Economics and Environmental Development: Testing the Environmental Kuznets Curve Hypothesis

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ABSTRACT

The Environmental Kuznets Curve (EKC) shows the relationship between economic development, which is proxied in per capita income, and environmental quality. This study aims to view the existence of the EKC by arranging the distribution of 62 countries into four sub-samples based on per capita income from 1992 to 2017. By applying panel data, the model uses the Error Correction Mechanism (ECM) method to see the effect of economic growth on environmental quality (CO_2 emission) in both the short and the long term. The results show that the EKCs on our four sub-samples used are not conclusive, and are more likely to refer to the "N" pattern. This result confirms that the impetus of development at a higher level will lead to a degradation of environmental quality. Therefore, policy intervention becomes an important thing.

Keywords: Macroeconomics, Government Policy, Sustainable Economic Growth, Environmental Economics, Panel Data
JEL Classifications: R11, Q58, Q56

1. INTRODUCTION

The relationship between economic development and the environment is still controversial today. Widespread pollution problems are often seen as an inability to cope with global warming, and evidence of human greed by making the environment a big rubbish site for various waste products of consumption or production. On the other hand, however, some countries have seen remarkable progress in the provision of sanitation, especially in rural areas, improvements in air quality in some major cities, and the continued improvement of human life with increasingly sophisticated technology (Brock and Taylor, 2004). The relationship between economic development and the environment began to gain considerable attention with the large number of empirical studies of the relationship between per capita income and pollution, which became known as the Environmental Kuznets Curve (EKC).

The EKC states that if economic development initially causes damage to environment, but only at a certain level of economic growth, people will be more aware of the benefits of environmental function improvement, so that environmental damage levels will decrease. In other words, the higher per capita income level, the more the environment will improve (Stern, 2004). When viewed simply, it can be said that economic growth is good for the environment. However, many people say that there is no guarantee for these countries to improve the environment when their income becomes higher. We can see this from the contribution of the countries group based on per capita income to the world environment degradation.

Viewed in Figure 1, the concentration of CO_2 emissions per capita in the world has increased from year to year. A decline occurred in some periods, but then increased again. Unlike the predictions, high-income countries have even become the largest contributors to CO_2 emissions in the world. The shape of the world CO_2 emission curve is consistent with the trend of CO_2 emissions in high-income countries. Countries that fall within the lower-income group of countries contribute less CO_2 emissions. Even in low-income countries, CO_2 emissions tend to be stable over the

period. This indicates that the more prosperous a country is does not guarantee an increase in environmental quality.

This study attempts to test the EKC with panel data from 62 countries comprising low-income, low-middle, high-middle, and high-income countries according to the World Bank classification. By taking the time period from 1992 to 2017, the relationship between these two is relatively inconsistent with the EKC hypothesis. If we refer to the EKC, the higher the per capita income of a country, the more revenue that is allocated for environmental improvement, so the EKC should be in the form of an inverted "U". The division of countries sample group is intended to determine whether the phenomenon occurs. However, some empirical studies show that the EKC form resembles the letter "N", rather than the inverted "U" as predicted (one of which is the empirical test of Allard et al., 2018). As seen in Figure 2, the EKC shape cannot be said to be similar for all four country groups. Low income countries have a tendency to take the "N" shape. In contrast to high-income countries that show an inverted

"U" trend, the middle-income countries category instead indicates a positive-trend, linear indication. If we take a look at the pattern of the EKC in each group of countries, it can be said that the EKC itself is not conclusive.

This study aims to look at the existence of the EKC by dividing countries on the basis of per capita income. By applying panel data, the model uses the Error Correction Mechanism (ECM) method to see the economic growth effect on CO_2 emissions in the short and long term. Studies on the EKC are already widely practised, but the results are not conclusive. When using panel data, endogeneity bias is an important thing to overcome. Bias can arise from unobserved variables or from simultaneity. Attempts to overcome both have been made. The results show that the EKC indeed does not necessarily occur. In other words, it is not guaranteed if an increase in economic growth brings environmental improvement, especially in a country based on manufacturing industries.

