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IS IT RIGHT TO SEE POLLUTION AS AN INEVITABLE BY-PRODUCT OF SUSTAINABLE ECONOMIC GROWTH? ANALYZING IMPACT OF WATER, PLASTIC AND AIR POLLUTION FOR ASEAN COUNTRIES

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Abstract. In the developing and underdeveloped countries, economic growth comes usually with the price of pollution in the form of byproduct. The pollution is of various types such as water pollution, plastic pollution, air pollution etc. and all of them are majorly caused by the economic activities in different sectors of the country. In this context, the current study has been designed so that the impact casted by water, plastic and air pollution on the sustainable economic growth of the ASEAN countries can be studied. Therefore, the researcher has collected the information from ASEAN countries for the period of 30 years about the variables included in the study. The collected data has been analyzed by conducting tests such as panel entity root test, coefficient estimation test, panel cointegration test and Granger casualty test and the outcomes have been obtained. The results have clearly indicated that the effect of water, plastic and air pollution on sustainable growth of economy has been found as substantial and positive. Moreover the impact of control variables i.e. population and literacy rate has also been found as significant and positive. In addition, casual relationships between the variables have also been observed as per the Granger Casualty test results.

Keywords: Water; Plastic; Air Pollution; Sustainable Economic Growth; ASEAN Countries

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Jel Codes: O1, O53

1. Introduction

Pollution is considered as a global ecological issue which in the form of air, haze, water and plastic material pollution does not only pose a major risk for the health of its citizens, but also negatively impacts the environment of the country (Borhan & Ahmed, 2017; Muniz, da Gloria, de Melo, Liberato, Wahnfried, & Vieira, G. 2018; Cardoso, Swan, & Mendes, 2018. Hao et al., 2018; Zamil, Furqan, & Mahmood, 2019; Tvaronavičienė, & Ślusarczyk, 2019; Mazzoni, 2020). As a consequence, the economic welfare and development is compromised (Lazăr, Minea, & Purcel, 2019). Many countries have enforced laws and policies to control and reduce the pollution to safe levels. If urgent attention is not paid by the government, the pollution levels are projected to dangerously rise to above 50 % by the year 2030 and disrupt the entire eco- system of the globe. The dense

population of the urban cities and rural irrigation returns filled up with fertilizers and pesticides are polluting the habitats and the aquatic environment (Borhan & Ahmed, 2017). See Figure 1. The implementation of appropriate pollution controlling policies can stabilize these levels which can damage the human health at mass and foster eco- economic growth (Hou, An, Song, & Chen, 2019; Organization, 2016).

