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Effect of Trade Openness on the Environmental Performance Index in Sub-Sahara Africa

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Abstract

A possible solution to overcome the dilemma between trade openness and the environment can be done by adjusting the factors that might affect the environmental performance index. However, this can only be done if there is an established relationship between the influencing factors. The purpose of this study was to analyze the effect of trade openness, energy, technology, and population on the environmental performance index in Sub-Saharan Africa. This type of research is a quantitative research using panel data regression analysis tool. Trade openness, energy, and population have a positive and significant influence on the environmental performance index in Sub-Saharan Africa.

Key words : Trade Openness, Energy, Technology, Population, Environmental Performance Index.

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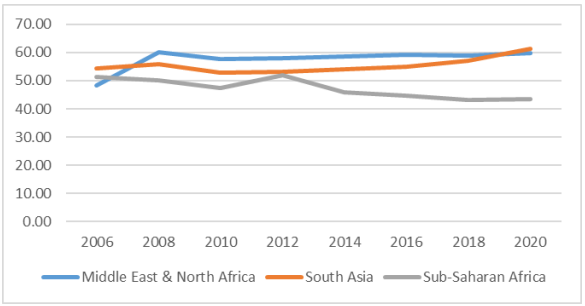
INTRODUCTION

Global trade which is now increasingly widespread has given rise to a new term, namely trade openness. Trade openness illustrates the disappearance of barriers to trade in the form of tariffs and non-tariffs and how tight a country's trade relations are with the outside world. In theory, trade openness is the amount of imports and exports normalized by GDP (Alotaibi and Anil, 2014). The World Trade Organization, the International Monetary Fund and the World Bank continue to direct, especially to developing countries to accelerate the trade liberalization process in order to achieve high economic growth. The Washington Consensus idea also states that trade openness is one of the efforts to improve a country's economy.

Trade openness and the environment often do not go hand in hand. The two are mutually contradictory conditions. When one shows its existence, the other must be sacrificed. The current world economic order which is pro-industrialization is often regarded as the cause of environmental damage. This is because most of the support for the global economy involves goods that are directly derived from the global resource base (Anna, 2007).

The increasingly complex production and economic activities today also increase the complex problems in the environment. The environment is not only measured by air quality, but also by water and soil quality. So, if you want to measure the environment, it is necessary to have a complex indicator that measures all aspects. The Yale Center for Environmental Law and Policy together with Columbia University (Center for International Earth Science Information Network) in collaboration with the World Economic Forum and the Joint Research Center of the European Commission developed an indicator called the Environmental Performance Index. This Environmental Performance Index is derived from a data set that measures four core indicators, namely air quality, water, greenhouse gas emissions, and land protection which is then further elaborated into 29 indicators on 11 environmental issues. Based on Figure 1. Environmental performance indices in two developing countries, namely Middle East & North Africa and South Asia, have shown an increasing movement every year. However, the problem occurs in Sub-Saharan Africa which is still decreasing every year.



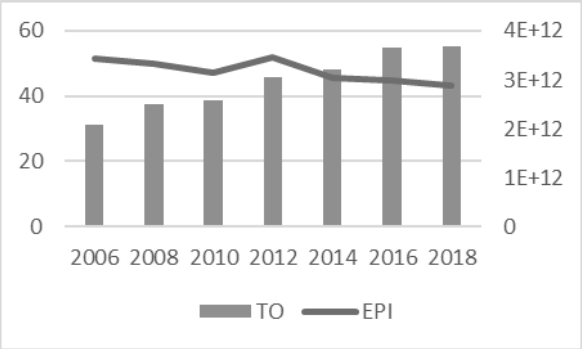
Source: Socioeconomic Data and Applications Center (SEDAC), 2020

Figure 1. Environmental Performance Index of Developing Countries

According to Sun et al. (2020), countries in Sub-Saharan Africa have established AfCFTA (African Continental Free Trade Area) to facilitate trade between their member countries, aiming to build a continental market for goods and services. This is also expected to expand trade integration between African countries which will later expand the economy. This expansion of trade cooperation shows the increasingly open trade in Sub-Saharan Africa and on the other hand causes environmental damage in Sub-Saharan Africa which is marked by a decrease in the environmental performance index every year as shown in Figure 2 below.

