Exploring the Impact of Trading Green Products on the Environment: Introducing the Green Openness Index

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Abstract

Environmental degradation has constantly increased over the years, and has become one of the main contributors to climate change. For this reason, researchers are increasingly on the lookout for parameters that positively impact environmental quality. Green Products are widely accepted as one of the vital tools to minimize the environmental degradation. This paper introduces a new index which is called the Green Openness Index. The index represents the importance of Green Products in a region by means of a measure of trade in Green Products. This new index revisits the trade-environment nexus in a case study of 31 Economic Co-operation and Development (OECD) countries over the period 2007-2017. The empirical findings provide evidence that Environmental Kuznets Curve hypothesis is valid, by means of Fully modified and Dynamic Ordinary Least Squares regression analysis. As such, the new index also opens up a wide span of opportunities for future research, as the index can be used as explanatory variable in numerous different research questions and fields of research. Additionally, the results demonstrate that the presence of Green Products in trade reduces a country's ecological footprint. This is essential information for practitioners and policy makers involved in the design of sustainable development policies.

Keywords

Trade openness, Green Products, Environmental degradation, Index, FMOLS, DOLS

1. Introduction

Energy consumption has exploded after the industrial revolution, which elevated the quality of life of mankind. However, in addition to this positive aspect, the increased energy consumption and related greenhouse gas emissions adversely affected environmental degradation around the world, year after year (Du et al., 2019). This paper investigates the impact of "Green Products", accounting for other economic parameters, on environmental degradation. The exercise is completed for the sample of OECD countries in the context of the EKC hypothesis.

This paper provides an essential contribution to the existing body of literature. Many other scholars have addressed environmental degradation for a long time within more conventional frameworks, using straightforward explanatory variables. The Environmental Kuznets Curve (EKC) hypothesis comes first among these frameworks. Grossman and Krueger (1991) first described the inverted U relationship between environmental degradation and income (He, 2009).

In addition to income, scholars have recently discussed the impact of other parameters on the environment in the context of the EKC hypothesis. Trade is the most frequently used among of these parameters because it potentially can alter the environmental quality levels of countries (e.g. by importing more energy-efficient and environmentally friendly products (Hu et al., 2020) or import clean production technologies (Wang and Lu, 2020). In addition to trade, also economic complexity (i.e. a region's potential to produce complex products) is investigated intensively as well by for example Apergis et al. (2018) and Can and Doğan (2017).

The current paper acknowledges the importance of these conventional parameters such as income, trade and economic complexity in explaining environmental degradation. However, in addition to these parameters, the paper introduces a new important parameter by means of a measure of "Green Products". In this context, Green Products refers to a technology which increases efficiency in energy production and tries to minimize environmental damages due to energy consumption (Paramati et al., 2020). Examples of Green Products are renewable energy technologies, energy efficiency technologies, waste management technology, environmental monitoring devices, and electric vehicles. The use of these products must result in a significant increase in environmental quality (Gao and Zheng, 2017, Ling Guo et al., 2017). A report by the IEA (2013) even claims that the application of Green Products can reduce CO_2 emissions by 60%.

To the best of our knowledge, this paper will for the first time quantify the impact of Green Products on environmental degradation in a holistic way by means of an indicator, covering a large set of (OECD) countries. The analysis is completed by means of Fully modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) regression techniques. Previous studies relied upon proxy indicators to measure the importance of Green Products in a region. Examples of these proxy indicators are the environmentally adjusted multifactor productivity, patent application, technological innovations (see for example Hao et al. (2021), Ibrahiem (2020), Ali et al. (2016), Yii and Geetha (2017), Demir et al. (2020), and Paramati et al. (2020). As such, the presented analysis differs from existing studies in many ways. First, this study develops an index that shows how open countries' economies are to green trade. This is important the index allows a quantification of the impact of green trade on sustainability. The availability of this kind of information is crucial in the design of sustainability policies, as discussed by Loiseau et al. (2016).