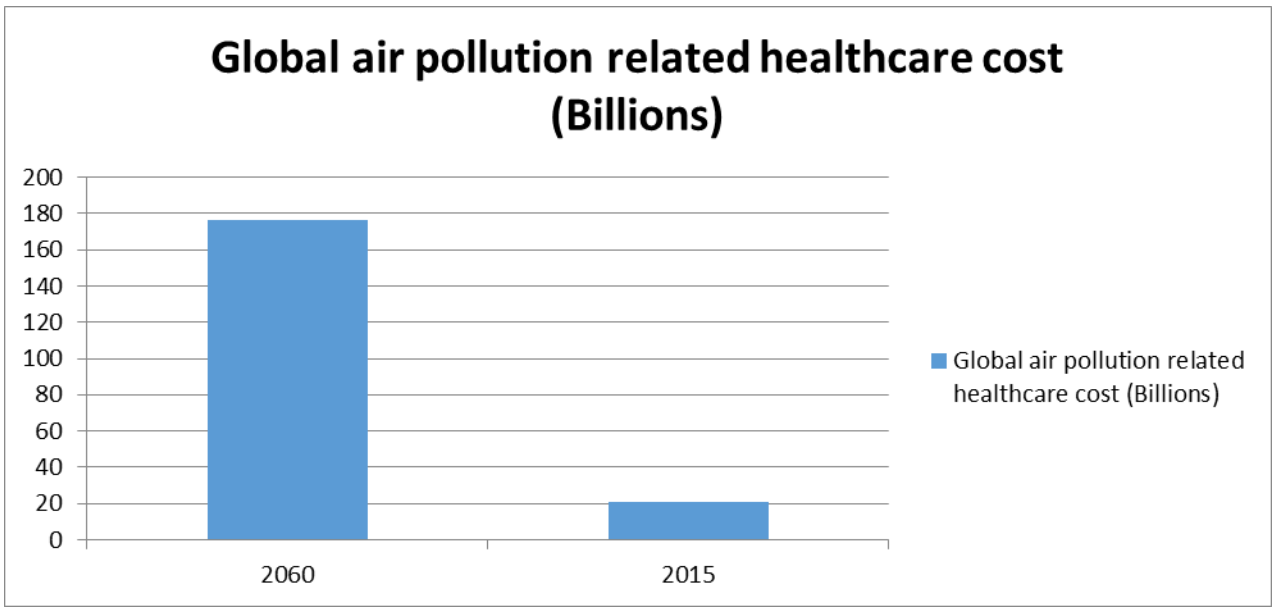

Figure 1. Projected Increase in the global health care cost due to air pollution (Billions)

Owing to the catastrophic and acute rise in the pollution levels, all the ten ASEAN nations have signed the Basel Convention, which is a treaty to control the inter- country transmission of the hazardous pollutants (Ibitz, 2012; Lian & Robinson, 2002). The plastic has intensively contaminated the rivers and other water bodies (Garcia, Fang, & Lin, 2019; Hisham & Florent, 2019), degrading them to reach unsafe levels of the Water Quality Index (WQI) due to the growth in population and urbanization (Garcia de Oliveira, Fang, & Lin, 2019; Prisandani & Amanda, 2019). See Table 1. Haze, smoke, carbon and other GHG emissions have destroyed the natural composition of air, hence, rising the Air Pollution Index of these countries very high, on average. All these pollution factors have taken a toll on the human lives and have reduced their productivity and increased the cost on the healthcare, giving another blow to the economy.

Table 1: Increase in the plastic waste in ASEAN region (Tonnes)

Year	Tonnes
2016	836, 529
2018	2, 265, 962

Based on the above discussion, it is important that the impact of pollution be examined on the economic growth of a country. Scholars have also highlighted the need for such studies for developing policy implications in the ASEAN region, which consists of emerging economies with the highly polluted areas of the world (Chontanawat, 2020; Haseeb, Kot, Hussain, & Jermsittiparsert, 2019; Thanh, Phuong, & Ngoc, 2019). In order to bridge this research discrepancy, this study aims to see if pollution is an inevitable by- product of sustainable economic development by analyzing the impact of water, plastic and air pollution by using panel data from the ASEAN nations. Also, the specific research objectives for the current study are as follows:

- To analyze how water pollution affects the sustainable economic growth
- To analyze how plastic pollution affects the sustainable economic growth
- To analyze how air pollution affects the sustainable economic growth.

This research has substantial significance to the literature and practice. Theoretically, this paper investigates the water, air and plastic pollution contributing to sustainable economic growth and development using panel data techniques. Practically, this study provides insight in to policy making for enforcing comprehensive laws and regulations to control the pollution by water, air and plastic and determining the monetary value of environmental quality for ensuring a sustainable economy.

The organization concerned with this paper is provided as follows. Starting with Introduction, the paper moves to the review of the literature on the variables. Next, the complete methodology for research is given, using which the findings of the study are deduced and presented. The last section concludes this study with the discussion, also highlighting the research limitations and research implications.