Exports of natural resources for developing countries tend to be profitable because they are able to bring in foreign exchange, but on the other hand developing countries that continuously export their natural resources will be prone to environmental damage, as happened

in Sub-Saharan Africa. This is in line with the classical international trade theory, namely the theory of absolute and comparative advantage. Sub-Saharan Africa has a comparative and absolute advantage in terms of its Natural Resources, in this case the sources of oil and natural gas. Based on the Heckscher-Ohlin theory, the production function of a country will tend to export commodities that are relatively intensive in using the relatively large number of factors of production because the factors of production are abundant and cheap. Therefore,



Source: World Development Index and SEDAC, 2020

Figure 2. Trade Openness and Environmental Performance Index Sub-Saharan Africa

In addition, regulations on environmental policies in Sub-Saharan Africa also tend to be weak. The Pollution Haven Hypothesis (PHH) explains that dirty industry can shift from developed countries to developing countries to exploit the benefits of relatively cheaper labor and less stringent environmental regulations. Copeland & Taylor (2013), also stated that gross industrial migration shifts the burden of pollution from the consumption of developed countries to developing countries such as Sub-Saharan Africa. In the Material Balance Model theory, the energy produced in the production sector in a company does not consume all the products supplied. They have waste called residue which is an unwanted by-product of production activities. This unwanted waste or residue is returned to the environment. Thus, there is a constant flow of residue from the production and consumption sectors back into the environment. Thus, Thai (2016), in his research says that energy has a negative influence on environmental quality in developing countries.

IPAT theory (Impacts of Population, Affluence, and Technology) as well as Cornucopian Optimistic Theory, explain that when economic growth in developing countries has succeeded in increasing, it will be followed by technological innovation of the population to carry out clean production so that it will improve environmental quality. So that technology will have a positive effect on environmental quality in developing countries. IPAT theory and Malthus theory also explain the influence of population on the environment. In these two theories, it is explained that population is the biggest negative influence on environmental quality.

Reduction of environmental problems through technological means or economic means such as rising fuel prices, introduction of taxes to limit the consumption of fossil fuels are the two main ways that previous studies have provided. However, these policies and innovations may have growth consequences although they may reduce environmental problems. A possible potential solution is to be able to adjust the factors that might affect the environmental performance index. However, this can only be done if there is an established relationship among the influencing factors. Based on the explanation above, the purpose of this study is to analyze the effect of trade openness, energy, technology, and population on the environmental performance index in Sub-Saharan Africa.

METHOD

This type of research is a quantitative research using panel data regression analysis tool. Based on classical and modern international trade theory, Neo Malthusian Pessimistic, Pollution Haven Hypothesis, Cornucopian Optimistic, and IPAT theory, the independent variables of this study are TO(X1), Energy(X2), Techno(X3), and Pop(X4). The dependent variable is the Environmental Performance Index (Y). The data used in this study uses biennial data sourced from the World Bank website and the Socioeconomic Data and Application Center (SEDAC). This study uses the Environmental Performance Index as an indicator of environmental variables. The Yale Center for Environmental Law and Policy has developed an environmental performance index using indicators from 11 environmental issues which are further translated into about 30 different indicators each year. However, to maintain the consistency of the data that the authors use, the authors use the same 11 indicators each year. Then the data that has been collected is calculated using Microsoft Excel software using the following formula (Hersandi, 2015):

Environmental Performance Index (Σi) = 1 WiPi (1)

K = number of proposed criteria
Wi = weight of each criterion.
Pi = Percentage of Bapedal Standard Deviations with Analysis Results
Pi formula:
Pi = (standard-analysis) / standard x 100% (2)

RESULTS AND DISCUSSION

In the Chow test, the F-statistical value is greater than the p-value of 5%. This means rejecting H1 and accepting Ho so that the best model in the Chow test is the CEM (Common Effect Model) model. In the Lagrange Multiplier test, the F-statistic value is greater than the p-value of 5%. Thus rejecting Ho and accepting H1, which means the REM model (Random Effect Model) was chosen as the best model in the Lagrange Multiplier test. In the Hausman test, the F-statistic value is 1.0000 so that H1 is rejected and H1 is accepted. So that the best model for the Hausman test is the REM (Random Effect Model) model. Two of the three tests that have been conducted chose REM (Random Effect Model) as the best model. So it can be concluded that the best regression model in this study is the Random Effect Model.