Second, the existing body of literature rightfully assessed the impact of trade on environment but did not further distinguish green trade from conventional trade. The index presented in this paper achieves the separation of "green products" from the total export/import basket. The rationale of the proposed index is based on the "trade openness" index, which is frequently used in foreign trade. However, that trade openness index is transformed into the new "Green Openness Index". This element is crucial as the analysis will demonstrate that this approach can break the seemingly inevitable link between trade openness and increased environmental impact. This is crucial information for practitioners and policy makers seeking for solutions to achieve sustainable development strategies and sustainable energy policies (Hao et al., 2021) by opening up their countries' for green trade, and not just any type of trade.

As such, the outcomes of this paper fill a crucial gap in literature and provide opportunities to further use the index in studies on environmental degradation, (green) economy, renewable and non-renewable energy consumption, especially in the context of economic growth, unemployment, income distribution and social well-being. Moreover, the index provides a means for benchmarking economies.

The rest of the paper is organized as follows. Section 2 introduces the "Green Openness Index". Section 3 explains data and econometric approaches. Section 4 provide policy recommendation and conclusion.

2. Introducing Green Openness Index

There are different approaches to categorize a product as a green product (or not) and there is hitherto no consensus on a "green product list". While the World Trade Organization released "The Friends' List" (WTO, 2009), The Asia-Pacific Economic Cooperation (APEC, 2012) presents the “APEC List of Environmental Goods “consisting of 54 products. Simultaneously, the OECD provides the “Plurilateral agreement on environmental goods and services” list (PEGS) consisting of 150 goods. Finally, the OECD compiled the “Combined List of Environmental Goods” (CLEG). While the CLEG consists of 248 products, the Core CLEG products (CLEG+) covers 40 goods (Sauvage, 2014).

This paper presents the GOP index, which is based on CLEG+ list. The reason to use the CLEG+ list is twofold. First, the CLEG+ list combines the three existing list of environmental goods (by the WTO, APEC, and the OECD’s PEGS). As such, CLEG+ provides a combination of different environmental goods and a holistic approach in this context. Second, the CLEG+ is widely accepted and clearly defined. The latter asset facilitates the data gathering for this measure and its use as an index in explanatory analysis. The index developed on the CLEG+ list is labelled as GOPCLEG from this point onward.

Simultaneously, this paper develops a second GOP index based on the APEC list to empirically test the indexes’ robustness. This index is labeled as GOPAPEC from this point onward. The data for CLEG+ and APEC Environmental Goods are collected from UN Comtrade for every individual green product by following their HS 2007 codes and aggregated by the authors. The HS 2007 codes for CLEG+ and APEC are provided in Appendix 1 and Appendix 2, respectively. GDP values are obtained from World Bank World Development Indicator database (WDI).

The Green Openness Index (GOP) is defined by the following equation:

$$GOP_{i,t} = \left(\frac{GX_{i,t}+GM_{i,t}}{GDP_{i,t}}\right) * 100 \qquad (1)$$

In equation (1), *GX* is the current value of total green goods export to the world by reporter country *I* at time *t*. *GM* is the current value of total green goods import from the world to reporter country *i* at time *t*. GDP is the total value of goods manufactured in current year *t* in country *i*. The calculation finds a value for GOP between 0 and 100, as a percentage of GDP. The indexes are calculated on an annual basis from 2007 to 2019 for 31 OECD countries (Appendix 3). This period is determined by the data availability in UN Comtrade because of the fact that the data starts in 2007 based on HS2007.

3. Data, Empirical Methodology and Results

The aim of the empirical analysis is to assess the impact of Green Products on environmental degradation. In this rationale, the total ecological footprint per capita serves as a proxy for environmental degradation. Compared to CO_2 emissions, the environmental footprint is a better proxy for environmental degradation because the latter provides a more holistic approach to environmental degradation. In addition to the CO_2 emissions, the environmental footprint also includes built-up land, cropland, fishing grounds, forest products, and grazing land.

