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Article

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Modelling the Environmental Kuznets Curve of Water Pollution Impact on Economic Growth in Developing Country

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ABSTRACT

This study attempts to examine the water pollution-economic growth relationship by using the environmental Kuznets curve analysis for the situation in Malaysia. This study estimates a simultaneous equation that is related to the level of pollution, the gross domestic product per capita, and other covariates. Water pollution is measured in terms of Biochemical oxygen demand, Cadmium and Arsenic. The per capita Gross Domestic Product was measured quarterly for the period 1996–2018. The study output supports the Environmental Kuznets Curve hypothesis for all measures of water pollutants examined here. The income equation revealed the negative significant impact of pollution, BOD and physical capital's favorable influence on income. From these expected outcomes it is clear that Malaysia's relevant policies should aim primarily to overcome the pollution problems but should not neglect economic growth sustainability. This would include the implementation of policies that do not disregard the needs of economic growth and development; execute strategies that will contribute to a decrease in greenhouse gas emissions; improve public awareness on environmental issues in Malaysia; give additional incentives to industries that comply with policy requirements; implement advanced and tertiary pollution control measures to decrease pollution; implementation of financial incentives to encourage invest in appropriate technology especially sewerage systems; and development of a solid monitoring and inventory system to be implemented by the relevant government authorities.

Keywords: Environmental Kuznets Curve, Pollution, Gross Domestic Product
JEL Classifications: O11, Q53, Q54, Q56

1. INTRODUCTION

Malaysia is listed as a country with a middle income. Since the colonial times, Malaysia has been concerned about environmental issues. For example, Malaysia is actively involved in South-East Asian Nation Association (ASEAN) and Asia-Pacific Economic Cooperation (APEC). Malaysia is a nation recognized as one of the world's twelve mega-countries of biological diversity. Air and water quality directly affect society's socio-economic condition, (Ridzuan et al., 2017) and Ridzuan et al., 2021a). Air and water pollution are generally expected to become more difficult due to the rapid economic growth in Malaysia over the past two decades (Ridzuan et al. 2019; Ridzuan et al., 2018a; Ridzuan et al., 2018b; Noranida and Khairulmaini, 2014). Water pollution in Malaysia is a serious problem and has an adverse impact on water resource security. It has not only influenced plants and living organisms, the population's wellbeing, and the economy (Afroz and Rahman, 2017). According to Hosenuzzaman et al., (2015) and Ridzuan et al. (2020b), rising demand for fossil fuel may result in increased greenhouse gas (GHG) emissions, given Malaysian economy's high dependence on generating energy. One of the main objectives of economic development in Malaysia over the past three decades is growth in urban areas, provided that the country has had a growth rate of about 4.5% since the 1990s; whereas the rise in urbanization has placed upward pressure on energy demand (Che Sulaiman et al., 2021). Including these interaction results will shed more light on both the partial and full environmental degradation effects of each of these factors. In addition, the use of methane (CH_4) and nitro oxide (NO_2) emissions as environmental measures was not noticed in Malaysian studies despite numerous EKC country studies (Md Razak et al., 2017; Gill et al., 2017).

The rapid socio-economic development presents serious challenges to the protection of water resources and the environmental environment in the Asian region (Pellicer-Martínez and Martínez-Paz, 2016). This phenomenon has two main reasons. The first is that large quantities of pollutants have been released into rivers and lakes, causing regional water quality to deteriorate (Wang et al., 2016; Hu et al., 2018). The other point is that regional use of water has increased with economic development and population growth, resulting in waste of water resources and enormous pressure on water supply (Bao and Fang, 2012; Wang and Li, 2019).

The verifiable study by Vincent, 1997, that examined pollution and economic growth in Malaysia using EKC found no relationship between the two factors. Moreover, this is an empirical study extension from the previous studies such as Elias et al. (2010) estimating EKC employing the simultaneous equation method in Malaysia. This study, however, conducts a comprehensive investigation of this relationship employing both the simultaneous and single equation models.

