Is Trade Good or Bad for the Environment?

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Abstract
The study adds to the argument of whether trade is good or bad for the environment by looking at the impact of trade on the environment in the presence of the level of income as a moderating variable, using both the EKC and the pollution haven hypothesis. The study used both the OLS and IV because OLS estimates rely on all of the natural variations that exist across the entire sample, while IV estimates are derived only from the variation attributable to the (exogenous) instrument. The study discovered that trade reduces SO_2 micrograms per cubic meter among the countries selected for the study. The study found a similar result with the OLS when using IV, but the difference is that under the OLS, trade openness (intensity) greatly affected SO_2 since it was significant at a 1% level of significance, while trade openness (intensity) moderately affected SO_2 because it was significant at a 10% level of significance. The study also found out from the pollution haven hypotheses that all countries selected, both OECD and non-OECD, are not at a trade disadvantage and rich countries do not transfer emissions to poor countries via trade advantage. The assertion that trade inspires some countries to concentrate on unclean environmental products was rejected.

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1 Introduction

Trade growth has elevated questions around the association between trade and the environment in the sense of whether a trade is beneficial to the environment. The response is not clear because the products traded will have environmental effects (Harris, 2004). The question is whether these effects increase or decrease with trade expansion. Will the association disturb the exporting country, the importing country, or the world at large? Does the environmental Kuznets curve (EKC) still hold true by examining the impact of trade on the environment for a given level of income per capita? Can the pollution haven hypothesis of comparative advantage, which states that rich countries export environmental quality to poor countries, still exist with trade? Researchers have tried to find answers to the above question over the years (see Reppelin-Hill, 1999; Muradian and Martinez-Alier, 2001; Liddle, 2001; Cole, 2003; Harris, 2004; Frankel and Rose, 2005; Neary, 2005; Khalil and Inam, 2006; Kellenberg, 2008; Korves *et al.*, 2011; Karp, 2011; McAusland and Millimet, 2013; Kreickemeier and Richter, 2013; Aklin, 2015; Cherniwchan *et al.*, 2017, Morin *et al.*, 2018, Okelele *et al.*, 2022).

Issues like ozone exhaustion, harmful wastes, acid deposition, international climate change, etc are associated with external trade. In order to address these questions, we used both the environmental Kuznets curve (EKC) and the pollution haven hypothesis to see the impact of trade on the most commonly used indicator of pollution, which is sulphur dioxide (SO_2). The study used these two theories because of the essence of the relationship between trade and the environment. Using EKC, Karp (2010), emphasized that trade is interrelated to the environment via an income effect because trade promotes growth, thus increasing income, while income, on the other hand, affects the environment. The study also used the EKC hypothesis to know the maximum turning point on the EKC graph where an increase in income will reduce environmental pollution and whether trade still affects environmental degradation using a dummy variable, which was also employed by Aklin (2015). The study used the pollution haven hypothesis to test for a comparative advantage in pollution, where openness leads to some open countries exporting pollution to other countries of the world, which was achieved in two ways. The first hypothesis is that rich countries that have a particularly high demand for environmental quality will specialize in products that can be produced cleanly, leaving poor countries to produce and sell products that require pollution. Secondly, the study adopted the pollution haven hypothesis to test whether countries that are endowed with large land area capita export "dirty" goods to countries with densely populated countries.

Numerous studies have examined the segregated impacts of trade openness on the environment. Liddle (2001) finds out that the benefits of trade can be either positive or negative on the environment, and its effects depend on a country's endowments. The pollution effects of trade are closely tied to the benefits of trade. This was also the finding of Korves *et al.* (2011) using 95 developed and developing countries from 1980–2004. The work by Frankel and Rose (2005) revealed that trade tends to reduce three measures of air pollution with concentrations of SO2, moderate NO2, and lack of particulate matter.