Following Al-Mulali et al. (2015) and Zhang et al. (2017), the EKC model is estimated as follows:

$$FP_{i,t} = f\left(GDPPC_{i,t}^{\beta_1}, GDPPC2_{i,t}^{\beta_2}, ENPC_{i,t}^{\beta_3}, GOP_{i,t}^{\beta_4},\right) + e_{i,t} \qquad (2)$$

$$FP_{i,t} = \beta_0 + \beta_1 GDPPC_{i,t} + \beta_2 GDPPC2_{i,t} + \beta_3 ENPC_{i,t} + \beta_4 GOP_{i,t} + e_{i,t} \qquad (3)$$

Where *FP*, *GDPPC*, *GDPPC2*, *ENPC*, and *GOP* represent the ecological footprint, income per capita, square of income per capita, energy consumption per capita and green openness index, respectively. In the further analysis, *GOP* is defined as GOPCLEG or GOPAPEC, depending on the used index. The data for ecological footprint per capita (FP) is obtained from the Global Footprint Network (2021), per capita income (constant 2010 US$) and energy consumption (kg of oil equivalent per capita) are sourced from World Development Indicator by World Bank (2021), respectively. The GOP is calculated by the authors as described in the previous section. Prior to the empirical section, the logarithmic form is taken for all of the variables, except the GOP.

The empirical study employs panel cointegration techniques and Granger causality test to explore the dynamic interaction between ecological footprint, income per capita and its square, energy consumption per capita and green openness index for a panel of 31 OECD countries spanning the period 2007 - 2017. No more recent data is available on the ecological footprint at present. Two models are considered in our empirical analysis depending on the introduced GOP index: The first model uses the GOPCLEG index, which is based on the OECD's CLEG+ list and consists of 40 products and calculated by following equation 1. The second model uses the GOPAPEC index, which is based on the "APEC List of Environmental Goods". The latter list contains 54 products.

First, the empirical analysis tests the presence of cross-sectional dependence of each variable in both models. In case this test finds cross-sectional dependence in residuals, the second-generation unit root tests are used to check for stationary proprieties. In this step, the existence of long-run cointegration between the variables can be computed using various statistic tests (Pedroni, 2004 and Kao, 1999). Powerful techniques of estimations such as FMOLS and DOLS are applied to investigate the effect of each estimated coefficient in ecological footprint of selected countries. Finally, Granger causality tests are employed to investigate the dynamic association among the variables for the short- and long-run relationships.

To discuss the dynamic causal links between the variables under consideration, the analysis should firstly check for the stationary proprieties of each series. However, technically cross-sectional dependence (CD) in the residuals must be examined in order to choose the appropriate panel generation unit root tests. Thus, using CD statistic test developed by Pesaran (2004) is suitable to allow for detecting the proper unit root tests. In fact, using directly the first-generation unit root tests may give spiritus results if the degree of cross-sectional dependence of the residuals is sufficiently higher. Therefore, the second-generation unit root tests are used for this case. The Pesaran's statistic is based on a simple average of all pair-wise correlation coefficients of the OLS residuals obtained from standard augmented Dickey and Fuller regressions for each variable in the panel. The null hypothesis suggests that variable is cross-sectionally independent, while the alternative hypothesis assumes the presence of residual cross-sectional dependence.

Table 1. Cross-sectional dependence (CD) test result

Variables	CD-test	P-value	corr	abs(corr)
FP	33.41	0.000***	0.467	0.583
GDPPC	38.23	0.000***	0.534	0.654
ENPC	29.97	0.000***	0.419	0.616
GOPCLEG	11.97	0.000***	0.167	0.437
GOPAPEC	5.51	0.000***	0.077	0.355

Notes: "***" indicates statistical significance at the 1% level. CD-test denotes the statistic of cross-sectional independence. The null hypothesis assumes the presence of residual cross-section independence of each variable. FP= Ecological Footprint; GDPPC= Gross domestic product per capita; ENPC= Energy consumption per capita; GOPCLEG= Green Openness index based on CLEG+; GOPAPPEC= Green Openness Index based on APEC. "Corr" defines the average correlation.

The results from the CD test are reported in Table 1 and reveal the presence of cross-sectional dependence in the variables and reject the null hypothesis. Thus, the stationary proprieties must be based on the second-generation unit root test.

In fact, more controlling outcomes could be provided by using the second-generation unit root tests. To check for stationary proprieties of each variable, the analysis uses the statistic proposed by Pesaran (2007), namely the cross-sectional augmented IPS (CIPS) unit root. This test assumes the null hypothesis of a non-stationary, while the alternative hypothesis suggest that variables are stationary.