This study aims to learn more about the links between economic growth and different water pollution indicators in Malaysia. In addition, this study aims to further improve the EKC model through the introduction of the concept of simultaneity of variables, an extension of previous studies' findings. This study also aims to test the endogeneity of different indicators of pollution and economic growth in Malaysia, to test whether the EKC actually applies to water pollution in Malaysia, to investigate the difference between single polynomial equation estimators and simultaneous equations estimators, to investigate the contribution of pollution to production and consequently to growth and to investigate the determinants of pollution abatement expense. This study is a continuation of the measurement of the water pollution and economic growth relationship in Malaysia for the period 1996–2018 using quarterly data. Quarterly data have been used as a means to study the linkages between changes in economic growth and changes in environmental quality more closely.

This study aims to close the gap in high-income countries like Japan, the UK, from what had happened and the United States over the last century. In comparison, all of these countries adopted the "pollute first and clean up later" approach. It must therefore be questioned whether a latecomer like Malaysia could have been able to avoid this trend by following the policy that economic growth from the earliest days of development could not proceed without recognizing its impact on the environment.

2. LITERATURE REVIEW

Over the past few decades, important researchers have been interested in the relationship between environment and economy in order to strengthen control and management of pollution emissions (Pellicer-Martínez and Martínez-Paz, 2016; Wang et al., 2017; Yang et al., 2018). Some researchers pointed out that, during the early stages of economic development, environmental pollution grew faster than economic growth, and then decreased at higher levels of economic development (Fernández-Amador, 2017; Sarkodie and Strezov, 2019) This is the popular Kuznets environmental curve (EKC), with a connection between indicators inverted-U-shaped. The EKC hypothesis was first applied to investigate the connection in the United States between contamination of the atmosphere and economic development. Later, several quantitative studies were conducted using EKC on the nexus of environmental pollution–economic development. Results showed that in most developed countries there has been an inverted-U-shaped relationship between environmental pollution and economic development (Tan et al., 2014).

Katz (2015) identified limitations with EKC in relation to water policy and planning decisions where it was found to be unable to represent the performance of individual countries accurately. Hemati et al., (2011) studied the interconnections between per capita industrial water use and income elasticity. The study which covered 132 countries was able to show that these two variables had a bell-shaped relationship.

Studies have also been conducted in China to show that there is a EKC relationship for industrial water use. Li et al. (2015) who attempted to find the EKC for per capita industrial and domestic water use in China were only able to verify the EKC for per the former but failed to verify the EKC for the latter as well as for per capita agricultural water use. The research was however unable to provide reliable references for individual regional industrial development due to the vast regional variances in economic and industrial developments in the country. The overall findings from the study are however of some import. Further, Zhang and Shen, (2016) who studied the value enhancement of industries as well as their water use in China, primarily the central, eastern and western parts, were able to find different relationships for the different regions. They concluded that the relationship for East China was represented by an inverted U-shaped EKC, whereas for Central China it was an N-shaped curve while for West China an approximately progressive increase was seen. Conclusive evidence was not available from the research however as the division of the regions featured did not include geographical characteristics and per capita information.

Generally, many research using local pollutants as markers of environmental degradation have found empirical support for EKC income-environment relationships. The EKC study results are highly dependent on the type of contaminant selected, and EKC may only function for certain particular air and water pollutants. Regional pollutants are more suitable for EKC analysis than global pollutants; they are easy to separate spatially and can be controlled for economic growth at relatively low cost (Gill et al., 2017). People need better quality of the environment as incomes grow, such as clean water and air. The government will take certain steps to meet the needs of people in life, such as enforcing environmental laws and investing in green technology. As incomes rise, regional unique emissions of pollutants begin to decline. Rapid socio-economic development will intensify the pressures of regional water use and supply (Alcon et al., 2014). Meanwhile, inefficient use and disproportionate distribution of water resources can have a range of adverse effects on local water safety and socio-economic sustainable development (Gu et al., 2017). Therefore, for local sustainable water management, systematic evaluation and quantitative study of water use and pollution control is particularly important.