Based on the inverted-U shape of EKC, Cole (2003) argued that the inverted-U relationship between per capita income and emissions is reasonably robust and little evidence is found to suggest that trade patterns are a significant determinant of the inverted-U shape. Using a panel of 128 countries from 1990 and 1995, Kellenberg (2008) said that countries with relative world

incomes of less than 0.5 or greater than 2.5 tend to have positive trade intensity elasticities, while countries with relative world incomes of between 0.5 and 2.5 tend to have negative trade intensity elasticities.

In a country-specific study by Khalil and Inam (2006) using time series data for Pakistan's economy over the period 1972–2002, they found that long-run relationships existed among the variables, indicating that spreading trade on a global level is harmful to environmental quality for developing countries because developed countries transfer their worse technology to the developing nations. McAusland and Millimet, (2013) find out international trade to be more environmentally beneficial than intranational trade due to a stronger decoupling effect and both intra and international trade to be pro-environment unless substitution effects are sufficiently strong.

The study, therefore, is set to examine whether a trade is good or bad for the environment using both EKC and pollution haven hypotheses. Through EKC, trade is linked to the environment via the income effect and also uses the pollution haven hypotheses to test for the comparative advantage of trade among selected countries. the study used both the OLS and IV because OLS estimates rely on all of the natural variations that exist across the entire sample while IV estimates are derived only from the variation attributable to the (exogenous) instrument.

The remainder of this study is organized as follows. Section 2 covers the methodology associated with the study. Section 3 focuses on the results of the study where different analyses relating to the objective were dealt with while Section 4 deals with the conclusion of the study.

2 Methodology

This section covers the theoretical framework and model specification, description of data, source of data, and estimation techniques.

2.1 Theoretical Framework and Model Specification

The theoretical framework that we used for this research is both the environmental Kuznets curve (EKC) and the pollution haven hypothesis. The EKC was recommended by Grossman and Krueger (1991), who postulated a relationship between environmental degradation and per capita income.

$$eg = f(inc) \tag{1}$$

where *eg* is environmental degradation and *inc* is per capita income. In the early stages of economic growth, pollution emissions increase and environmental quality decline, but beyond some level of per capita income (which will vary for different indicators), the trend reverses, so that at high-income levels, economic growth leads to environmental improvement. This implies that environmental impacts or emissions per capita are an inverted *U*-shaped function of per capita income, using per capita income square (*incsqr*) to measure the *U*-shape.

$$eg = f(incsqr) \tag{2}$$

The EKC is named after Simon Kuznets who proposed that income inequality first rises and then falls as economic development proceeds. The EKC has been the dominant approach among economists to modeling ambient pollution concentrations and aggregate emissions since Grossman and Krueger (1991) introduced it. The EKC is an essentially empirical phenomenon which has led many researchers in researching in this area. According to Karp (2011), trade is sometimes linked to the environment via an income effect. Therefore, trade openness (intensity) is also the determinant of environmental degradation.

$$eg = f(pwtopen) \tag{3}$$

The indicator *pwtopen* is the trade openness (intensity) and the idea is that trade promotes growth, thus increasing income, and income affects the environment, e.g., in the manner described by the environmental Kuznets curve (EKC). The EKC, an inverted-*U*-shaped relation between income and emissions, is based on the hypothesis that scale effects dominate in the early stages of growth: As an economy begins to develop, pollution levels rise. Higher incomes increase the demand for a clean environment, leading to stricter environmental regulations. Whether higher incomes increase the demand for a clean environment, leading to stricter environmental regulation is still a subject of debate. Some economists believed that there should be a dummy variable to show this effect in a particular region and by so doing, we included a dummy variable to show this effect on the number of countries that we decided to use and this was done by Aklin (2015) where he included OPEL members in his research work. The study classified the countries into OECD members and not OECD members.

$$eg = f(oecd) \tag{4}$$

Therefore, *oecd* dummy variable will be 1 if *oecd* and 0 otherwise. If the coefficient of *oecd* is positively significant, trade still affects environmental degradation among *oecd* members and if *oecd* coefficient is negatively significant, it means that trade affects the environmental degradation of non *oecd* members. Following Frankel and Rose (2005), we adopt government policy (*polity*) and land area per capita (*lareapc*) as control variables due to their effects on trade and environmental degradation. Any region or country with a good government policy will reduce environmental degradation and vice versa.