2. Literature review

Water Pollution

The world's water resources are particularly limited and scarce sand are more vulnerable to the pollutants and the associated destruction (Markantonis et al., 2019). Water pollution is considered to be a challenge for the quality of the world's eco- system. While the industries are accounted for significant boosters of the country's economy (Sakamoto, Ahmed, Begum, & Huq, 2019), their extensive spread in the suburbs of the cities and towns are contaminating the river and streams with the dirty water emitted from them (Wanhong, Fang, Fan, Maiqi, & Tiansen, 2019). As more resources and inputs are being utilized to manufacture more goods, their tendency to produce greater air pollutants and solid waste are induced, resulting in environmental degradation (Khan, 2019). Water pollution has become a serious threat to the water resources, the quality of which is being deteriorated day by day, disrupting the ecological systems of ground water and the offshore waters. The safety of the agricultural products growing from such water and the drinking water used by people are also compromised, leading to complete loss of the welfare of society and the economy. This problem is now spreading wide across the countries and strict laws need to be governed and enforced to address this challenge soon before the situation gets completely out of control and the risk factors could not be mitigated in the long run (Liu, 2019). (Melloul & Collin, 2003) has stated that in order to develop and maintain sustainable development, efficient management of the water resources and social requirement be coordinated. (Ali, Naveed, ul Hameed, & Rizvi, 2018; Hamid, Shahid, Hameed, Amin, & Mehmood, 2019; Judova & Janský, 2005) has pin pointed that the presence of high rate of pesticide drained as waste water into the water bodies are a major source of agricultural pollution. (Simon, Brüggemann, & Pudenz, 2004) has also suggested that water environment and its economic impact be dealt with by maintaining a balance among the water resources and social economy if the goal related to the sustainable development is to be accomplished. Contemporary scholars have investigated the relationship between urbanization, air pollution and growth of economy. Their findings revealed that the pollution sources massively distresses the quality of the atmosphere (Liang & Yang, 2019). In a similar study by (Liu, 2019), using the data from 2008 – 2017 for China, the impact of water pollution was explored on the regional economic development. Their findings showed that water pollution is alleviated with the economic development. As the income levels increase, the per capita GDP and the discharge for industrial waste water also increases initially. However, in the long run, a negative correlation is seen between the pollution levels and the GDP, implying that water pollution and economic growth are negatively linked to each other (Liu, 2019). The results of the previous studies indicate that an adverse correlation can exist among water pollution and sustainable growth of economy. Hence, the following hypothesis is deduced:

H1: Water Pollution has significant relationship with Sustainable economic growth.

Plastic Pollution

Plastic waste is a global problem ranging from the Arctic to Antarctic (Cressey, 2016). The fragments of the plastic are illegally dumped on the ground and are later blown into the lakes and streams, from where it goes to the rivers and the oceans (Van Sebille, Spathi, & Gilbert, 2016). Hence, the plastic effluence can be seen in both the fresh water and the marine environment, posing a threat to the bio diversity and economy. Most of the plastic dump has created both from land and ocean based sources (Van Sebille et al., 2016). Plastic is produced in large quantities, i.e., around 300 million tonnes globally (Cressey, 2016). This non- degradable plastic contaminates and is not easily biodegraded while floating in the marine areas even for longer time periods. It is estimated that about five trillion plastic pieces are found in the oceans of the world (Eriksen et al., 2014). The chemicals used for manufacturing polymer plastic are hazardous materials derived from raw crude oil and are divided into minor micro plastics, huge micro plastics, meso-plastics and macro-plastics (Kibria, 2017). The main plastics used for packaging around the world include polypropylene, polyethylene, polystyrene, polyvinyl chloride and polyurethane. Many developed countries are using the plastics categorized as solid waste (Rochman et al., 2013). When this material is not properly filtered or disposed off then this is dumped openly into the aquatic waterways and is transported with the tides or wind (Kibria, 2017). A worrisome level of the plastics are found on land and in the rivers every year (Blettler, Abrial, Khan, Sivri, & Espinola, 2018; Jambeck et al., 2015) due to the human recreational activities (Wang, He, & Sen, 2019; Cristófoli & Fronti, 2020). Hence, for environmental concerns, the contamination by plastic has to be reduced through generating long term measures for eradication (Stafford & Jones, 2019) and economic growth can be made possible by adopting green measures (Avery-Gomm, Walker, Mallory, & Provencher, 2019). These findings imply that plastic pollution has significant linkages to the development of economy of a country. So, hypothesis for showing this relationship is:

H2: Plastic Pollution has significant relationship with Sustainable economic growth.