Although the inverted U-shaped relationship is common, it has to be emphasized that it is not applicable to all data. Indiscriminate use of the model may thus result in statistical errors. Duarte et al. (2013) successfully used the quadratic polynomial fixed effect regression model and the panel smooth transition autoregression model to verify the inverted U-shaped relationship between per capita water use and income for the period 1962-2008 for 62 countries. It must be pointed out however that the models showed significant variations in the types of curves as well as estimated turning points in addition to variations in water use for varying time periods and countries.

The environmental Kuznets curve was found to be applicable two sub-groups of countries that had rivers along their borders as well as those that did not (Thompson, 2014). The EKC relationship has been negatively received by several researchers. Chien-Chiang and Yi-Bin (2010), who conducted a global study on the EKC relationship between real income and biological oxygen demand (BOD) pollutants, concluded that the relationship differed in different regions. The study found that while the inverted U shaped EKC was applicable in America and Europe the same could not be said for Africa, Asia and Oceania.

Kohler (2013) and Yavuz (2014) both state that the inverted U-shape relationship is indicative of a quadratic connection between pollution and income. According to these researchers the assumption of non-linearity is applicable and shows that when growth is at its highest there is a certain level of pollution. Wang et al. (2011) was among researchers who found evidence of N-shaped cubic relationships after testing the superior polynomial order of assumed function (i.e. more than 2). On the other hand, the study by Yang et al. (2015) on 67 countries showed more complex conclusions which indicate the existence of non-linear types of functions which include inverted U, inverted N and M-shapes. Alkhathlan and Javid (2013) whose study in investigated the situation in Saudi Arabia, found that per capita income rose in congruence with increase in pollution. Their study was based on monotonically increasing models.

The study by York (2012) found increased growth of carbon emissions rise with economic growth as compared to drops during recessions. This was refuted by the study by Burke et al. (2015) which states that the assumption of higher emissions-income elasticity associated with economic expansion periods as compared to recessionary years could not be proven conclusively. They however state that when the effects are studied over longer periods there can be seen significant evidence of asymmetry whereby boom periods were followed by faster rates of emission growth and more slowly after recessions.

Application of the EKC is widespread, where it has been used on a multitude of concerns, ranging from species under threat to nitrogen fertilizers (Zhang et al., 2015). It is even mentioned in textbooks (e.g. Frank et al., 2012). In the academic world however it continues to be discussed and reexamined (e.g. Kaika and Zervas, 2013; Chow and Li, 2014; Wagner, 2015). While the EKC is essentially an empirical phenomenon, EKC model estimates are not found to be dynamic statistically. In relation to pollution, developed countries have clearly demonstrated a decline in some local pollutants. On the issue of pollutant emissions and drivers of changes in emissions however there is less clarity and consensus.

This study shows that the inverted-U shape EKC is applicable for all groups of developed and developing countries but not for the low income developed countries. A positive relationship between GDP and BOD was shown for the low income developed countries grouping. As many of these countries with low income have partial sea or ocean boundaries, the influence of seawater pollution on the EKC shape has to be factored in. The EKC relationship for all coastal countries in our target sample was thus studied to examine this relationship which showed that the inverted-U shape EKC curve was applicable. It was also however subject to a high-income turning point which was nowhere near the average GDP per capita for those countries. It can thus be concluded that increasing income in these coastal countries is contributing to increasing water pollution (Ahmadreza et al., 2016).

3. METHODOLOGY

This study explores the relationships between water quality and per capita income using data on water quality in Malaysia. Secondary source data was used in this study. This includes the Air Quality Data Report 1996-2018, Malaysia Environmental Quality Report 1996-2018, Department of Environment, Malaysia, and National Product and Expenditure Accounts GDP 2018, Department of Statistics Malaysia. Additionally, relevant information was sourced from books, newspapers, journals and internet. All the sources used are mentioned in the relevant sections of the research report.