$$eg = f(polity\ \&\ lareapc) \tag{5}$$

All five (5) equations above are combined to form the model for this research work. Sulphur dioxide (SO_2) emissions is adopted to measure environmental degradation since it is widely acceptable as an indicator of pollution. SO_2 is emitted when fuels containing Sulphur are combusted and it is a pollutant that contributes to acid deposition, which, in turn, can lead to potential changes in soil and water quality. The model is presented in equation (6) below;

$$eg = f(inc, incsqr, pwtopen, oecd, polity\ \&\ lareapc) \tag{6}$$

where *sulfdm* is SO_2 emission, *inc* is the logarithm of real per capita *GDP*, *incsqr* is squared value of the log of real per capita GDP, *pwtopen* is trade openness (intensity), *oecd* is dummy variable which is 1 for OECD countries, and 0 otherwise, the *polity* is government policy and *lareapc* is

the logarithm of land area per capita. The linear regression model that we established in this research work is given below in equation (7).

$$sulfdm = \pi + \alpha inc + \beta incsqr + \varphi pqtopen + \delta oecd + \gamma polity + \omega lareapc + \mu \quad (7)$$

The focus of the model in equation (7) is on the coefficient of φ which shows the impact of trade openness (intensity) on Sulphur dioxide which is our measure of environmental degradation. Also, we use this model to show the inverted *U-she* between real per capita *GDP* and Sulphur dioxide and it is expected that α to be positive and to be β negative. By so doing, per capita income will have a maximum turning point if ($-\alpha/2\beta$).

The pollution haven hypothesis is also adopted to test comparative advantage in pollution where openness leads to some countries exporting pollution to other countries of the World. The study will test this hypothesis in two ways. The first hypothesis is that rich countries that have a particularly high demand for environmental quality will specialize in products that can be produced cleanly leaving poor open countries to produce and sell the products that require pollution. The study multiplied per capita income with openness and incorporate it into the model. This is presented in equation (8) below.

$$sulfdm = \pi + \alpha inc + \beta incsqr + \varphi pqtopen + \delta oecd + \gamma polity + \varphi lareapc + \omega inc * pwtopen + \mu \quad (8)$$

The coefficient ω is expected to be negative indicating it has a negative impact on Sulphur dioxide which in turn will show that the rich countries have a trade advantage by transferring emissions to the poor countries.

Furthermore, the study used the pollution haven hypothesis to test for the second comparative advantage if countries that are endowed with large land area per capital export dirty goods to countries with densely populated countries. The study also incorporated the variable that we used to measure this which is the multiplication of trade openness (intensity) with land area per capital.

$$sulfdm = \pi + \alpha inc + \beta incsqr + \varphi pqtopen + \delta oecd + \gamma polity + \omega lareapc + \sigma pwtopen * lareapc + \mu \quad (9)$$

Also, negative coefficient of σ indicate that rich countries have trade advantage by transferring emission to the poor countries.

2.2 Description of Data

The variables that we considered in the model and for the analysis are summarized below in Table 1.

Table 1:List of Variables

Variables	Definitions
Sulfdm	mean 1990 SO_2 concentration, in micrograms per cubic meter
Inc	logarithm of real per capita *GDP* from the Penn World Table 5.6, in 1990 *PPP*-adjusted US dollars
Incsqr	squared value of log of real per capita *GDP*
Pwtopen	*100(Imports+Exports)/GDP* from the Penn World Table 5.6
Polity	index of democratic (+10) vs. autocratic (-10) institutions
Lareapc	logarithm of land area per capita
Oecd	dummy variable which is one for *OECD* countries