Table 2. CIPS unit root test result

Variables	CIPS test			
	at level		at first difference	
	statistic	prob.	Statistic	prob.
FP	2.610	1.000	-2.707	0.000***
GDPPC	-1.313	0.981	-2.881	0.000***
ENPC	-1.956	0.114	-3.039	0.000***
GOPCLEG	-0.586	0.279	-3.120	0.000***
GOPAPEC	-1.877	0.211	-2.688	0.000***

Notes: "***" denotes statistical significance at 1%. The cross-sectional augmented IPS (CIPS) developed by Pesaran (2004) assuming the null of non-stationary. Tests are computed the case of constant and trend for statistical estimation.

The outcomes from CIPS test are reported in Table 2 and indicate that, at level, all series are non-stationary. However, after first difference all variables became stationary. Thus, our variables are integrated of order one.

Given that all variables are stationary after first difference, it's well possible to procced for testing the existence of long-run cointegration among the variables when the ecological footprint is dependent (endogenous). To do that, Pedroni (2004) and Kao (1999) are applied. Within heterogeneous panel, seven statistic tests are developed by Pedroni which are classified in two types. Based on four panel statistic tests, the first type (within dimension) includes v-statistic, rho-statistic, PP-statistic and ADF-statistic. However, the second type (between dimension) is based on three statistic tests and includes rho-statistic, PP-statistic and ADF-statistic. According to these statistic tests, the null hypothesis assumes that no cointegration observed between the variables, while the alternative hypothesis suggests the existence of long-run association between the variable. The computation of statistic tests for cointegration are based on the residuals of equation (3). The confirmation of the existence of long-run association between the analysis variables are well established using Kao (1999). This test is based on the ADF statistic.

Table 3a. Panel residual cointegration results (model with GOPCLEG)

Pedroni cointegration tests				
Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.762178	0.7770	-3.350078	0.9996
Panel rho-Statistic	4.493516	1.0000	5.170375	1.0000
Panel PP-Statistic	-15.36050	0.0000***	-16.43333	0.0000***
Panel ADF-Statistic	-11.50985	0.0000***	-8.580943	0.0000***
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	7.047196	1.0000		
Group PP-Statistic	-26.82045	0.0000***		
Group ADF-Statistic	-12.75660	0.0000***		
Kao cointegration test				
ADF			t-Statistic	Prob.
			-5.409488	0.0000***

Notes: "***" indicate statistical significance at the 1% significance level. Pedroni residual tests are estimated for the case with constant and deterministic trend.

Table 3b. Panel residual cointegration test results (model with GOPAPEC)

Pedroni cointegration tests				
Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.123397	0.5491	-2.079144	0.9812
Panel rho-Statistic	3.563578	0.9998	4.045069	1.0000
Panel PP-Statistic	-11.72446	0.0000***	-10.74597	0.0000***
Panel ADF-Statistic	-11.34307	0.0000***	-8.490528	0.0000***
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	6.078694	1.0000		
Group PP-Statistic	-14.64423	0.0000***		
Group ADF-Statistic	-9.708022	0.0000***		
Kao cointegration test				
ADF			t-Statistic	Prob.
			-5.182547	0.0000***

The results from these tests are reported in Table 3a and 3b and indicate that, for both models, two tests among four from the within dimension and two tests among three from the between dimension reject the null of no cointegration. Thus, in total, four tests among seven from the statistics proposed by Pedroni panel cointegration approve the existence of a long-run relationship between the assessed variables. Also, the developed ADF statistic test of Kao (1999) rejects the null of no cointegration between the variables. Consequently, either for model with GOPCLEG or the model with GOPAPEC, we authorize that all selected variables are cointegrated when the ecological footprint is selected as dependent variable.

This conclusion allows the computation of the long-run estimates of equation 3 by using Fully modified OLS (FMOLS) developed by Pedroni (2004) or Dynamic OLS (DOLS). Using OLS estimation could lead to biased estimator and its distribution depends on nuisance parameters. Instead, FMOLS and DOLS avoid spurious results because they correct for the endogeneity and serial correlation problems. The FMOLS applies a non-parametric approach while the DOLS uses a parametric approach. For both two models, all estimations are done for the case with intercept and deterministic trend. The FMOLS and DOLS panel method are applied for the weighted pooled event. Table 4a and 4b report the results of long-run estimates for the model with GOPCLEG and the model with GOPAPEC, respectively.