This study will devise an income-environment simultaneous model and then estimate the EKC. In this analysis, it will first establish a conceptual model of the simultaneous income-pollution relationship and then formulate two empirical research formulas. One is the equation of income and the other is the equation of emissions. Although this study cannot estimate the full structural model because its estimation requires data over a large number of years, not only for emissions and income, but also for all intermediate variables, such as policy, technological progress and structural changes, this study takes a more flexible approach by estimating a simultaneous two-equation model. Integrating theoretical and quantitative models gives us a better understanding of the relationship between economic growth and the environment. In order to determine the econometric justification of the model specification, a Hausman income endogeneity test is given. This study describes the income and environmental simultaneity model to estimate the per capita pollution-to-GDP relationship in Malaysia. This research integrates a single polynomial income equation concerning emissions with an expanded function of Cobb-

Douglas production and an equation describing environmental policy determinants (government pollution abatement expense), taking into account the feedback effect of pollution on production and the reciprocal relationship between pollution and abatement expense. Water pollution is treated as a function of economic growth (Y) and includes secondary industry share (ind), government pollution abatement expenses (abate), population density (PD), and Time (T). Constituents of water pollution are Cadmium (CD), Arsenic (AS) and Biochemical Oxygen Demand (BOD). Therefore, it forms the model:
CD, AS, BOD = f (Y, I, A, PD, T)
The following working model is the result:
CD = f (Y, I, A, PD, T)
AS = f (Y, I, A, PD, T)
BOD = f (Y, I, A, PD, T)

where,

Y: Income
I: Secondary industry share
A: Government pollution abatement expenses
PD: Population density
T: Time
Equations of the model are:

Water Pollution (Pollutants) = f (Income, Government pollution abatement expenses, Secondary industry share, Population density, Time)

Equation 2:
Income (Y) = f (Labour, Government spending, Foreign Direct Investment, Fixed capital, Time)

Equations (1) and (2) designate the simultaneous equations for the model.

Equation (1):

$$logCD_{tiQj} = \alpha 0 + \alpha 1IogY_{tiQj} + \alpha 2(IogY_{tiQj})2 + \alpha 3logA_{tiQj} + \alpha 4logI_{tiQj} + \alpha 5logPD_{tiQj} + \alpha 6T2 + \alpha 7T3 + \alpha 8T4 + e_{tiQj}$$

$$logAS_{tiQj} = \alpha 0 + \alpha 1IogY_{tiQj} + \alpha 2(IogY_{tiQj})2 + \alpha 3logA_{tiQj} + \alpha 4logI_{tiQj} + \alpha 5logPD_{tiQj} + \alpha 6T2 + \alpha 7T3 + \alpha 8T4 + e\ tiQj$$

$$logBOD_{tiQj} = \alpha 0 + \alpha 1IogY_{tiQj} + \alpha 2(IogY_{tiQj})2 + \alpha 3logA_{tiQj} + \alpha 4logI_{tiQj} + \alpha 5logPD_{tiQj} + \alpha 6T2 + \alpha 7T3 + \alpha 8T4 + e\ tiQj$$

Equation (2):

$$IogY_{tiQj} = \beta 0 + \beta 1IogL_{tiQj} + \beta 2IogG_{tiQj} + \beta 3logFDI_{tiQj} + \beta 4logK_{tiQj} + \beta 5T2 + \beta 6T3 + \beta 7T4 + €_{tiQj}$$

i: 23 years
j: 4
t: time
Q: quarterly

Equation (1) represents the water pollution equation, where

CD_{tiQj}, AS_{tiQj}, BOD_{tiQj}: water pollution for quarterly in year t;

Equation (2) represents the income equation.

4. FINDINGS AND ANALYSIS

A t test was applied in determining the statistical significance of the cubic terms of log (per capita GDP) for all the pollutants. Regression tests indicate that the cubic terms in water pollutants equations were mostly statistically insignificant. The cubic terms of log (per capita GDP) for all water pollutants were thus dropped from Equation 1.