Source: Author's Computation

2.3 Source of Data and Estimation Techniques

The study center on outcomes of 1990 measures of air pollution, measured as focuses in micrograms per cubic meter (simply averaged across a country's measuring stations and cities, in cases where more than one observation was available). SO_2 means sulfur dioxide. Real per capita *GDP* in 1990 measures real PPP-adjusted dollars from the Penn World Table 5.6, in 1990 *PPP*-adjusted US dollars. Trade openness (intensity) is the summation of imports and export divided by *GDP* from the Penn World Table 5.6, government policy is measured by the index of democratic (+10) vs. autocratic (-10) institutions which is extracted from the Polity IV project, land area per capita is taken from CIA's Web site and is intended to allow for the likelihood that higher population density leads to environmental degradation and *oecd* is a dummy variable for measuring *oecd* members and it will take a value of 1 if the country is a member of OECD and 0 otherwise. If the coefficient is positively significant, trade openness still affects environmental degradation among *oecd* members and if *OECD* coefficient is negatively significant, it means that trade affect the environmental degradation of non *oecd* members.

Based on the estimation techniques, we used both ordinary least squares (OLS) and instrumental variables (IV). Both OLS and IV is adopted because the OLS estimates rely on all of the natural variations that exist across the entire sample while IV estimates are derived only from the variation attributable to the (exogenous) instrument. Following Frankel and Rose (2005), the study adopted *elhsfs*, *incfs* and *incfsq* as the instrument for trade openness (intensity), per capita income, and squared value of per capita income.

Table 2: List of Countries included in the Sample

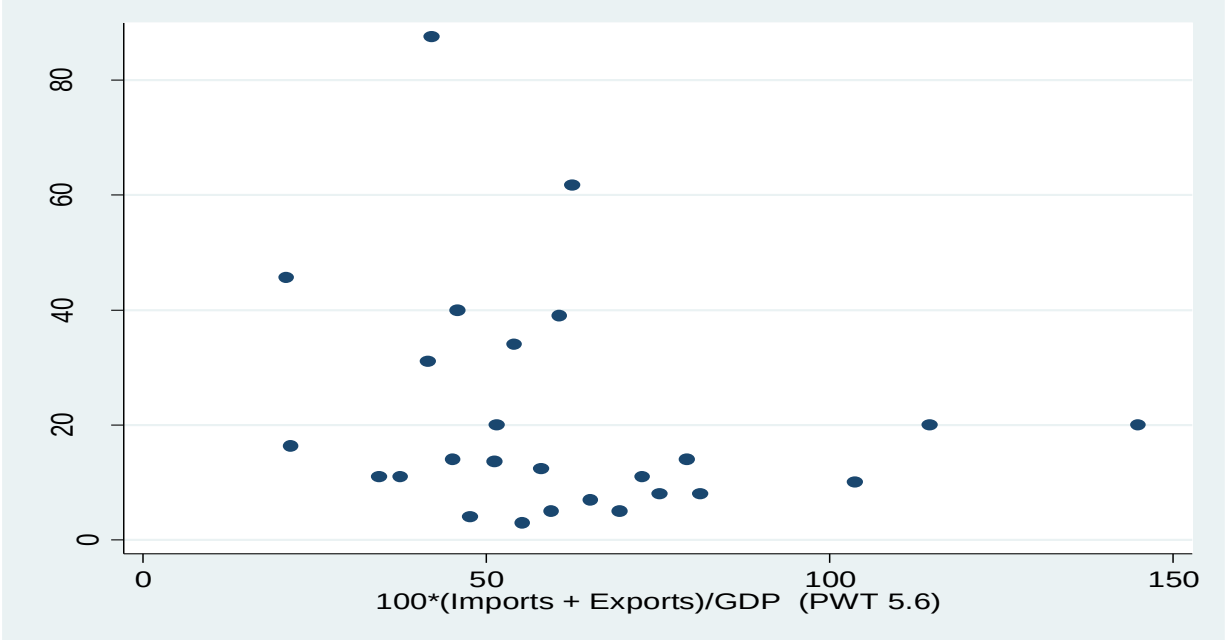
OECD Countries	Non OECD Counties
Australia	Bulgaria
Austria	Brazil
Belgium	Chile
Canada	China
Switzerland	Ecuador
Germany	Egypt Arab Rep.
Denmark	India
Spain	Iran Islamic Rep.
Finland	Mexico
France	Malaysia
United Kingdom	Philippines
Greece	Singapore
Hungary	Thailand
Ireland	Venezuela
Iceland	South Africa
Italy	
Japan	
Korea Rep.	
Netherlands	
Norway	
New Zealand	
Poland	
Portugal	
Sweden	
Turkey	
United States	