Table 4a. Long-run estimates (model with GOPCLEG)

Variables	GDPPC	GDPPC2	ECPC	GOPCLEG
FMOLS	3.159765 0.0000***	-0.247263 0.0000***	0.809512 0.0000***	-0.166935 0.0000***
DOLS	3.149905 0.0005***	-0.143854 0.0007***	0.870986 0.0000***	-0.041374 0.1961

Notes: "***" indicates statistical significance at 1%. The FMOLS and DOLS are computed for the case with constant and deterministic trend.

Table 4b. Long-run estimates (model with GOPAPEC)

Variables	GDPPC	GDPPC2	ECPC	GOPAPEC
FMOLS	2.678887 0.0000***	-0.157107 0.0003***	0.799403 0.0000***	-0.182115 0.0000***
DOLS	6.159214 0.0000***	-0.251413 0.0000***	0.168062 0.0155**	-0.010681 0.0546*

Notes: "***" and "**" indicate statistical significance at 1% and 5%, respectively. The FMOLS and DOLS are computed for the case with constant and deterministic trend.

For the models with GOPCLEG, all estimated coefficients are statistically significant, except for the GOPCLEG coefficient for DOLS approach. The EKC hypothesis is established for this model, given that the coefficients of real GDP per capita and its square are positive and negative, respectively. Long-run estimates suggest that per capita energy consumption leads to an increased ecological footprint, while the GOPCLEG index indicates that Green Products lower a country's ecological footprint in the long-run. Taking a closer look at the GOPCLEG index, the findings obtained from FMOLS indicate that when a country's green openness expands by 1%, its ecological footprint will decrease by approximately 0.17%.

For the model with GOPAPEC, all estimated coefficients are statistically significant at mixed levels (1% and 5%). In fact, the coefficients of real GDP per capita and its square are found to be positive and negative, respectively. This result confirms the validity of the EKC hypothesis for our sample. Interestingly, the estimated coefficients of GOPAPEC and ENPC are found to be negative and positive, respectively. The interpretation of the estimated coefficient for the GOPAPEC index in the FMOLS and DOLS results is as follows: if the green openness measure increases by 1%, the ecological footprint will decrease by 0.18% and 0.01%, respectively. Under FMOLS estimation, a 1% increase in the growth of real GDP per capita and the consumption of energy per capita lead to an increase of the ecological footprint by 2.67% and 0.8%, respectively. Under DOLS estimation, a 1% increase in per capita real GDP and energy consumption per capita will increase the ecological footprint by 6.16% and 0.16%, respectively.

The last step of the empirical study is reserved to discuss the short and long-run dynamic causal links between the analysis' variables using Granger causality tests for both two models. To do that, Engle and Granger (1987) developed a two-step procedure . This procedure consists of an estimation of the long-run relationship in equation 3 (first step) to recuperate the residuals which are reserved to define the error correction term (second step). For the short-run, pairwise Granger causality is applied to investigate the dynamic causality relationship between variables in pair and based on the significance of Fisher-statistic test in this event. The null hypothesis assumes the non-existence of causality between two variables, while the alternative suggests that there is a causality between them. The long-run association between the variables is tested using the significance of the lagged ECT which is based on the significance of t-student statistic. In case the estimated coefficient of the lagged error correction term is statistically significant, then the existence of a long-run relationship between the variables is confirmed. The null hypothesis suggests no long-run causality, while the alternative hypothesis assumes the presence of causality in the long-run. The results of the short and long-run association between the variables under investigation and for both two models are reported in Table 5a and Table 5b, respectively.

Table 5.a. Granger causality test results (model with GOPCLEG)