The Jacque-Bera (JB) Normality Test was used to determine if final estimation regression residuals in this study were normally distributed. The results showed a significant probability level, leading to the null hypothesis of a normal distribution not being rejected. Further, testing of the stationarity of the available data was conducted using the conventional Augmented Dickey-Fuller (ADF) unit root and Phillips-Perron (PP) unit root tests. The results indicate stationarity for the entire Malaysian data set subsequent to the first difference for both DF/ADF and PP Unit root tests. According to these results the requirements to proceed with time series analysis are met by the model.

Confirmation of categorization of all the series as stationary was followed by implementation of the Johansen-Juselius test to determine if fundamental long-run relationships existed between all the variables, dependent and all independent, for all the equations. As no autocorrelation was seen for all the residuals (Lagrange Multiplier [LM] Serial Correlation Test) the optimum lag length was selected. The Johansen-Juselius cointegration test showed that for Malaysia, the trace statistic and max-eigen values were above the 5% critical value resulting in rejection of the null hypothesis of there being no cointegrating vector found in the long term. Correlation test for multicollinearity determination found no correlation between the independent variables. White test estimation for heteroscedasticity found no evidence of heteroscedasticity. All the model's variables showed error terms of constant variance or homoscedasticity. The significance levels of the coefficients were below 5% (in White test generally up to 5% level of significance is counted) of at least one cointegrating vector offering a consistent relationship among the variables.

In respect of the exogeneity of the per capita Gross Domestic Product log form, its quadratic term and per capita pollution reduction expense, statistical rejection of the null hypothesis of exogeneity of these variables was shown. This applied to almost all cases except for two of the measures of water pollutants: Arsenic (AS) and Biochemical Oxygen Demand (BOD). The Hausman test for exogeneity (Table 1) results is indicative of this. The water pollutants AS and BOD were thus not found to have a simultaneous relationship and so were dropped from the model. A per capita income and per capita pollutant emission synchronous linkage is thus proven for the Malaysian data.

The two methods used for the estimation were the single equation method and the simultaneous equation method.

4.1. Single Equation Method

1. In case of all water pollutants Cadmium (CD), Arsenic (AS), Biochemical oxygen demand (BOD) the anticipated EKCs is found to exist. The coefficient of log Y is +83.7530 and log Y2 is −28.8630 for CD, +35.5484 and −9.4812 for AS, and +2.5035 and −1.2580 for BOD. This follows the EKC theory
2. Cadmium (CD) is approximated nearly 1.46 times bigger (single equation: $-\alpha 1/2\alpha 2$ = 83.7530/28.8630 = 2.90, simultaneous equation: $\alpha 1/2\alpha 2$ = 266.2709/134.0494 = 1.99, magnitude = 2.90/1.99 = 1.46) in magnitude concentrating on the turning points, $-\alpha 1/2\alpha 2$ of these inverse-U-shaped curves in water pollutants. The turning points are over approximated.

4.2. Simultaneous Equation Method

1. In case of one water pollutant, Cadmium (CD) the anticipated EKCs is found to exist. The coefficient of log Y is +266.2709 and log Y2 is −134.0494. This follows the EKC theory
2. Water pollutant, CD is approximated nearly 1.46 times smaller in magnitude concentrating on the turning points, $-\alpha 1/2\alpha 2$ of these inverse-U-shaped curves for the water pollutants. Different policy implications might be enforced by the government of Malaysia due to these different turning points. As an example, in the case of CD, the outcome presented is that at higher per capita GDP levels the per capita emissions should reduce with income increases, if the assumption of income and pollution not having any synchronous linkage is accepted. In actual fact, according to the simultaneous equations model, subsequent to per capita GDP achieving lower-level per capita emissions are expected to begin to reduce. The different environmental and economic policies enforced by the central government of Malaysia may be due to the differences in the different estimation forms. This indicates Malaysia's success in water pollution abatement before the stage of single equation
3. The effect of increases in the contributions of secondary industries on per capita pollutant emission is greater. Two sources have been referred to examine the industrial structural impact.