2. LITERATURE REVIEW

The Kuznets Curve in economy initially illustrates the hypothesis which states that along with an economic development, market power will initially increase the imbalance within an economy, but in the future this imbalance will continue to decline. This hypothesis was put forward by Simon Kuznets in the 1950s. The explanation of this hypothesis is more or less as follows. Before a country begins to grow, its average income is very low because almost everyone works on traditional farms or other sectors with low productivity. Because almost everyone is at a lower productivity, there is almost no room for income imbalances.

As economic growth begins to emerge and the expansion of modern life begins to show, high-productivity sectors will have higher incomes than those working in traditional sector. At this time there will be a transfer transition from the labour of the sector

Figure 1: Pollutant (CO_2 Emission) by Countries Group. This figure was created by the authors and was based on the database from the World Bank Data (2020)
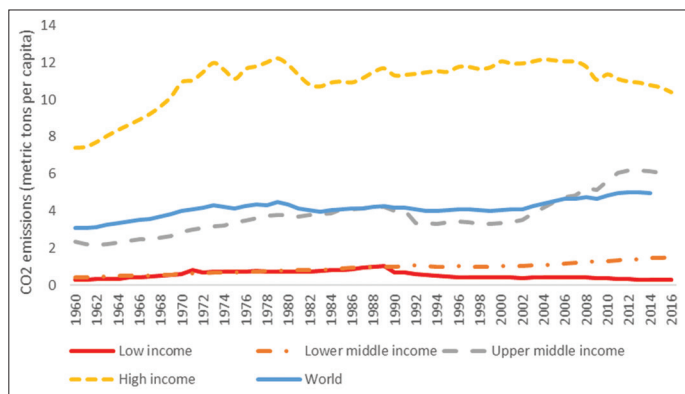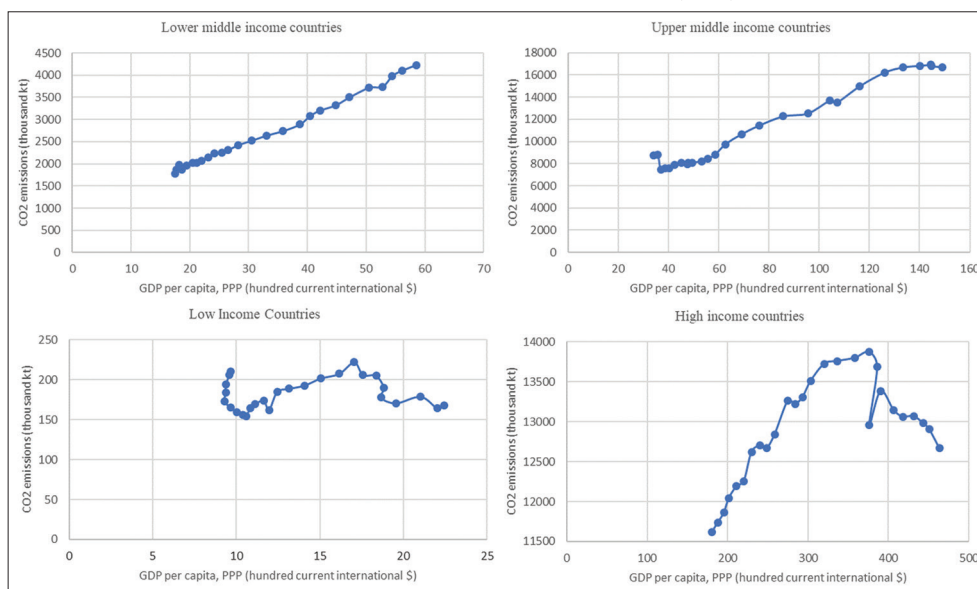

Figure 2: Pollutant (CO_2 Emission) Relationship and Per capita Income by Countries Group. This figure was created by the authors and was based on the database from the World Bank Data (2020)

with low productivity to high-productivity sectors. Revenue will increase, but not equally, until at one point the country reaches middle income status with a very high level of income inequality. As the economy grows, the share of labour employed in low-productivity sectors will decrease so that income inequality will also decrease, even though the average income will increase. A country will even reach a point where the entire workforce has been absorbed in the modern sector with high productivity, the point where average income is high, but income inequality has dropped back to a relatively low level. If depicted in graphical form, the Kuznets Curve will be in the form of an inverted "U".