Table 1. Regression Model Selection Results

Test	F-Stat	Hypothesis and Result
Chow Test	1.0000	Ho: CEM is the best model (p-value > 5%)
		H1: FEM is the best model (p-value < 5%)
		Result: H1 rejected, CEM is the best model
LM Test	26.28571	Ho: CEM is the best model (p-value > 5%)
	(0.0000)	H1: REM is the best model (p-value < 5%)
		Result: Ho rejected, REM is the best model
Hausman Test	1.0000	Ho: REM is the best model (p-value > 5%)
		H1: FEM is the best model (p-value < 5%)
		Result: H1 rejected, REM is the best model

Test	F-Stat	Hypothesis and Result
Conclusion	Two of the three tests chose REM, so the best model in this model is REM.	

Source: Processed Data, 2022

A probability value of less than 5% alpha, this indicates that the independent variables in this study consisting of trade openness, energy, technology, and population together have a significant effect on the dependent variable, namely the environmental performance index. The F test was conducted to determine the joint effect of the independent variable on the dependent variable. The results of the F test in this study are

Table 2. F-Test Results

F-Stat	Probability	Conclusion
1085.157	0.000000	Significant

Source: Processed Data, 2022

The R squared test is used to determine how much the independent variable affects the dependent variable. The value of the coefficient of determination (R2) lies between 0 to 1. If the coefficient of determination is 0 it means that the independent variable has absolutely no effect on the dependent variable. However, if the coefficient of determination is getting closer to one, it can be said that the independent variable has an effect on the dependent variable. The results of the R2 test in this study are as follows:

Table 3. R2 Test Results

R-squared	Adjusted R-square
0.922826	0.921975

Source: Processed Data, 2022

Based on the results of the R-squared test above, in this study R2 is worth 0.922826 and the adjusted R-squared is 0.921975. This indicates that the independent variables in this study consisting of trade openness, energy, technology, and population have an effect of 92.28% on the dependent variable, namely the environmental performance index. While the remaining variable of 7.72% is explained by other variables outside this model.

The equations of the results obtained in the Random Effect Model regression model in this study are as follows:

EPI = -0.014815TO - 0.267821Energy + 0.354223logTechno -5.187370logPop + eit (3)

EPI = environmental performance index
TO = trade openness
Energy = energy
logTechno = technology
logPop = population
eit = error

Based on the results of panel data regression estimation, trade openness (TO) has a significant negative effect on the environmental performance index of Sub-Saharan Africa with a coefficient value of -0.014. This means that if trade openness in Sub-Saharan Africa increases by 1%, the environmental performance index in Sub-Saharan Africa will decrease by 0.014%, and vice versa. The energy variable in this study has a coefficient value of -0.267 which indicates that energy has a negative and significant effect on the environmental performance index in Sub-Saharan Africa. If energy use in Sub-Saharan Africa increases by 1% then the environmental performance index in Sub-Saharan Africa will decrease by 0.267% and vice versa. The technology variable has a coefficient value of 0, 354 which indicates that technology in Sub-Saharan Africa has a positive and significant effect on the environmental performance index. Every 1% increase in high technology exports will result in an increase of 0.354% in the

environmental performance index, and vice versa. The population variable has a coefficient value of -5,187, this indicates that the population in Sub-Saharan Africa has a negative and significant effect on the environmental performance index. If the population increases by 1% then the environmental performance index in Sub-Saharan will decrease by 5.187%. The population variable has a coefficient value of -5,187, this indicates that the population in Sub-Saharan Africa has a negative and significant effect on the environmental performance index. If the population increases by 1% then the environmental performance index in Sub-Saharan will decrease by 5.187%. The population variable has a coefficient value of -5,187, this indicates that the population in Sub-Saharan Africa has a negative and significant effect on the environmental performance index. If the population increases by 1% then the environmental performance index in Sub-Saharan will decrease by 5.187%.

International trade has an impact on environmental performance indices that vary according to their comparative advantages (Le et al, 2016). Developing countries such as Sub-Saharan Africa are relatively labor-abundant and therefore must export labor-intensive (net) goods. This is the opposite of what happens in developed countries. They are especially relatively rich in capital so that what is exported is capital-intensive goods (polluters). The same thing is supported by the findings of Copeland & Taylor (2013), who say that gross industrial migration shifts the pollution burden from the consumption of developed countries to Sub-Saharan Africa, thereby reducing pollution in developed countries. This is in accordance with The Pollution Haven Hypothesis which states that when developed countries with large industries try to set up factories abroad.