Table 1: Estimated regression results for water pollutants and income (Eq- 1)

Independent variable	Single polynomial equation			Simultaneous equations
	Dependent variable			Dependent variable
	CD	AS	BOD	CD
Intercept	–22.6269 (–0.7977)	–10.1161 (–0.3391)	2.0720 (3.2882)	–119.6364 (–1.7185)
log Y (per capita GDP)	83.7530 (1.8576)*	35.5484 (0.7497)	2.5035 (2.4996)**	266.2709 (2.2736)** White 0.9418
log Y^2 (per capita GDP)^2	–28.8630 (–1.1887)	–9.4812 (–0.3713)	–1.2580 (–2.3324)**	−134.0494 (–2.0209)* White 1.0598
log A (abatement expense)	0.6463 (3.9930)***	0.4676 (2.7467)***	–0.0030 (–0.8404)	0.4780 (1.2755) White 2.4696
log I (secondary industry share)	–16.1153 (–2.9745)***	–10.1595 (–1.7831)*	–0.2808 (–2.3336)**	–21.5943 (–2.3956)** White 0.5735
log PD (population density)	–8.4214 (–3.0756)***	–4.8937 (–1.6995)*	0.0640 (1.0519)	–4.5975 (–0.9583) White 1.2867
Time trend, T2	–0.3635 (–1.1194)	–0.1258 (–0.3683)	–0.0025 (–0.3495)	–0.5859 (–1.3552) White –0.7609
Time trend, T3	–0.9643 (–2.6477)**	–0.4415 (–1.1528)	–0.0080 (–0.9950)	–1.2309 (–2.4035)** White –1.1566
Time trend, T4	–1.1718 (–3.0211)***	–0.5553 (–1.3614)	–0.0101 (–1.1725)	–1.4124 (–2.5325)** White –1.1483
Adjusted R–square	0.4897	0.1276	0.0156	0.1782
Hausman Test for exogeneity (F-statistic)	-	-	-	4.8687***
Turning point	1.4509	1.8747	0.9950	0.9932

(1) t-statistics in parentheses. (2) *** represents $P<0.01$; **$P<0.05$; *$P<0.1$

In Equation (1), a direct effect calculated by its coefficient. The net effect should be computed as the net values of these two effects. For example, for CD.

The direct effect (Table 1) shows that a 1% increase in the secondary industry share causes a reduction of 21.5943% in per capita emission.

4. Time effect T2 becomes more significant in CD.

It appears that for this model single equation method produces better result for EKC that show all indicators of water pollutants follow the EKC theory whereas using the simultaneous equation method only CD was found to follow the EKC theory.

4.3. Endogenous Variables Effects on Water Pollution

Income contribution: A 1% income increase led to a 266.27% increase in the water pollution indicator CD and a subsequent 134.05% decrease. The results are in line with the theory of pollution increases in tandem with income increase at the initial stages and subsequent decreases at later stages.

Government abatement expenses contribution: As government abatement expenses increase by 1%, water pollution indicator BOD decreases by 0.003%. In this study pollution decreases at a small percentage.

Population density contribution: In Malaysia population density is not seen to contribute to higher pollution. On the contrary it is shown that population density increases resulted in a decrease in two water pollution indicators (as population density increases by 1% CD decreases by 8.42% and AS decreases by 4.90%) (Table 2).

