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THE IMPACT OF ENVIRONMENTAL STANDARDS AND REQUIREMENTS ON TRADE LIBERALIZATION: EMPIRICAL EVIDENCE FROM OECD COUNTRIES

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ABSTRACT

Objective: This study aims to measure the impact of environmental standards and requirements on trade liberalization in the OECD countries from 1990 to 2021.

Theoretical Framework: The study utilizes economic and environmental theories to examine the relationship between regulatory policies and trade liberalization, utilizing key frameworks such as environmental economics, the Kuznets curve, and global trade models to analyze this interaction.

Method: We used unconditional quantile regression methods to examine the relationship between environmental regulations and trade liberalization. The model includes variables such as environmental policy stringency, environmental taxes, carbon emissions, and renewable energy production.

Results and Discussion: The study concluded that stringent environmental policies increased freedom of trade at different levels of trade liberalization. The results also confirm that environmental tax policies are particularly effective in promoting trade liberalization in countries with weak or low levels of trade liberalization. The results further suggest that in the case of countries where trade liberalization is weak or below average, carbon emissions are associated with increased trade liberalization. Furthermore, renewable energies contribute to deepening levels of trade liberalization in countries characterized by higher-than-average levels of trade liberalization.

Research Implications: This study provides insights into how environmental policies can be strategically used to promote trade liberalization. The findings may influence policy-making in areas such as environmental taxation, energy transition, and international trade.

Originality/Value: This study explores the impact of environmental regulations on trade liberalization, highlighting how different policies can either promote or hinder trade freedom, especially in economies at different stages of liberalization.

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O IMPACTO DOS PADRÕES E REQUISITOS AMBIENTAIS NA LIBERALIZAÇÃO DO COMÉRCIO: EVIDÊNCIAS EMPÍRICAS DOS PAÍSES DA OCDE

RESUMO

Objetivo: Este estudo tem como objetivo medir o impacto dos padrões e requisitos ambientais sobre a liberalização do comércio nos países da OCDE de 1990 a 2021.

Referencial Teórico: O estudo utiliza teorias econômicas e ambientais para examinar a relação entre as políticas regulatórias e a liberalização do comércio, utilizando estruturas importantes como a economia ambiental, a curva de Kuznets e modelos de comércio global para analisar essa interação.

Método: samos métodos de regressão de quantis incondicionais para examinar a relação entre as regulamentações ambientais e a liberalização do comércio. O modelo inclui variáveis como rigor da política ambiental, impostos ambientais, emissões de carbono e produção de energia renovável.

Resultados e Discussão: O estudo concluiu que políticas ambientais rigorosas aumentaram a liberdade de comércio em diferentes níveis de liberalização comercial. Os resultados também confirmam que as políticas fiscais ambientais são particularmente eficazes na promoção da liberalização do comércio em países com níveis fracos ou baixos de liberalização do comércio. Os resultados sugerem ainda que, no caso de países em que a liberalização do comércio é fraca ou está abaixo da média, as emissões de carbono estão associadas a uma maior liberalização do comércio. Além disso, as energias renováveis contribuem para aprofundar os níveis de liberalização do comércio em países caracterizados por níveis de liberalização do comércio acima da média.

Implicações da Pesquisa: Este estudo oferece percepções sobre como as políticas ambientais podem ser usadas estrategicamente para promover a liberalização do comércio. As descobertas podem influenciar a formulação de políticas em áreas como tributação ambiental, transição energética e comércio internacional.

Originalidade/Valor: Este estudo explora o impacto das regulamentações ambientais sobre a liberalização do comércio, destacando como diferentes políticas podem promover ou dificultar a liberdade comercial, especialmente em economias em diferentes estágios de liberalização.

Palavras-chave: Políticas Ambientais, Impostos Ambientais, Emissões de CO2, Produção de Energia Renovável, Regressão Incondicional de Quantis, Liberalização do Comércio.

EL IMPACTO DE LAS NORMAS Y REQUISITOS MEDIOAMBIENTALES EN LA LIBERALIZACIÓN DEL COMERCIO: PRUEBAS EMPÍRICAS DE LOS PAÍSES DE LA OCDE

RESUMEN

Objetivo: Este estudio pretende medir el impacto de las normas y requisitos medioambientales en la liberalización del comercio en los países de la OCDE desde 1990 hasta 2021.

Marco Teórico: El estudio utiliza teorías económicas y medioambientales para examinar la relación entre las políticas reguladoras y la liberalización del comercio, utilizando marcos clave como la economía medioambiental, la curva de Kuznets y los modelos de comercio global para analizar esta interacción.

Método: Utilizamos métodos de regresión cuantílica incondicional para examinar la relación entre las normativas medioambientales y la liberalización del comercio. El modelo incluye variables como el rigor de la política medioambiental, los impuestos medioambientales, las emisiones de carbono y la producción de energías renovables.

Resultados y Discusión: El estudio concluye que las políticas medioambientales estrictas aumentan la libertad de comercio en diferentes niveles de liberalización comercial. Los resultados también confirman que las políticas fiscales medioambientales son especialmente eficaces para promover la liberalización del comercio en países con niveles débiles o bajos de liberalización del comercio. Los resultados sugieren además que en el caso de los países en los que la liberalización del comercio es débil o inferior a la media, las emisiones de carbono están asociadas a una mayor liberalización del comercio. Además, las energías renovables contribuyen a profundizar los niveles de liberalización del comercio en los países caracterizados por niveles de liberalización del comercio superiores a la media.