Air Pollution

The bad quality of the outside air has detrimental impact on the health, labor productivity and agricultural yields which can cause the economic costs to increase considerably. Hence, the air pollution takes a toll on the human lives and the sustainable economy (Tasri & Karimi, 2019; Kamarudin et al., 2020). Previous research studies have examined the effect of air pollution and economic development by depleting the natural ozone layer. They found that the urban air quality will decline with the rising GDP per capita, implying that an undesirable relationship occurs between them (Selden & Song, 1994; Jabarullah, 2019). Another study by (Cole, 2000) has investigated the effect of environmental pollution on the economy of developing and developed countries and found that the emissions from the manufacturing concerns and industries change the composition of the air and atmosphere and revealed that with rise in the income level, industrial pollution also increases which can have negative impact on the economic conditions (Cole, 2000). In a similar study by (Sun & Gu, 2008), the influence of the air pollution on the heath of people and economic development of community was explored. The results showed that growth in the index for environmental pollution was more in the urban areas and it worsened the health conditions and the economic situation of that community (Sun & Gu, 2008). In a recent study, it was postulated that the rise of haze and smoke in the atmosphere has contaminated the air quality and reduces visibility and its negative impacts are observable for the economic development and growth using OLS (Ordinary Least Square) method. Panel data was employed for the time period of 2013 – 2015 (Haseeb et al., 2021), it was found that negative correlation exists among the environmental pollution and GDP per capita and the economic development. The study proved that the air pollution with higher concentration of pollutants with PM 2.5 can significantly affect the economic development and its sustainability, however reducing these levels can benefit the growth and development of society and economy at large (Hao et al., 2018). Other studies have also revealed similar results, implying that air pollution significantly affects the economic growth (Azam, Khan, & Ozturk, 2019; Tasri & Karimi, 2019; Wu, Pu, & Li, 2020). These findings indicate that air pollution and sustainable economic growth are significantly linked to each other. For this relationship, the following hypothesis is given:

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H3: Air Pollution has significant relationship with Sustainable economic development.

3. Data and Methods

Data

Being one of the most important and critical steps of a research process, the researcher has collected the data required for this particular study from the most authentic databases for example World Bank Development Indicators and Global Economy. The records from these data bases ensures the reliability and accurateness of the results obtained by the application of different experiments and approaches on the data. The information for this specific study was collected from the ASEAN countries about the aspects for instance water pollution, plastic pollution, air pollution and sustainable economic growth based on the purpose of this study i.e. to find out the impact of water, plastic and environmental pollution on sustainable growth o economy in ASEAN countries. The time period for which data has been collected is 30 years and the details of measurement units has been given in the next section.

Model Specification

As far as the measurement units are concerned, the measurement unit of water pollution is taken as concentration of pollutants dissolved milligrams per liter. In the same way, plastic pollution has been measured in context of millions of metric tons per year. The last independent variable, air pollution has the measurement units of micrograms per cubic meter. As far as the dependent variable, sustainable economic growth is considered; it has been measured as the GDP growth in a country. Furthermore, the researcher has chosen two control variables as well i.e. literacy rate and population which have been measured through the number of people and percentage of literate people in the country respectively. The researcher has come up with the following regression model to be used for the analysis purpose;

$$SEG_{it} = \alpha + \beta_1 WAP_{it} + \beta_2 PLP_{it} + \beta_3 AIP_{it} + \beta_4 POP_{it} + \beta_5 LIT_{it} + \varepsilon_{it}$$

In the above equation, SEG represents sustainable economic growth, WAP represents pollution, PLP shows plastic pollution, AIP denotes air pollution, POP shows population, LIT represents literacy rate while $\varepsilon_{it}$is the tern that shows any error.