Source: Author's Computation

3 Results

Figure 1 shows the relationship between SO_2 and trade openness (intensity) concentration in OECD and non-OECD members. The study showed how institutions whether democratic or autocratic via her government policy were able to intermediate between SO2 concentration through trade openness (intensity) were regulated.

Figure 1
SO_2 versus Measure of Trade Openness (Intensity) Concentration in OECD and Non OECD



Source: Author's Computation

In Table 3, the study presented the summary statistics to give insights into the nature and features of the variables. The dependent variable, SO_2 hovers around 3 micrograms per cubic meter and 209 micrograms per cubic meter with a standard deviation of 37.991 micrograms per cubic meter. They showed that at least one of the countries that we selected recorded lower micrograms per cubic meter of 3 while the country with the highest SO_2 recorded 209 was the highest micrograms per cubic meter. On the average, 33.214 micrograms per cubic meter was the SO_2 emitted by countries. From the result, the average growth of per capita *GDP* within the period that we selected was 8.886% indicating that the real per capita for the countries that we selected grow by 8.886% on average during the period. Furthermore, the minimum and maximum values of real per capita *gdps* were 7.142% and 9.801% with a standard deviation of 0.755%. The average value of squared value of real per capita *GDP* was 79.515% suggesting that the average squared value of real per capita *GDP* stood at 79.515% during the period and as a matter of fact, the squared value of real per capita *GDP* is within its minimum and maximum value. Besides, the minimum and maximum with standard deviation values are 51.009%, 96.062%, and 13.011% respectively. The mean value of trade openness (intensity) was 68.398 dollars on average which is within the minimum and maximum values. In addition, the minimum and maximum values of 12.66 dollars and 373.26 dollars with a standard deviation of about 57.944 dollars during the period. Focusing on the index of democratic vs. autocratic, the study noted that the mean value was 7.341 indicating a strong democratic regime in the selected countries. Therefore, most countries are more democratic nations than autocratic. As seen in Table 3, the average value of land area per capita of the selected countries was 2.728 meaning that the land area per capita grows by 2.728% the age. This shows that the selected countries are developing by 2.728% yearly. The study also showed from the outcomes that there are more OECD members than non-OECD members. OECD members represents 63.4% of the selected countries while the remaining are non-OECD members.

Table 3:Summary Statistics

Variables	Mean	Std. Dev.	Min.	Max.	Obs.
sulfdm	33.214	37.991	3	209	41
Inc	8.886	0.755	7.142	9.801	41
Incsqr	79.515	13.011	51.009	96.062	41
Pwtopen	68.398	57.944	12.66	373.26	41
Polity	7.341	4.591	-7	10	41
Lareapc	2.728	1.481	-1.489	6.102	41
Oecd	0.634	0.488	0	1	41

Source: Author's Computation where SO_2 is sulfur dioxide, *inc* is real per capita *GDP* as 1990, *incsqr* is squared value of real per capita *GDP* as 1990, *pwtopen* is trade openness (intensity), *Polity* is index of democratic vs. autocratic, *lareapc* is land area per capita and *oecd* is a dummy variable for measuring *oecd* members and it will take a value of 1 if the country is a member of OECD and 0 otherwise.