Short-run causality		
Null Hypothesis:	F-Statistic	Prob.
Y does not Granger Cause EF	0.63382	0.4266
EF does not Granger Cause Y	1.55998	0.2126
EC does not Granger Cause EF	2.15986	0.1427
EF does not Granger Cause EC	4.51091	0.0345**
GOPCLEG does not Granger Cause EF	0.66547	0.4153
EF does not Granger Cause GOPCLEG	6.91638	0.0090***
EC does not Granger Cause Y	0.38007	0.5380
Y does not Granger Cause EC	1.12128	0.2905
GOPCLEG does not Granger Cause Y	4.39768	0.0368**
Y does not Granger Cause GOPCLEG	9.35640	0.0024***
GOPCLEG does not Granger Cause EC	0.33666	0.5622
EC does not Granger Cause GOPCLEG	6.55851	0.0109**
Long-run causality		
EF=f(GDPPC, ECPC, GOPCLEG)	-0.038417	[-2.85187]***
GDPPC=f(EF, ECPC, GOPCLEG)	-0.002462	[-3.30866]***
ECPC=f(EF,GDPPC, GOPCLEG)	0.007223	[3.36723]
GOPCLEG=f(EF,GDPPC,ECPPC)	0.013143	[2.96229]

Notes: "***" and "**" indicate statistical significance at 1% and 5%, respectively.

Table 5.b. Granger causality test results (model with GOPAPEC)

Short-run causality		
Null Hypothesis:	F-Statistic	Prob.
Y does not Granger Cause EF	0.63382	0.4266
EF does not Granger Cause Y	1.55998	0.2126
EC does not Granger Cause EF	2.15986	0.1427
EF does not Granger Cause EC	4.51091	0.0345**
GOPAPEC does not Granger Cause EF	0.30391	0.5818
EF does not Granger Cause GOPAPEC	4.40761	0.0366**
EC does not Granger Cause Y	0.38007	0.5380
Y does not Granger Cause EC	1.12128	0.2905
GOPAPEC does not Granger Cause Y	2.51979	0.1135
Y does not Granger Cause GOPAPEC	9.25995	0.0025***
GOPAPEC does not Granger Cause EC	1.22988	0.2683
EC does not Granger Cause GOPAPEC	4.90625	0.0275**
Long-run causality	Coefficient	t-statistic
EF=f(GDPPC, ECPC, GOPAPEC)	-0.039174	[-2.82515]***
GDPPC=f(EF, ECPC, GOPAPEC)	-0.000706	[-3.29446]***
ECPC=f(EF,GDPPC, GOPAPEC)	0.004874	[3.03888]
GOPAPEC=f(EF,GDPPC,ECPPC)	0.004855	[1.34151]

Notes: "***" and "**" indicate statistical significance at 1% and 5%, respectively.

For both the GOPAPEC and the GOPCLEG models, the Granger causality reveals that, in the short-run, there is a unidirectional causality running from the ecological footprint to energy consumption without feedback. This is a straightforward conclusion, as countries with high ecological footprints tend to consume larger volumes of products with a high environmental impact. In this rationale, it can be expected that these countries also consume higher levels of energy. Finally, Granger suggests no short-run causal links between economic growth and ecological footprint. However, in the long-run, the estimated coefficients of the lagged error correction terms corresponding to ecological footprint and real GDP equations are statistically significant, which confirms the existence of long-run association among these two variables. Thus, any changes in the added value of economic sectors will have an impact on a country's ecological footprint and its contribution to environmental degradation. But also the opposite reasoning stands: the evolution of a country's ecological footprint will also affect economic growth in the long-run.

For the GOPCLEG model, the Granger causality indicates unidirectional short-run causalities running from the ecological footprint and energy consumption to GOPCLEG and bidirectional short-run causality between economic growth and GOPCLEG. Hence, the presence of Green Products, measured by the CLEG+ index, positively impact economic growth and vice versa.

For GOPAPEC model, the Granger causality reveals unidirectional short-run causalities running from ecological footprint, economic growth and energy consumption to GOPAPEC. So the presence of Green Products is driven by a country's economic strength, energy consumption and its ecological footprint.

4. Policy and Research Implications

This paper's analysis demonstrates that economic growth is likely to result in an increased environmental footprint. This finding confirms many previous research, for example assessed in a meta-analysis by Mardani et al. (2019). The latter research clearly confirms the existence of 'bidirectional causality between economic growth and CO_2 emission trends. This is a problematic finding for developing countries in the process of achieving economic growth and higher welfare levels as it would by default imply a growing ecological footprint.