Later, the popular Kuznets Curve has been used to explain the relationship between multiple environmental quality indicators and per capita income over time. This is preceded by a study by Grossman and Krueger (1991) that examines the effect of trade liberalisation (NAFTA) on air quality, using economic growth as a proxy in Mexico. Their study result shows that level of pollutant concentrations increases with as per capita income at lower level but begin decrease as GDP growth keeps going higher. There are three mechanisms of how trade liberalisation and inclusion of foreign direct investment affect the quality of the environment. Firstly, the existence of the scale effect. If trade and investment liberalisation encourage economic activity expansion, and if the natural pattern of such activity remains unchanged, then the resulting pollution will inevitably increase. At that time, increased economic growth leads to increased demand for energy. Until the end, increasing output of harmful pollutants follows the increase in economic output. Similarly, with increasing trade, the demand for cross-regional transport will be higher, increasing air pollution if there is no change in transportation practices.

Secondly, there is the composition effect. This effect is the result of changes in trade policy. When trade is liberated, each country will specialise in sectors in which they have a competitive advantage in it. If the competitive advantage they receive is largely derived from differences in environmental arrangements, then the composition effect due to trade liberalisation will further damage the environment. On the other hand, if its comparative advantage is more traditional, given the difference in resource ownership and technology, the resulting composition effect will be ambiguous. The net effect of this activity will depend on whether the intensified pollutant-intensive activity decreases in the country having a more stringent pollution control policy.

Thirdly, there is a technical effect whereby output should be produced using techniques that are not exactly the same in case of trade and investment liberalisation. In fact, pollutants generated from per unit of output are believed to be decreasing, especially in less developed countries. This is due to the transfer of new technology that is more modern than the country owner of the investment. Modern technology is relatively more "clean" than old technology, because of awareness development of environmental conservation. In addition, if free trade encourages increased revenue, political institutions will demand cleaner environmental management as part of their concern for the welfare of the people. Thus, environmental regulations and law enforcement will tend to be more stringent, and can be a natural political response to economic growth.

The phenomenon is that the environment quality in high income countries are relatively better than in developing one. As a person's welfare increase, the priority of their basic needs changes. When their primary needs for food, clothing, and housing have been met properly then environment moves up to become one of human important need (Beckerman, 1992). In this case there is a strong positive relationship between income levels and environmental quality because in the long run each country will strive to restore its environmental quality according to a healthy and acceptable standard of living. However, experience of each country may be different due to: first, changes in technology, in relative prices, in the patterns of output, and in policies impact on the emergence of new sources of pollution. Second, the global character of many pollutants is becoming more serious although the types of pollutants are the same. Third, international trade in polluting activities from countries where strict controls are imposed to countries (developed countries) in which environmental considerations do not have a very high priority (generally are developing countries). Fourth, the rampant urbanization which encourages widespread vehicle demand distribution and traffic increase pollution caused by automotive use. The effect of urbanization to environmental deterioration not only come from automotive use but also conversion to urban land use without considering their limit and capacity (Li Yu et al, 2020).

If the EKC hypothesis were true, then economic growth would be the means to eventual environmental improvement (Stern, 2004). Some empirical researches have confirmed the EKC existence (for example, Apergis and Ozturk, 2015; Tiwari et al, 2013). Usama Al-mulali et al (2015) tested the existence of EKC by dividing countries based on income groups. The result shows if the EKC is confirmed in upper-middle- and high-income countries. The inverted "U" pattern, which shows relationship between ecological footprint (as an indicator of environmental degradation) and per capita income, only occurs during a development stage in availability of technology that increase energy efficiency, energy saving, and renewable energy. This kind technology is not accessible to lower income country due to its cost.

The perception of growth importance as a driving force for development has changed since the 1992 Rio Conference in favour of the idea that, if it is to be sustainable, development must balance the social, economic and environmental pillars (Hallegatte et al., 2012). The relationship between economic and social pillars in sustainable development is generally positive. Economic and social improvements tend to go hand in hand and develop even faster with the presence of policies to reduce inequality. But not so with the environment. Environmental performance in general does not deteriorate first to then improve along with the increase in income, as stated in the Kuznets Curve. Some environmental indicators, often exemplified by the quality of water and air, are indeed improving as income increases. But not for long-term pollutants, such as pesticide accumulation and global pollutants (greenhouse gases) that can get worse with increasing income. Therefore, changes in environmental indicators (on the vertical line) due to an increase in per capita income differ (thus do not form an inverted "U" as hypothesised), depending on the type of pollutant (environmental indicator) used. This has become one of

the criticisms of the EKC literature (Costantini and Martini, 2006). The use of EKC was later expanded to see its impact on economic sustainability in a broader sense which known as Modified EKC.