Estimation Procedure

Panel Unit Root Test

In the initial step, with the aim to study and analyze the stationary properties of the data and to determine the integration order of the variables of the study, the researcher has applied the test of panel unit root in the study. These aspects are necessary to be evaluated before the application of further tests in the study and test of panel unit root is the best option for this purpose. There are various tests that come under unit root such as ADF, LLC and IPS etc. which are based on null and alternate hypothesis. As far as null hypothesis is concerned, it assumes that there exists a unit root in the collected data that makes it non stationary (Im, Pesaran, & Shin, 2003). On the other hand, if the alternate hypothesis is considered, it has the assumption that there does not exist any unit root in the data that makes it inactive. The rejection and acceptance of these hypotheses are based on the value of p. This test can be applied using the following model;

$$\Delta y_{i,t} = a_i + \rho y_{i,t} - 1 + \sum_{J=1}^{pi} a_J \Delta y_{i,t-J} + \varepsilon_{i,t}$$

Here, $\Delta y_{i,t}$ shows the difference of the term $y_{i,t}$ involving i[th] country and the time period of t.

Panel Cointegration Test

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After studying the stationary conditions and the order of integration of the variables, the subsequent stage is to explore that whether there exist any cointegration among the variables or not. To study this aspect, the most appropriate test that is being used by the researchers is known as panel cointegration test such as Kao and Pedroni cointegration test. These conducted tests are also centered on the alternate and null hypothesis. In case of null hypothesis, the assumption concludes that there is no cointegration present amongst the variables while in case of alternate hypothesis the situation is different i.e. cointegration is present between the variables. Two types of statistics are used for this purpose i.e. within dimension or homogeneous panel and the other one is between dimension or heterogeneous group. The rejection of null hypothesis depends on the significance level of these statistics values (Levin & Lin, 1993). The following equation can be used in order to use this test;

$$y_{i,t} = \alpha_i + \delta_{i,t} + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \cdots + \beta_n X_{n,i,t} + \varepsilon_{i,t}$$

Coefficient Estimation Test

The most critical test that has been applied in the study is refereed as coefficient estimation test that provides the information about the impact that is casted by one variable over the other and the direction of that impact as well i.e. positive or negative. In this regard, different techniques are used for example dynamic and fully modified ordinary least square i.e. FMOLS and DOLS (Pedroni, 2001). The following equation can be used while applying this test.

$$\hat{\beta}_{FM=}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{i,t}-\bar{x}_i)^2\right)^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{i,t}-\bar{x}_i)\hat{V}_{i,t}-T\hat{\delta}_{\varepsilon u}\right)$$

In the above equation, $\hat{V}_{i,t}$ is represented as the transformed dependent variable because of endogeneity while $\hat{\delta}_{\varepsilon u}$ is because of the serial correlation correction.

Granger Casualty Test

At last, the researcher has applied the test of Granger Casualty so that the presence of any casual relationship between the variables can be probed effectively. For this purpose, Dumitrescy and Hurlin Granger Casualty Test is the best option which provides information about the unidirectional and bidirectional casual relationships between the variables (Dumitrescu & Hurlin, 2012). Just like other tests, it also has null and alternate hypothesis with null hypothesis assuming no casual relationship and vice versa. The following equation may be used in this regard;

$$x_t = \sum_{i=1}^{\infty} a_i\, x(t-i) + c_1 + \mu_{1(t)}$$

$$x_t = \sum_{i=1}^{\infty} a_i\, x(t-i) + \sum_{j=1}^{\infty} b_j\, y(t-j) + c_2 + \mu_{2(t)}$$

4. Results and Analysis

Results of Panel Unit Root Test

The results obtained by the application of test of panel unit root have been reported in the table 2. In the table, results for two series have been given i.e. level and first difference. Let consider them one by one. As far as the level series is concerned, it is quite clear that only three variables i.e. sustainable economic growth, air pollution and population have prohibited the null hypothesis continuously.