However, this paper's findings related to Green Products provide a strategy to break the seemingly inevitable trend between economic growth and environmental impact. It is demonstrated that the presence of Green Products in trade can significantly decrease a country's environmental impact. This confirms earlier findings by for example Paramati et al. (2020). More importantly, this finding indicates that increased emphasis on Green Products can counterbalance the negative environmental impact of economic growth. Investments in

Green Products can therefor serve as a tool for policy makers in charge of developing sustainable growth plans. Wang et al. (2020) provide some policy recommendations in support of Green Products such as financial technology, green investments, development of human capital, and public-private partnership investments.

Wang et al. (2020) also find that trade openness increases production-based emissions. Again, this suggest an inevitable link between engaging in international trade on the one hand and a negative environmental impact on the other hand. The Green Openness Index presented in this paper also provides an escape route out of this causality. The analysis clearly demonstrates that an increased Green Openness Index contributes to a shrinking environmental footprint. This is a crucial insight as it demonstrates that is not trade as such which negatively affects a country's environmental impact, what really matters is the type of products traded. The presented index provides a useful tool to policy makers in this context as it allows to distinguish green from not-so-green products. The index allows policy makers to track the evolution of the importance of green products in trade flows, and benchmark against other countries.

Finally, the new index developed in this paper will provide a lever for future research as the index can be applied in different research and policy areas. The index can, for example, be incorporated in research on the impact of green technologies on renewable and non-renewable energy consumption. This kind of research on its turn will generate an impact on energy policies. Other potential research areas for application of the index for example cover unemployment, income distribution and social well-being. As a final remark, this paper acknowledges that the Green Openness Index is used as an explanatory variable in this analysis, but that no attention is paid to the drivers of Green Products. Hence, future research could aim to discover the factors which drive the pressence of Green Products.

5. Conclusion

This paper presents the first index to measure the importance of Green Products in a region, i.e. the Green Openness Index. By applying this new index, this paper revisits the trade-environment nexus in a case study for 31 OECD countries over the period between 2007 and 2017 in the context of the EKC hypothesis. To fulfil this study's objective, the paper employs various panel econometric procedures such as Pedroni and Kao cointegration tests, DOLS and FMOLS long-run estimator, and panel Granger causality analysis. The findings provide evidence in favour of the EKC hypothesis. Furthermore, the results clearly indicate that the presence of Green Products in trade (measured by the index) reduces a country's ecological footprint. This finding is especially crucial for countries seeking for sustainable development strategies. The hitherto paradigm states that economic development results in an increased environmental impact. A comparable paradigm exists in the context of trade: increased trade openness results in increased environmental pressure. This paper describes that focusing on more trade of Green Products, instead of focusing on more trade in general, provides a way-out of these two paradigms and escape the growth-emissions deadlocks.

The latter policy recommendation requires improved understanding on the Green Openness Index. Thus, future research can examine the impact of Green Openness Index on various environmental indicators (e.g. air quality, CO_2 emissions....), economic indicators (unemployment, income distribution, measures of a green economy, renewable and non-renewable energy consumption…), and social well-being. Finally, future research can also validate this paper's findings by covering other countries and focus on the nexus between Green Openness Index and economic growth.

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Appendix 1. Core CLEG+ Product List According to their HS 2007 Codes

380210
730300
730431
730490
730630
730690
730900
731010
731029
732490
761290
840410
840420
840510
841410
841780
841790
841989
842121
842129
842139
842199
842833
846291
847982
848110
848130
848140
850590
901540
901580
902610
902680
902710
902720
902730
902750
902780
902810
902820

Appendix 2. APEC List of Environmental Goods List According to their HS 2007 Codes

441872
840290
840410
840420
840490
840690
841182
841199
841290
841780
841790
841919
841939
841960
841989
841990
842121
842129
842139
842199
847420
847982
847989
847990
850164
850231
850239
850300
850490
851410
851420
851430
851490
854140
854390
901380
901390
901580
902610
902620
902680
902690
902710
902720
902730
902750
902780
902790
903149
903180
903190
903289
903290
903300

Appendix 3. OECD Country List

Australia
Austria
Belgium
Canada
Chile
Czechia
France
Germany
Greece
Hungary
Ireland
Israel
Korea
Lithuania
Luxemburg
Mexico
Netherland
New Zealand
Portugal
Slovakia
Slovenia
Spain
Sweden
United Kingdom

Denmark
Finland
Italy
Japan
Norway
Poland
United States of America

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