3. METHODOLOGY

This study uses data from 62 countries in the world from 1992 to 2016. This period was chosen because of the latest data obtained for CO_2 emission until 2016. The sample is then categorized into four groups based on the amount of income in accordance with the division of the World Bank. There are several reasons why the sample should be divided on revenue (Allard et al., 2018), of which middle-income countries are home to 73% of the poor. In addition, middle-income countries are the main drivers of world growth. The countries used in this study are divided into four income categories. First, low income consists of 21 countries that are: Burundi, Burkina Faso, Central African Republic, Congo, Dem. Rep. Ethiopia, Gambia, Guinea, Haiti, Madagascar, Mali, Mozambique, Malawi, Niger, Rwanda, Sudan, Sierra Leone, Chad, Togo, Tajikistan, Uganda, and Yemen, Rep. Second, lower-middle income group consist of 9 countries that are: Bolivia, El Salvador, Cameroon, Sri Lanka, Morocco, Philippines, Senegal, Tunisia, and Vietnam. Third, upper-middle countries consist of 5 countries that are: Gabon, Malaysia, Peru, Turkey, and Indonesia. Fourth, high income group consist of 27 countries that are: Australia, Austria, Bahamas, Denmark, Finland, Germany, Korea, Rep., Macao SAR, China, Netherlands, New Zealand, Singapore, Spain, Sweden, Malta, England, United States, Bahrain, Barbados, Greece, Ireland, Switzerland, Brunei Darussalam, Canada, Cyprus, Japan, United Arab Emirates, and Greenland.

The result of the literature review indicates the possibility of a two-way causal relationship between per capita income and the environment. Granger Causality analysis was applied to determine the direction of their relationship. This is to confirm whether the two variables can have a two-way or a one-way effect.

The analysis in this research uses dynamic regression Error Correction Mechanism (ECM). This model is applied with the intention of lifting the dynamic movement of the short-term balance pattern of income per capita. Some advantages in using this model include: (1) The ECM combines short-term and long-term effects that can provide information about the speed of adjustment of the dependent variable in response to the shock in the independent variable; (2) all variables are stationary, so the standard regression result is valid; (3) ECM is closely related to the concept of co-integration (Harris, 1995). Considering variables dynamism in a along research period and data characteristics of each variable, ECM seen as an appropriate method. Models used as follows:

$$\Delta CO2_{i,t} = \delta_1 \Delta GDP_{i,t} + \delta_2 \Delta GDP_{i,t}^2 + \delta_3 \Delta pop_{i,t} + \delta_4 \Delta trade_{i,t}$$
$$+ (1 - \alpha_1) \begin{bmatrix} y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 GDP_{i,t-1} - \hat{\beta}_2 GDP_{i,t-1}^2 \\ -\hat{\beta}_3 pop_{i,t-1} - \hat{\beta}_4 trade_{i,t-1} \end{bmatrix} + u_t \quad (1)$$

Where CO_2, it is the CO_2 emissions per capita of country i in period t from 1992 to 2016. This indicator is often used to measure air

quality. The higher emission levels indicate worse air quality in a region. In accordance with the hypothesis of the EKC, the effect of per capita income on environmental degradation is expected to be positive. Since the EKC curve is non-linear, the model must include the quadratic of per capita income. If the quadratic value of per capita income is negative, then the EKC hypothesis is met because of the inverted "U" shape.

ECM indicates the speed of per capita income adjustment due to changes in the independent variable. Negative and significant values show the overall effect of independent variables to encourage per capita income to return to its long-term patterns. The larger the ECM term value is, the faster the short-term imbalance caused by the shock will return to its long-term balance.

$GDP_{i,t}$ is the per capita income of a country. This variable is intended to see the existence of the Environmental Kuznets Curve. Other variables included in the model are population growth, $pop_{i,t}$, as one of the inputs in economic growth, which can cause changes in air quality. The greater population of a country's population can have a direct effect on the quality of the air.