The study presented the results of equation (7) in Table 4 by using both OLS and IV. The interest of our study is the coefficient φ which shows the impact of trade openness (intensity) on SO_2 and it has the expected sign of negative which is significant. This by implication means that trade openness (intensity) has a negative significant effect on SO_2. By implication, a percentage increase in trade openness (intensity) by a dollar, decreases SO_2 by 0.288 micrograms per cubic meter. Therefore, openness (intensity) to trade reduces SO_2 micrograms per cubic meter among the countries we have selected for our study. Also, the coefficients of both real per capita GDP and squared value of real per capita confirmed the existence of the EKC hypothesis in our study. They both have the expected signs. Real per capita GDP has a positive significant effect on SO_2 while the square value of real per capita GDP has a negative sign on SO_2. The inverted U-shaped is in place among the countries selected which is in line with the proposition of the EKC hypothesis that as per capita income increases, countries tend to produce clearer energy. Therefore, a dollar increase in real per capita income will result in an increase of 287.764 micrograms per cubic meter but as the income increases further in the dollar, SO_2 will decrease by 16.78% micrograms per cubic meter. Also, the maximum turning point on the EKC graph where an increase in income will reduce environmentally bad energy to environmentally friendly is 8.57 micrograms per cubic meter. Based on the variable on the impact of the institution on SO_2, we found out that the presence of the institution in formulating good policy relating to how environmental bad energy can be reduced to bring about a reduction in SO_2 by 6.739 micrograms per cubic meter. Also, land area per capita has a negative insignificant effect on SO_2 indicating that an increase in land area capita will reduce SO_2 by 2.456 micrograms per cubic meter while the study found out that the OECD coefficient is positive but insignificant which mean that trade does not affect environmental degradation among OECD members.

Also, from the IV result, we found a similar result with the OLS however the difference is that under OLS, trade openness (intensity) greatly affects SO_2 since it is significant at a 1% while trade openness (intensity) moderately affects SO_2 with 10% level of significance. The study interest coefficient φ also has the expected sign of negative implying that a dollar increase in trade openness (intensity) brings about a 0.214 micrograms per cubic meter decrease in SO_2. The selected countries' trade openness (intensity) reduces energy that are environmentally unfriendly among selected countries. The IV result also affirmed the EKC hypothesis that inverted U-shaped exist among members with a maximum turning point of 8.14 micrograms per cubic meter. Both

real per capita and squared value of real per capita have positive and negative significant impacts on SO_2 respectively. Institution and land area per capita were also insignificant with a negative impact on SO_2. The study found that both will reduce SO_2 among selected countries by 7.752% and 0.256% respectively. Activities of government by enacting good policy on the environment will curb environmental bad energy and bring about good energy in the environment. The study findings are in line with the finding of Frankel and Rose (2005) and Aklin (2015) who also confirmed that trade openness (intensity) reduces environmental degradation and the existence of the EKC hypothesis.

Table 4: Determinants of SO_2

Variables	**OLS**	**IV**
	SO_2	**SO_2**
Inc	287.764	266.210
	(0.023)**	(0.025)**
Incsqr	-16.782	-16.35
	(0.022)**	(0.017)**
pwtopen	-0.288	-0.214
	(0.003)***	(0.054)*
Polity	-6.739	-7.752
	(0.000)***	(0.000)***
lareapc	-2.456	-0.256
	(0.429)	(0.942)
Oecd	6.485	40.659
	(0.646)	(0.187)
_cons	-1117.597	-986.660
	(0.038)**	(0.054)***
Observations	41	40
R^2	0.678	0.643
Adj. R^2	0.622	
F(6, 34)	11.95	
Prob > F	(0.000)***	
Wald chi2(6)		78.14
Prob. > chi2		(0.000)***
Maximum turning point	8.57	8.14
*** $p<0.01$, ** $p<0.05$, * $p<0.1$		

Source: Author's Computation where SO_2 is sulfur dioxide, *inc* is real per capita *GDP* as 1990, *incsqr* is squared value of real per capita *GDP* as 1990, *pwtopen* is trade openness (intensity), *Polity* is index of democratic vs. autocratic, *lareapc* is land area per capita and *oecd* is a dummy variable for measuring *oecd* members and it will take a value of 1 if the country is a member of OECD and 0 otherwise.

