Kuznets Curve (EKC) in the K-abundant countries, it showed that in the K-abundant countries, there is no turning point of the EKC therefore it means that in K-abundant nations, the EKC curve is not supported. This might be due to the amount of technologies and machinery used in K-abundant countries and that they practiced an environment friendly production. Based on a study by Jordaan et al. (2017), a clean energy innovation can enable a reduce in CO_2 emission, this shows that advancement in technologies might cope with the problem of CO_2 emission.

On the other hand, in the L-abundant nations, the graph showed an inverted U-shaped although only slightly, but it does show a turning point, hence, in the L-abundant nations supported the existence of Environmental Kuznets Curve. The different result postulated in L-abundant nations might be due to the number of worker as these countries mainly utilize the resources of labor, according to Olsen (2008), based on the International Labor Standards, employment and labour market can help to curb climate change by using the guidelines in the International Labor Standards to not only achieve sustainable development but a better economic and environment as well.

The graph postulated the result of EKC as an overall by combining both group of countries, as shown above there is no inverted U-shaped nor a turning point that shows the existence of EKC, thus, both group of countries combined does not supported the Environmental Kuznets Curve. By combining both group of country, the EKC is not achieve, the reason behind this is because when a country has both resources which is capital and labour, they could have implemented a clean and efficient production. A study by Zhao et al. (2016) stated that there is a bi-directional impact between capital input and labour force towards economic growth that will definitely affect the atmospheric pollution.

CONCLUSION AND RECOMMENDATION

With steadfast industrialization, changes in lifecycle, rise in population as well as environmental degradation has increased over the past few decades (Apergis & Ozturk, 2015). They also mention that, Environmental Kuznets Curve (EKC) hypothesis suggested that with this fast development, it is expected that the level of carbon dioxide emission will increase further and contribute to global warming.

The goal of this paper is to investigate the impact between economic growth towards environmental degradation (CO_2 emission) in two different group of country which is the K-abundant nations, L abundant nations and as overall spanning the period 1995 until 2014. As mentioned early on this paper, this paper aims to re-examine the turning point of Environmental Kuznets Curve and to determine whether there is significant difference between the factor endowment towards the environment degradation.

The empirical result postulated that in K-abundant countries, all the variables (Gross Domestic Product Per capita, Energy consumption, Trade Openness and Population) have a positive impact towards CO_2 emission and all the variables are significant except for Population. On the other hand, the result for L-abundant countries is different whereby Gross Domestic Product Per capita and Energy consumption have a positive relationship while Trade Openness and Population have a negative relationship, not only that, only Energy consumption is significant. A combination of both K and L abundant countries as a whole also produce the same outcome as the K-abundant countries.

Since the regression suffers heteroscedasticity, robust estimation was done to treat the problem. The empirical result after robust is in K-abundant countries, all the variable has a positive significant impact towards CO_2 emission, meanwhile, in

L-abundant nations, the result showed that Gross Domestic Product Per capita and Energy consumption have a positive relationship while Trade Openness and Population have a negative relationship, but only Energy consumption is significant. The result for both groups of country combined postulates that all the variables has a positive relationship with CO_2 emission, but only Gross Domestic Product Per capita and Energy consumption is significant.

The existence of EKC curve only existed in L-abundant nations, hence, in this study, only L-abundant nations supported the existence of EKC. As a conclusion, differences in the factor endowment of each country gives a different result on the Environmental Kuznets Curve and impacted towards the environmental degradation in the same way because the empirical result showed a positive impact of economic growth on environmental degradation.

It is recommended for future researcher to always adopt a timeline (more than a year) to determine the Environmental Kuznets Curve Hypothesis to produce the curve. A different method of achieving the EKC hypothesis may vary from different studies, future researchers may choose the ones that can show the existence of EKC. As a policy implication, first, every country should have taken measures to reduce environmental degradation without sacrificing the economic growth. Second, support in investing for the applications of environmental technologies. Lastly, at various level, concerned government agencies should share with other country on their successful regulatory experiences.

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