Meanwhile, the $trade_{i,t}$ variable shows the level of country's economic openness to international trade. This variable is included to explain the linkages of trade liberalisation to per capita income of a country, because international trade is often associated with the deterioration of environmental quality of a region to be able to follow the competition in the free market. Description variables used in this study is presented in Table 1.

Statistic summary of data used is presented in Table 2.

One assumption that must be met in the OLS pooled model is exogeneity, i.e. an error that should not be correlated with one of the explanatory variables to ensure an efficient and unbiased estimate (Wooldridge, 2005). Endogeneity is a serious problem in econometrics. This may be due to neglect of the relevant variables, error measurement, sample selection, selection bias, and other causes (Baltagi, 2005). One way to avoid the emergence of bias due to unobserved variables is to include control variables, which are other variables that affect CO_2. However, there are other sources of bias that must also be addressed if we want valid estimation results. One commonly used technique for solving the problem is to include individual effects in the model by applying the Fixed Effects Estimation Method (FEM). In FEM, unobserved individual effects are assumed to be unchanged over time and independent and identically distributed. FEM, however, has the disadvantage of losing a degree of freedom (*df*) due to the entry of dummy parameters to capture country-specific effects (Medvedev, 2006).

4. RESULTS AND DISCUSSION

If all the variables used have a degree of integration *I(0)*, or all independent variables have an integrated degree at *I(0)*, then the estimation at the level reflecting the long-term estimate can give a valid result. However, if the variables used have different degrees of integration, *I(0)* and *I(1)*, then regression at the level will only result in spurious regression. Spurious regression is when

the estimation results indicate a significant relationship between variables in the model, whereas in reality there is a more random correlation, rather than a meaningful correlation (Harris, 1995). The unit root testing techniques used here are the common Im, Pesaran, and Shin (IPS) test which is used to see whether there is a root of the unit in the panel data by allowing heterogeneous y_{it-1} coefficients and test procedures based on the average unit root-average individual (Baltagi, 2005). Other unit root tests commonly used in data panel models are Levin, Lin and Chu (LLC) (Table 3).

Unit root test results show if all the variables used in this study are stationary in different degrees. Population and trade ratios appear to be integrated at the level or $I(0)$, while the GDP per capita and CO_2 per capita are integrated at the first difference or $I(1)$. Since linear combinations between variables show different integration, the data with the highest degree of integration will be integrated with the variables that have the lowest integration

(Pagan and Wickens, 1989). Regression using data at the level will give an estimation result that cannot be interpreted (Insukindro and Sahadewo, 2010).

The sample in this study is divided into four sub-sample groups, based on the criteria of income per capita from the World Bank (low-income countries, high middle-income countries, and high-income countries). Granger Causality testing results between GDP per capita and CO_2 per capita across the country group show relatively the same results, as shown in Table 4.

In general, this test indicates a one-way relationship between CO_2 per capita and the per capita income of the country. The results of the sub-sample test show the results as shown in Table 5.

With the exception of sub-samples of low- middle income countries, the results show that the relationship between CO_2 gas emissions and per capita income evolves into an "N" shape, not just an inverted "U", as hypothesised. Similar results were obtained from studies conducted by Allard et al. (2018), Poudel et al. (2009), and Özokcu and Özdemir (2017). These results indicate that environmental degradation will increase again at a certain level of income. There is no guarantee that the environment will improve as the country's income or economic growth increases. Sub-sample of low-income countries shows an inverted "N" curve shape.

The EKC in the form of "N" indicates if the EKC hypothesis will not occur in the long run. At a certain level of income, increased revenue will bring back environmental degradation. Torras and Boyce (1998) states if this relationship occurs, then the scale effect exceeds the composition effect and technical effect. This may be a consequence of a further decrease in the possibility of improvements in the industry distribution, or of diminishing returns in technological changes. The test results using ECM are shown in Table 6.