The study presented determinants of SO_2 with comparative advantage hypothesis 1 using both OLS and IV in Table 5 by testing the pollution haven hypothesis. The study multiplied per capita income with trade openness (intensity). The hypothesis is that a negative coefficient (ω) implies that rich countries transfer emissions to poor countries through trade advantage but we found out that the coefficients for both OLS and IV were positive and significant with 0.348 and 0.378 suggesting that rich countries do not transfer emission to poor countries through trade advantage.

This means that trade is not disadvantageous to both OECD and non-OECD member countries selected for this study.

Table 5:Determinants of SO_2 with Comparative Advantage Hypothesis 1

Variables	**OLS**	**IV**
	SO_2	**SO_2**
Inc	371.872	353.641
	(0.005)***	(0.002)***
Incsqr	-22.611	-22.200
	(0.004)***	(0.001)***
pwtopen	-3.501	-3.734
	(0.004)***	(0.018)**
Polity	-6.387	-7.161
	(0.000)***	(0.000)***
lareapc	-1.595	-0.019
	(0.597)	(0.995)
Oecd	3.294	27.797
	(0.810)	(0.323)
*inc*pwtopen*	0.348	0.378
	(0.063)*	(0.026)**
_cons	-1398.708	-1287.127
	(0.011)**	(0.007)*
Observations	41	40
R^2	0.711	0.643
Adj. R^2	0.649	
F(6, 34)	11.59	
Prob > F	(0.000)***	
Wald chi2(6)		100.19
Prob. > chi2		(0.000)***
*** p<0.01, ** p<0.05, * p<0.1		

Source: Author's Computation where SO_2 is sulfur dioxide, *inc* is real per capita *GDP* as 1990, *incsqr* is squared value of real per capita *GDP* as 1990, *pwtopen* is trade openness (intensity), *Polity* is index of democratic vs. autocratic, *lareapc* is land area per capita and *oecd* is a dummy variable for measuring *oecd* members and it will take a value of 1 if the country is a member of OECD and 0 otherwise.

To test the second hypothesis of comparative advantage, we used the pollution haven hypothesis to confirm whether countries that are endowed with large land area per capital export dirty goods to countries with densely populated countries. the study presented this under Table 6 by incorporating the multiplication of trade openness (intensity) with land area per capita. The coefficient (σ) must be negative and significant to conclude that rich countries have a trade advantage by transferring emissions to the poor countries. However, it was negative and insignificant with -0.029 and -0.062 for both OLS and IV. This implies that rich countries do not transfer emissions to poor countries via trade advantage.

Table 6:Determinants of SO_2 with Comparative Advantage Hypothesis II

Variables	**OLS**	**IV**
	SO_2	**SO_2**
Inc	302.616	287.136
	(0.019)**	(0.021)**
Incsqr	-17.736	-18.080
	(0.018)**	(0.012)**
Pwtopen	-0.287	-0.184
	(0.003)***	(0.121)
Polity	-6.478	-7.621
	(0.000)***	(0.000)***
Lareapc	-0.413	4.934
	(0.919)	(0.339)
Oecd	7.572	56.675
	(0.596)	(0.102)
*pwtopen*lareapc*	-0.029	-0.062
	(0.435)	(0.134)
-cons	-1177.665	-1053.55
	(0.032)**	(0.049)**
Observations	41	40
R^2	0.684	0.613
Adj. R^2	0.617	
F(6, 34)	10.22	
Prob > F	(0.000)***	
Wald chi2(6)		73.98
Prob. > chi2		(0.000)***
*** p<0.01, ** p<0.05, * p<0.1		

Source: Author's Computation where SO_2 is sulfur dioxide, *inc* is real per capita *GDP* as 1990, *incsqr* is squared value of real per capita *GDP* as 1990, *pwtopen* is trade openness (intensity), *Polity* is index of democratic vs. autocratic, *lareapc* is land area per capita and *oecd* is a dummy variable for measuring *oecd* members and it will take a value of 1 if the country is a member of OECD and 0 otherwise.