Similarly, same three variables have prohibited the null hypothesis in continual plus trend. All the remaining variables have acknowledged the null hypothesis. On the other hand, in case of first difference series, all the variables in both constant and constant plus trend have prohibited the null hypothesis. This specifies that in the

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level successions the data was not stationary but when the first difference was applied on it, it became stationary. It can also be stated that in this series, the direction of integration of the variables is I (1).

Table 2: Unit Root Test

Constructs	Level		1st Difference	
	Constant	Constant+ Trend	Constant	Constant+ Trend
SEG	-2.0203*	-2.2844*	-4.2389**	-4.3885***
WAP	-0.5289	-0.2442	-6.3994***	-6.3955***
PLP	-0.2048	-0.2944	-7.7299***	-7.3955***
AIP	-4.2034**	-4.2233*	-6.4995***	-6.3885***
POP	-3.2904*	-2.2004*	-7.3784***	-7.3995***
LIT	-0.2994	-0.2944	-6.2004**	-8.2884***

Results of Panel Cointegration Test

Afterwards the identification of order of integration, the next test in the research was applied to explore the cointegration among the variables and the outcomes obtained have been presented in the table 3. As far as the within dimension or homogenous panel results are concerned, it is clear that three statistics values i.e. v, rho and PP have forbidden the null hypothesis of absence of cointegration. Correspondingly, if the between dimension or heterogeneous group results are considered, it is clear that two out of three statistic values i.e. rho and PP have rejected the null hypothesis of absence of cointegration. In short, it can be summarized and briefly elaborated that as five values out of seven values have not accepted the null hypothesis, the final result is that cointegration is present among the variables. The comprehensive results of the tests and the results can be viewed and evaluated in the following table.

Table 3: Panel Cointegration Test

Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	-3.24929*	0.0262	9.587	0.0033
Panel rho-Statistic	2.20334*	0.0068	2.639	0.0283
Panel PP-Statistic	-2.28334*	0.0401	-4.1498	0.0038
Panel ADF-Statistic	0.19388	0.3092	-0.4294	0.2094
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	5.03592*	.00000		
Group PP-Statistic	-4.12917**	0.0000		
Group ADF-Statistic	-3.12299	0.4512		
Kao test.	**Statistic**	**Prob.**		
ADF	-4.6387*	0.0452		

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Results of Coefficient Estimation Test

The results of the most critical and decisive test have been presented in the table 4 both for pooled and grouped versions of coefficient estimation. Let us consider the results in context of each variable separately. First of all the impact of water pollution has been found as significant in both the versions and it can be stated that with one percent increase in water pollution, the sustainable economic growth will be enhanced by 26.3% for pooled and 25.8% for grouped version. In the same way, the impact of plastic pollution has also been indicated as substantial and with rise of one percent of plastic pollution, the sustainable economic growth will face and increase of 12.2% in pooled and 13.3% in grouped version. Similarly, the third independent variable i.e. air pollution has also significant impact on sustainable economic growth as per the table. When there is one percent increase in air pollution or environmental pollution, sustainable growth of economy will show and increase of 12.8% in pooled and 12.5% in grouped version. Apart from these variables, the impact of control variables i.e. population and literacy rate have also been found as efficient and significant. It can be stated that as population increases by one percent, sustainable economic growth will face an increase of 22.8% for pooled and 23.3% for grouped version. Similarly, with one percent increase in literacy rate, sustainable economic growth will have an increase of 23.6% for pooled and 22.4% for grouped version. In short all the control and independent variables have major and affirmative impact on sustainability of economic growth.