The test results indicate that the ECM value of all sub-samples is negative and significant, which means that if there is a short-term

Table 1: Description of variables and source

Variables	Definition	Sources
CO_2	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. CO2 emissions in metric tons per capita	https://data.worldbank.org/indicator/EN.ATM.CO2E.PC
GDP	GDP per capita is gross domestic product divided by midyear population in current U.S. dollars.	https://data.worldbank.org/indicator/NY.GDP.PCAP.CD
Pop	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.	https://data.worldbank.org/indicator/SP.POP.GROW
Trade	Merchandise trade as a share of GDP is the sum of merchandise exports and imports divided by the value of GDP, all in current U.S. dollars.	https://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS

Table 2: Summary statistics

Variables	Descriptive statistics				
	Observation	Mean	S.D.	Min	Max
CO_2/capita	1300	5.880482	6.498883	0.016280	35.91576
Trade	1300	107.3151	448.6475	7.805932	8434.100
Population Growth	1300	1.749468	1.514861	−6.766223	15.17708
GDP/capita	1300	17210.95	18864.62	102.5980	93777.11

Table 3: Unit root test result

Unit root test	Variables			
	CO_2/capita	GDP/capita	Trade	Population growth
I.P.S.				
Level	3.82551	6.64999	−3.13630***	−3.03975***
1st Diff.	−23.5655***	−18.3280***	−25.9820***	−11.2084***
L.L.C.				
Level	2.02312	1.48917	−4.06676***	−1.12419
1st Diff.	−24.2194***	−20.4729***	−27.5402***	−16.9483***

H_0: ρ=0 (There are root units, the variable X is not stationary). Sign ***means significant at α=1%, **significant at α=5%, and *significant at α=10%.

shock due to changes in explanatory variables, short-term CO_2 gas emissions will return to their long-term equilibrium pattern. It's just that the relatively low ECM term coefficient value (lower than 0.5) indicates a slow adjustment to return to the long-term balance. The low ability of these variables (income per capita, population, and trade) to push CO_2 back into its long-term balance suggests that environmental degradation is not easy to overcome. Higher per capita income does not create a better environment by itself, as the Kuznets Curve hypothesised. This indicates the importance of policy intervention in restoring optimal environmental conditions.

The small coefficient value of each variable of GDP also indicates that GDP per capita may not be the main variable that affects CO_2 gas emission. In the case of the EKC hypothesis, where economic development is proxy with per capita income, it is associated with environmental degradation proxy with CO_2 per capita. The inconclusive results in supporting the existence of EKC in different sub-sample groups indicated that the test was highly sensitive to the change in sample. The ambiguous results above clearly show the complexity of the relationship between economic growth and environmental quality.

Mazzanti et al. (2007) concluded through a sectoral disaggregation analysis that the aggregate outcome conceals a heterogeneity between different sectors. The industry sector tends to provide evidence of an inverted "N" form in most cases. The manufacturing industry exhibits an EKC existence with an inverted "U" shape mixed with an "N" curve, depending on the type of emission used. The same thing applies to all types of industries (not just manufacturing): once the turning point is exceeded, the "N" shape can occur due to rising emissions, and due to the drivers of development at very high levels.

The issue of whether environmental degradation increases monotonic, decreases monotonic, or rises first and then declines, as the pattern of development of the country, has important implications for policy (Panayotou, 2003). If the trend of environmental degradation increases monotonically (as happens in low-income countries) it demonstrates the need for strict environmental regulations and restrictions on economic growth to ensure the scale of sustainable economic activity in support of ecological living systems. If what happens is a monotonic decline, no explicit environmental policy is required. Even certain policies may be counterproductive and will degrade environmental quality. However, if the Kuznets Curve hypothesis is proven, then the development policy is potentially environmentally friendly in the long term (with high incomes), but policies can also damage the environment significantly in the short term (when incomes are low/moderate).