The Neo Malthusian Pessimistic Perspective explains the limitations of planet Earth. There are ecological and natural limits to economic growth. Earth is finite, closed, and does not grow. This means that Sub-Saharan Africa cannot carry out global trade by increasing the production of goods and services using natural resources and dumping the waste generated in the production process into the biosphere forever (Katar & Anil, 2007). Subair (2015), in his writings said that based on the Malthusian Pessimistic, international trade in Sub-Saharan Africa which always exports natural resources will pose a threat in the form of depletion of the ozone layer and global warming so that it will reduce the value of the environmental performance index.

Sun et al. (2020), say that the economy of Sub-Saharan Africa is dependent on the production and export of natural and agricultural resources. Some countries such as Ghana and Nigeria have rich oil reserves which have opened them up to foreign investment and business, thus contributing greatly to their economies. Trade between countries has increased substantially in Sub-Saharan Africa thereby increasing free trade with the emergence of the General Agreement on Tariffs and Trade (GATT). Sub-Saharan African countries also formed AfCFTA (African Continental Free Trade Area) which aims to develop a common continental market for goods and services. It is hoped that the enhanced trade integration between countries can generate substantial economic benefits for the country. On the other hand, when Sub-Saharan African countries signed this trade agreement resulted in a decrease in the value of the environmental performance index due to an increase in carbon dioxide (Sun et al., 2020). This is due to the absence of proper regulation.

Copeland (2013) and Farhani et al. (2014), say that the effect of trade openness on the environmental performance index can be explained using composition effects, scale

effects, and technical effects. On the scale effect, trade openness in Sub-Saharan Africa has a negative effect on the environmental performance index due to an increase in trade activity which increases production. This increase in production and consumption causes a decrease in the environmental performance index. The composition effect explains that the environmental performance index depends on changes in the number of goods produced. The amount of production changes when demand changes, if the demand for goods produced by the pollutant method, the value of the environmental performance index will be lower. The environmental effects can be positive or negative depending on the trade specialization and the technique used. The engineering effect shows that technological developments lead to changes in the effect of production on the environmental performance index. This illustrates the effect of the environmental performance index of transferred skills and creative manufacturing practices as profits and trade increase. With free trade, the transition of new and more environmentally friendly technologies with more energy efficient processing methods will lead to lower environmental performance index values. Engineering effects can also represent technological advances that lead to a more serious decline in the value of the environmental performance index. The engineering effect shows that technological developments lead to changes in the effect of production on the environmental performance index. This illustrates the effect of the environmental performance index of transferred skills and creative manufacturing practices as profits and trade increase. With free trade, the transition of new and more environmentally friendly technologies with more energy efficient processing methods will lead to lower environmental performance index values. Engineering effects can also represent technological advances that lead to a more serious decline in the value of the environmental performance index. The engineering effect shows that technological developments lead to changes in the effect of production on the environmental performance index. This illustrates the effect of the environmental performance index of transferred skills and creative manufacturing practices as profits and trade increase. With free trade, the transition of new and more environmentally friendly technologies with more energy efficient processing methods will lead to lower environmental performance index values. Engineering effects can also represent technological advances that lead to a more serious decline in the value of the environmental performance index. This illustrates the effect of the environmental performance index of transferred skills and creative manufacturing practices as profits and trade increase. With free trade, the transition of new and more environmentally friendly technologies with more energy efficient processing methods will lead to lower environmental performance index values. Engineering effects can also represent technological advances that lead to a more serious decline in the value of the environmental performance index. This illustrates the effect of the environmental performance index of transferred skills and creative manufacturing practices as profits and trade increase. With free trade, the transition of new and more environmentally friendly technologies with more energy efficient processing methods will lead to lower environmental performance index values. Engineering effects can also represent technological advances that lead to a more serious decline in the value of the environmental performance index.

Ozturk & Eventvci (2013), in their research in Turkey, found a positive and significant relationship between CO_2 and trade openness,

while Boutabba (2014), showed that trade openness had a negative effect on CO_2 levels in India. In addition, many studies have found a relationship between CO_2 emissions and trade openness with contradictory results (Jalil, 2011). A unidirectional causality running from trade openness to CO_2 emissions was also identified by Omri et al. (2015), using instrumental variables, Managi et al. (2012), measure the aggregate effect of trade on environmental quality. The findings reveal that foreign trade reduces pollution in developing economies, with the opposite response in developed countries: these changes are attributed to the scale and composition of trade impacts.