Table 4: Coefficient Estimation Test

Variable	Value	Pooled	Grouped
WAP	Beta	0.263**	0.258**
	SE.	0.212	0.488
PLP	Beta	0.122*	0.133**
	SE	0.543	0.485
AIP	Beta	0.128*	0.125*
	SE	0.677	0.794
POP	Beta	0.228**	0.233**
	SE	0.521	0.474
LIT	Beta	0.236**	0.224**
	SE	0.561	0.387
Adj. R Square	**Beta**	**0.765*** **	**0.774*** **
	SE	**0.866**	**0.993**

5. Results of Granger Casualty Test

Finally the casual relationships among different variables have been studied through Granger Casualty test. In context of Granger Casualty test results showed in the table 5, it can be stated that casualty runs between the pollution of water and sustainability of economic growth, environmental pollution and sustainable economic growth, population and sustainable economic growth, plastic pollution and water pollution, air pollution and water pollution, population and plastic pollution, population and air pollution and finally literacy rate and air pollution. Thus it can be concluded that various variables have casual relationships between them.

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Table 5: Granger Casualty Test

Variables	EGS	WAP	PLP	AIP	POP	LIT
EGS	0.773					
WAP	0.388*	0.674				
PLP	0.356	0.309*	0.876			
AIP	0.583*	0.294*	0.566	0.753		
POP	0.112*	0.499	0.398*	0.388*	0.687	
LIT	0.299	0.388	0.378	0.384*	0.291	0.780

Discussion and Conclusion

Discussion

The results that have been obtained by the application of various tests and techniques on the collected data for fulfilling the purpose of the current study have been discussed in this section. The researcher had designed three hypotheses in the literature review section so that they can be tested. The first hypothesis that was generated by the researcher was that water pollution has significant impact on sustainable economic growth. As the results found this impact significant and efficient thus it can be stated that this hypothesis has been accepted. Water pollution increases by more industrial practices that have the positive impact on the economic growth. This result is affirmative with the studies of similar context from the past (Khalid & Khaver, 2019). The next hypothesis was that plastic pollution has significant impact on sustainable economic growth and the results presented this impact as significant too leading towards the acceptance of this hypothesis. This result is in consistence with the past literature (Beaumont et al., 2019). The last hypothesis of the study was that air pollution has significant impact on sustainable economic growth. The results proved that this impact is also significant and thus the last hypothesis was also accepted. The increase is air pollution is majorly caused by the heavy industrial activities in different sectors of the country thus increasing the economic growth of the country. This result is in accordance with the literature found in the past (Bagoulla & Guillotreau, 2020). Moreover, two control variables i.e. population are also found to have a significant impact on sustainable economic growth. When the population of a country is increased, more people get jobs in different industrial sectors of the country and work there resulting in increase in sustainable economic growth. Similarly, when the literacy rate is increased, more educated and skilled people work for the country leading towards the sustainable economic growth of the country. In a nutshell, all the hypotheses of the study have been accepted (Muda, 2017).

Conclusion

In order to achieve the objectives of the current study i.e. to explore the impact casted by water, plastic and air pollution on the sustainable economic growth of the ASEAN countries, the researcher collected data from ASEAN countries for 30 years about the variables involved in the study. The results obtained by the application of the tests and techniques on the collected data indicated that all the independent variables i.e. water, plastic and air pollution have significant impact on sustainable economic growth and it leads to the conclusion that the countries must work on the adoption of new technology and refined practices in different sectors of the country so that the pollution can be reduced effectively in spite of the increasing sustainable economic growth.

Implications and Limitations

The basic practical implication of the current study is that it will guide the industrial sector of the ASEAN countries to take steps and adopt new technology and refine practices in different sectors of the country so that the pollution can be reduced effectively in spite of the increasing sustainability if economic growth. It will also guide the policy makers to devise environment friendly policies and regulations for the ASEAN country. In addition, the theoretical implication of the study is that it will provide literature and information to the other researchers for

further research purposes. It is recommended to add more countries and regions for this research so that their perspective of the problem can be addressed efficiently. In addition, other variables may also be considered so that new literature can be created further.

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