But apart from the basic theory, the EKC is empirically proven. Although there is no uniformity as to shape and altitude, there are some things to note (Panayotou, 2003). Firstly, the decline in EKC in line with rising incomes may be due to decline or progress,

Table 4: Granger causality analysis result

Sub-sample categories	Granger causality	
	H_0: CO_2/c does not Granger cause GDP/c	H_0: GDP/c does not Granger cause CO_2/c
Low income	0.07190	11.0258***
Low Middle income	0.97854	3.40643**
High Middle income	0.82778	0.27525
High income	0.34389	3.61029**

Table 5: GDP per capita effect on CO_2 emission in the long term in sub-samples model

Dependent variable: CO_2/c	Sub-sample categories			
	Low income	Low middle income	High middle income	High income
Constant	0.011713 (0.047194)	0.079540 (0.117563)	−0.573262 (0.398947)	10.75861*** (0.708046)
Trade	5.36E-06 (7.30E-06)	0.005033*** (0.000764)	0.029352*** (0.001848)	−0.023398*** (0.004611)
Population	−0.021461*** (0.005144)	0.085679 (0.054264)	−0.312431** (0.127753)	−0.150935** (0.065051)
GDP/c	0.001010*** (0.000332)	0.000111 (0.000167)	0.000987*** (0.000249)	0.000155*** (4.82E-05)
GDP/c^2	−0.001793*** (0.000690)	4.21E-05 (9.33E-05)	−0.000125** (4.81E-05)	−3.83E-06*** (1.16E-06)
GDP/c^3	1.21E-06*** (4.34E-07)	−4.79E-09 (1.51E-08)	6.22E-09** (2.66E-09)	2.38E-11*** (8.46E-12)
R^2	0.210780	0.959645	0.810764	0.924313
F-stat	19.71007***	303.8593***	101.9690***	253.3056***

Standard error in parentheses. Sign ***means significant at α=1%, **significant at α=5%, and *significant at α=10%. Model uses FEM due to rejected null hypothesis in Hausman test. FGLS method to overcome autocorrelation and heteroscedasticity problems.

Table 6: GDP per capita effect on CO_2 emission estimation in the short term

Dependent variable: D (CO_2/c)	Sub-sample categories			
	Low income	Low middle income	High middle income	High income
Constant	−0.000244 (0.001845)	0.017445** (0.007347)	0.018973 (0.023099)	−0.096493** (0.047536)
D (Trade)	3.28E-05*** (6.73E-06)	0.003192** (0.001267)	−0.003572 (0.002666)	−0.005242 (0.006322)
D (Population)	−0.003724 (0.004027)	0.022418 (0.073269)	−0.236128 (0.268509)	−0.014706 (0.095765)
D (GDP/c)	0.000271* (0.000161)	3.84E-05 (0.000257)	0.000206 (0.000204)	0.000128 (8.06E-05)
D (GDP/c^2)	−0.000354 (0.000324)	−7.67E-06 (0.000142)	−8.58E-06 (3.19E-05)	−9.38E-07 (1.68E-06)
D (GDP/c^3)	1.70E-07 (1.93E-07)	2.10E-09 (2.39E-08)	1.29E-10 (1.53E-09)	−9.73E-14 (1.07E-11)
ECM Term	−0.208589*** (0.015863)	−0.417350*** (0.077463)	−0.213423*** (0.052273)	−0.279406*** (0.028307)
R^2	0.374823	0.274307	0.313127	0.165145
F-stat	35.27338***	4.120132***	4.969015***	3.801720***

Standard error in parentheses. Sign ***Means significant at α=1%, **Significant at α=5%, and *Significant at α=10%.

weakening or strengthening, caused by policy interventions. It is not per capita income that makes the environment improve, but rather the response of supply and policy to the increasing demand for environmental quality, through the enactment of environmental regulations and the development of new institutions to protect the environment. Secondly, since it may take decades for low-income countries to move from slope to slope to ascending, the accumulated damage in that period may exceed the present value of future growth and a cleaner environment. Therefore, an early active environmental policy with prevention may be more cost-effective than if it is late. Thirdly, the EKC's height reflects the environmental price of economic growth: the steeper the EKC, the more environmental damage occurs with every per capita income rise. Because this is influenced by the level of income (as a proxy in the development stages), market and policy efficiency is the biggest factor determining the extent of EKC. When markets are filled with failures (externalities, undefined property rights, etc.) or distorted due to subsidised input, outputs and processes that are destructive to the environment, the environmental price to be paid for economic growth will be significantly greater. Inefficient economies and unnecessary environmental degradation are two consequences of market failures, and policies that will be seen in elevated EKC levels vary empirically.