Ben Jebli et al., (2016), and Dong et al., (2018), found that in Sub-Saharan Africa, the energy sector is poorly regulated and renewables are consumed the least and are barely managed. more than 90% of the countries in their sample are noted to use non-renewable energy, which induces substantially carbon emissions. This shows that the sustainable use of fossil fuel energy for commercial purposes has achieved exponential growth among countries in Sub-Saharan Africa compared to the use of natural gas; thereby contributing to carbon emissions. In addition, and to some extent, the increasing use of more non-renewable energy and the absence of substituted energy in Sub-Saharan Africa appears to be the most prominent challenge to improve its environmental performance index, a situation that deserves attention. Analysts and international institutions suggest the use of renewable energy (Africa Progress Report, 2016; & Shahbaz et al., 2017). The Africa Progress Panel (2016), notes that renewable energy can be used to reduce the adverse effects of climate change which in turn will increase the value of its environmental performance index and more importantly encourage economic growth.

Avom et al (2020), found that technology in Sub-Saharan Africa has a significant positive effect on carbon emissions. In his research, if there is a 1% increase in technology, it will increase carbon emissions by 0.0358%. This happens because of the inefficiency of energy use in the technological equipment. Park et al., (2018), in their research use the use of the internet to measure technology variables. In his research, the internet significantly contributes to carbon emissions in Belgium, Bulgaria, Finland, and Poland. Lee and Brahmasrene (2014) found that 1% of telecommunications technology will increase 0.66% of carbon emissions in ASEAN countries.

Asongu et al., (2017), in their research show that the environmental performance index value in Sub-Saharan Africa decreases monotonically with increasing penetration of information and communication technology. The increasing penetration of information and communication technology in Sub-Saharan Africa coupled with the inefficient use of energy and the heavy dependence of certain countries on fossil fuels for electricity have caused the environmental performance index in Sub-Saharan Africa to worsen. Asongu et al., (2017), also show that technology has an indirect positive effect on CO_2 emissions through its effects on energy consumption and financial development and a negative indirect effect through trade openness in Sub-Saharan Africa.

Malthus said that humans will be the main cause of environmental damage and a sharp decline in the value of the environmental performance index. Malthus predicted what was known as Neo Malthusian, in which humans would ignore the capacities of the environment, then the world would be plagued by hunger and disease. (De Sherbinin et al., 2007). Malthus emphatically stated that the increase in population would be greater than nature's ability to feed. Malthus gave a bleak picture of the future of mankind, but Malthus provided two solutions to his postulates. Mechanism of

preventive and positive check. Prevention of population growth in Sub-Saharan Africa can be done voluntarily at the individual level by organizing pregnancy. The number of children must be matched with economic capacity to maintain the quality of life in Sub-Saharan Africa. A positive check is an automatic consequence when a preventive check fails. When families do not regulate births then starvation, death and even war will become mechanisms that reduce population numbers. Malthus further stated that the positive check mechanism would be more common in lower-class communities such as Sub-Saharan Africa, where infant mortality is high and health quality is low (Bremner et al., 2010).

Cornucopian believes that the earth has an abundance of wealth that can support human needs. Cornucopian admits that there will indeed be a decline in some natural resources, due to the increasing use of natural resources by humans. However, Cornucopian argues that humans will find ways to solve problems that occur, humans have the ability to find innovations. When there is a scarcity of natural resources, humans will find substitute resources. Cornucopian views that the decline in the value of the environmental performance index is not caused by the human population, whether due to the number, rate or distribution.

CONCLUSION

Openness to trade, energy, and population have a positive and significant influence on the environmental performance index in Sub-Saharan Africa. Meanwhile, technology has a negative and significant effect on the environmental performance index in Sub-Saharan Africa. The research suggestion is that Sub-Saharan African economies should develop and enforce efficient laws and policies to prevent or reduce environmental pollution while supporting sustainable growth. As an environmental problem reduction initiative that will be implemented in the energy sector, companies and organizations must use renewable energy sources to increase the adoption of energy-efficient technologies. Governments of Sub-Saharan African countries should encourage companies to use environmentally friendly technologies, and shifting from short life cycle products and conventional technology equipment to more modern technologies. Prevention of population growth in Sub-Saharan Africa is done by regulating pregnancy.

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