The coefficient of labor shows 0.0754 that is positively related to the income. This is congruent with the sign anticipated. Physical capital in the income equation is positively (coefficient of 0.0635) related to the income and highly significant (t-statistic of 2.6525). Physical capital is thus shown to be the main determinant of

Table 2: Estimated regression results for income (Eq-2)

Independent variable	Dependent variable
	log Y(GDP)
Intercept	0.7583 (4.2156)***
log L (labor)	0.0754 (0.2001) White −0.1865
log K (physical capital)	0.0635 (2.6525)*** White −0.7125
log G (govt.spending)	0.3522 (8.6596)*** White 0.5819
log FDI (foreign direct investment)	0.0255 (2.5682)*** White −1.4332
Time trend, T2	−0.0158 (−3.2335)*** White −1.0319
Time trend, T3	−0.0322 (−3.5890)*** White −0.3565
Time trend, T4	−0.1058 (−3.9952)*** White −1.2268
Adjusted R-square	0.8923

1. t-statistics in parentheses. 2. *** represents $P<0.01$; **, $P<0.05$; *, $P<0.1$.

income in Malaysia as compared to human capital although it is unconceivable that production can proceed without labor inputs.

The government expenditure coefficient is seen to have a highly important (t-statistic of 8.6596) effect on income and positive relationship (coefficient of 0.3522) with income. Foreign direct investment is also among the major income attributors in Malaysia as it shows positive (coefficient of 0.0255) relationship with income and significant (t-statistic of 2.5682) effect on income.

5. CONCLUSION

All the research objectives in this study were achieved. This includes examination of the relationships between economic growth and varied water pollution indicators in Malaysia and further improves the EKC model incorporating what is learnt previous study findings to further extend and introduce concurrence between variable.

The outcome from this study is that the EKC hypothesis is applicable for all measures of water pollutants. The income equation revealed the negative significant impact of pollution, BOD and physical capital's favorable influence on income. From these expected outcomes it is clear that there is a necessity for Malaysian policies to address primary pollution related problems while at the same time sustaining economic growth. This would include the implementation of policies that do not disregard the needs of economic growth and development; execute strategies that will contribute to a decrease in greenhouse gas emissions; improve public awareness on environmental issues in Malaysia; give additional incentives to industries that comply with policy requirements; implement advanced and tertiary pollution control measures to decrease pollution; implementation of financial incentives to encourage invest in appropriate technology especially sewerage systems; and development of a solid monitoring and inventory system to be implemented by the relevant government authorities.

Other than that, Malaysia also can offer policies such as growing influence of international stakeholders, strengthen national capacity in environmental health risk assessment and management, inter-country cooperation, co-policy instruments and actions, contravention license granted to some firm industries as well as its renewals and polluter pay principle. Malaysia's government policies are formulated in line with the national objective of maintaining a balance between development and protection of its natural resources. While Malaysia has whole heartedly supported all international and regional policy efforts related to the protection of natural resources certain crucial issues and challenges demand immediate attention which may have an effect on future environmental policies in the country. The significance of the findings is that policy makers have higher motivation to make bigger investments on pollution control measures in order to decrease pollutants by the usage of renewable energy as stated by Vija Kumaran et al. (2020) and Ridzuan et al. (2020a). Water pollutants attributable to secondary industries in Malaysia constitute a major portion of the nations' the water pollution. At the same time the human capital component in the production factor is not of significance in the model despite labor being undeniably an essential factor in production. Malaysian economic development is thus shown to be largely dependent on capital-intensive industries.

Returning to the objectives posed in the introduction by this research, this study may draw conclusions. First, because in the case of some pollutant indicators, the EKC theory is supported, there is a trend of "pollute first and regulate pollution later" in Malaysia. There is much evidence that the regulation and execution of environmental protection policies by local governments has been somewhat inconsistent. Second, in an earlier stage of economic development, the turning points about the Malaysian EKC occurred. There may be four factors for the "latecomer advantage," which is increased technology accessibility, lower unit abatement costs, and increased exposure to global environmental pressures.

In conclusion, most of the estimated coefficients in income equations, abatement equations and population density equations are significant and consistent with the expectation. Variables such as the share of clean energy in the overall energy source is lacking in the statistics. In addition, the environment exerts an all-round influence. Apart from water quality, solid waste treatment, hazardous waste and noise in the city are all important to residents. A further extension could be made in any of these directions.

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