The relationship between economic growth and the environment is complex. Several different drivers come into play, including the scale and composition of the economy. We may consider a country's basic economy: for example, the share of services in GDP, as opposed to primary industries and manufacturing. We also should think about the changes in technology that have the potential to reduce the environmental impacts of production and consumption decisions, whilst also driving economic growth (Everett et al., 2010). Jaffe and Palmer (1997) examined the correlation between pollution expenditures by industry and indicators of innovation more broadly. They found that high-tech industries tend to be less pollution expenditure-intensive than low-tech industries. Moreover, they found that there is a significant correlation with industries over time between the rate of expenditure on pollution abatement, and the level of research and development spending.

Another study, by Castiglione et al. (2015), reports a positive reverse causality relationship between the rule of law and income. It indicates that higher income implies a stronger rule of law, and vice versa. The rule of law is found to have a negative relationship with pollution, confirming that the enforcement of rules is a must to control emissions. No causality relationship is found for pollution and income that can be due to the different stages of economic development of emerging, former-transition, and developed economies, implying heterogeneity in their environmental protection policies. One of the policy instruments expected to maintain environmental sustainability is green public procurement. However, it must still consider the needs and number of bidders and the procurement system for this policy to be effective (Lundberg et al., 2015).

The role of environmental policy is to manage the provision and use of environmental resources in a way that supports

improvements in prosperity and wellbeing. There are several things that underlie the importance of government intervention in this matter. Especially in excessive use of natural resources due to market failures. The causes could be from natural resources which are often referred to as public goods, difficulty in calculating the benefits of developing research and development in the environmental sector, and information asymmetry (Everett et al., 2010). In terms of market failures, governments can use fiscal and other policy instruments to calculate the social costs of externalities. Policies implemented in the form of subsidies to provide more benefits or the application of taxes to impose social costs. Like any other instrument that uses a market strategy, this policy will be the most efficient and economical in terms of predetermined parameters. Policies in the form of direct regulation can also be applied, including in regulating the technology used or imposing high costs for activities that have the potential to damage the environment. However, the risk of violation is also considered to be higher and inefficient. Market failure can also be overcome by a greater role of government through government spending to provide assets in environmental terms at least to a minimum level. The government can also develop environmentally friendly aspects of development if the private sector cannot provide it. This is to ensure that everyone can have equal access to a good quality environment. As an important addition, the government can function in providing information if information asymmetry occurs. Without accurate and unreliable information, many activities that should be carried out to protect environmental and economic benefits are often overlooked.

Basically, maintaining environmental sustainability is not only government responsibility. There needed community active roles to ensure that environmental functions remain in optimal conditions. Society, through social capital, can contributes to environmental protection. Social capital indicators, including social trust, institutional trust, civic participation, and a composite index were constructed to analyze the relationship between each and the individual's decision to contribute. The results of the empirical study of the four parameters are a strong and significant incentive for the community to be willing to contribute in maintaining environmental functions (Marbuah, 2019).

5. CONCLUSION AND POLICY IMPLICATIONS

The Environmental Kuznets Curve (EKC) has long been a concern, especially with the enactment of environmental conservation targets together with the economy in the target of sustainable economic development in SDGs. EKC itself is a curve that tries to explain the relationship between environmental quality and increased income per capita. When referring from the initial reference, the EKC curve is hypothesised as an inverted "U". This is to explain that at the beginning of development, environmental damage will be the price to pay in that stage, but along with the increase in per capita income, the demand for better environmental quality will increase, so as to restore environmental quality in the country.

The research in this study shows that the EKC curve shape is no longer an inverted "U", but rather leads to the "N" shape. These results suggest that the higher drivers of development can lead to environmental degradation. The results of the analysis show that the shape of the EKC curve is not conclusive on all sub-samples used. The importance of the right policy at every stage of development becomes an important point then, since per capita income cannot improve the environment on its own. Environmental issues have entered policy design when we talk about sustainable development. Sustainable development is basically development that meets the needs of the present without reducing our future generation needs fulfilment. To be able to implement the right policies, quality of institution and human resources in the country concerned must be improved in order to build sustainable development path (Costantini and Monni, 2008). But the limitation in this study is not including policy indicators in the model, so it is expected to be input in further research. In addition, the main economic sectors in the development of a country are key in the analysis of EKC. Therefore, in order to support sustainable economic development as mandated in SDGs, the complexities of development and environmental relationships need to be examined more deeply.

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