4 Conclusion

Trade can affect the environment in diverse ways. The study examined whether a trade is good or bad for the environment using both EKC and pollution haven hypotheses. Through EKC, trade is linked to the environment via the income effect and also uses the pollution haven hypotheses to test for the comparative advantage of trade among selected countries. the study used both the OLS and IV because OLS estimates rely on all of the natural variations that exists across the entire sample while IV estimates are derived only from the variation attributable to the (exogenous) instrument.

The study discovered that trade reduces SO_2 micrograms per cubic meter among the countries we have selected for the study trade openness (intensity) has a negative significant effect on SO_2 micrograms per cubic meter. This finding indicated that trade is good for the environment and the hypothesis of an international race to the bottom driven by trade was rejected. We also found out from the pollution haven hypotheses that all countries selected both OECD and non-OECD members are not at a trade disadvantage and rich countries do not transfer emissions to poor

countries via trade advantage. Therefore, the assertion that trade inspires some countries to concentrate on unclean environmental products was rejected.

The study found among others that both real per capita GDP and squared value of real per capita confirmed the existence of the EKC hypothesis by having the expected signs on SO_2 micrograms per cubic meter and the maximum turning point on the EKC graph where an increase in income will reduce environmental bad energy was 8.57 micrograms per cubic meter. Also, the study finds out that the presence of institutions in formulating good policy relating to how environmental bad energy can be reduced brings about a reduction in SO_2 by 6.739 micrograms per cubic meter and the dummy variable for OECD indicated that trade does not affect environmental degradation among OECD members.

References

Reppelin-Hill, V. (1999), Trade and environment: An empirical analysis of the technology effect in the Steel Industry". *Journal of Environmental Economics and Management,* 38:3 283–301.

Muradian, R., & Martinez-Alier, J. (2001), Trade and the environment: from a "Southern" perspective. *Ecological Economics,* 36:2 281–297.

Korves, N., Martínez-Zarzoso, I., & Voicu, A. M. (2011), Is free trade good or bad for the environment? New empirical evidence. *Climate Change–Socioeconomic Effects*, 1-30.

Harris, J. M. (2004), Trade and the Environment. *Tuft University*.

Frankel, J. A., & Rose, A. K. (2005), Is trade good or bad for the environment? Sorting out the causality. *Review of economics and statistics*, 87:1 85-91.

Cherniwchan, J., Copeland, B. R., & Taylor, M. S. (2017). Trade and the environment: New methods, measurements, and results. *Annual Review of Economics*, 9:1 59–85.

Liddle, B. (2001), Free trade and the environment-development system. *Ecological Economics*, 39:1 21–36.

Neary, J. P. (2005), International trade and the environment: Theoretical and policy linkages. *Environmental & Resource Economics*, 33:1 95–118.

Cole, M. A. (2003), Development, trade, and the environment: how robust is the Environmental Kuznets Curve? *Environment and Development Economics,* 8:4 557–580.

McAusland, C., & Millimet, D. L. (2013), Do national borders matter? Intranational trade, international trade, and the environment. *Journal of Environmental Economics and Management,* 65:3 411–437.

Kreickemeier, U., & Richter, P. M. (2013). Trade and the environment: The role of firm heterogeneity. *Review of International Economics,* 22:2 209–225.

Morin, J.-F., Dür, A., & Lechner, L. (2018). Mapping the trade and environment nexus: Insights from a new data set. *Global Environmental Politics,* 18:1 122–139.

Kellenberg, D. K. (2008), A reexamination of the role of income for the trade and environment debate. *Ecological Economics,* 68:1-2 106–115.

Khalil, S., & Inam, Z. (2006), Is trade good for environment? A unit root cointegration analysis. *The Pakistan Development Review*, 45:4 1187-1196.

Karp, L. (2011), The environment and trade. *Annual Review of Resource Economics*, 3:1 397–417.

Aklin, M. (2015). Re-exploring the trade and environment nexus through the diffusion of pollution. *Environmental and Resource Economics,* 64:4 663–682.

Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement.

Okelele, D. O., Lokina, R., & Ruhinduka, R. D. (2022). Effect of Trade Openness on Ecological Footprint in Sub-Saharan Africa. *African Journal of Economic Review*, *10*(1), 209-233.