Implicaciones de la investigación: Este estudio aporta ideas sobre cómo pueden utilizarse estratégicamente las políticas medioambientales para promover la liberalización del comercio. Las conclusiones pueden influir en la formulación de políticas en ámbitos como la fiscalidad medioambiental, la transición energética y el comercio internacional.

Originalidad/Valor: Este estudio explora el impacto de las regulaciones medioambientales en la liberalización del comercio, destacando cómo las diferentes políticas pueden promover u obstaculizar la libertad comercial, especialmente en economías en diferentes etapas de liberalización.

Palabras clave: Políticas Medioambientales, Impuestos Medioambientales, Emisiones de CO2, Producción de Energías Renovables, Regresión Cuantil Incondicional, Liberalización del Comercio.

1 INTRODUCTION

The relationship between the environment and trade has occupied an important space in economic literature. Theoretical foundations and empirical studies have addressed aspects of the interactive relationships between the two phenomena. It is important to emphasize that environmental taxes are a mechanism used to absorb the external effects associated with pollution. By taxing activities that harm the environment, governments aim to make the prices of goods and services more reflective of their genuine social costs. Accordingly, environmental taxes seek to internalize environmental costs by placing a monetary value on externalities. These are practices that can have impacts on production costs and competitiveness, consequently, an impact on trade flows.

In this context, points of view differed about the nature of the effects that arise from environmental dimensions through pricing mechanisms and other tools. This mechanism would burden industries with additional costs that would harm competitive advantages and affect the desired economic goal of trade liberalization associated with reducing the prices of tradable goods and increasing economic well-being. In this context, Bhagwati (2002) believes that free trade is the first and best policy despite two centuries of theoretical challenges. In his view, almost everywhere free trade remains the best the best policy (Bhagwati, J. Free Trade Today, 2002). Bhagwati (1994) also believes that the new challenges in the field of free trade have two aspects. The first comes from demands for fair trade as a precondition for free trade. The other is the concern that free trade, although efficient, impoverishes unskilled workers in more affluent countries (Bhagwati, 1994). In this context, Bhagwati (2002) tends to say that the environment and international trade conflict. Bhagwati (2002) strongly opposes the links between less restricted trade measures and labor and environmental regulations. He believes these foreign policy objectives should be addressed separately from trade by intergovernmental bodies and other non-governmental organizations (Bhagwati, J. The Wind of the Hundred Days: How Washington Mismanaged Globalization, 2002). Wherefore, according to Bhagwati, this situation creates an explicit contradiction between global trade liberalization policies and environmental conservation policies. The former reduces relative costs while the latter raises the relative costs of products in the international exchange fold. These policies may lead to their removal from international exchange.

An abundance of literature has explored the relationship between trade liberalization and environmental regulations. The race to the bottom hypothesis suggests that countries may

lower their environmental regulations to attract foreign investment and remain competitive in the global market. Conversely, proponents of trade liberalization argue that it could lead to a race to the top scenario, in which countries adopt higher environmental regulations to gain a competitive advantage in environmentally conscious markets.

On the other hand, supporters of environmental issues justify this trend and its effects in the areas of free trade based on the Porter Hypothesis (Porter & Linde, 1995) which states that strict environmental regulations can drive innovation and enhance the competitive advantage of any country. By imposing stricter regulations, companies are encouraged to invest in cleaner technologies and processes, which improves environmental performance without sacrificing economic growth. Furthermore, stricter environmental regulations can enhance competitiveness by encouraging innovation. The latter would increase competitive and dynamic advantages, urging countries to trade and expand international trade.

Supporters of including environmental dimensions in international trade practices believe that environmental regulations, including environmental policies and environmental taxes applied at their core, are incentives directed at the economic behavior of investors, through which governments create financial incentives for companies and individuals to adopt more friendly environmental practices and enhance the capabilities of innovation and creativity. This could include reducing pollution, conserving resources, or investing in clean technologies. In addition, of great importance, environmental taxes are considered a tool for enforcing regulation and compliance. This is because they contribute to raising the levels of regulatory enforcement among institutions and companies and provide a clear financial incentive for companies to comply with environmental regulations and standards. In contrast, if institutions do not meet particular environmental regulations, they may face higher tax rates, which create a direct financial incentive to improve environmental performance. Environmental taxes also contribute to making the environmental impact of some activities clear and measurable. This transparency can facilitate decision-making by companies, policymakers, and consumers. It also allows for more transparent accountability regarding who is responsible for environmental impacts and who contributes to mitigating them.

2 THEORETICAL FRAMEWORK

Many studies explored the bonds between environmental regulation and trade flows. Based on what is available to us, we can divide those studies into two groups. The first group

has re-examined the Porter Hypothesis while the second group has tackled the effect of environmental regulations on trade.

Concerning the studies that re-examined the Porter Hypothesis, many are in support of it. We can mention, for instance, the study of Wang, P. et al. (2021) that demonstrated an inverted "U" relationship between environmental regulation and green technology innovation (Wang et al., 2021). In addition, the work of Nie et al. (2021) concluded that the Porter hypothesis is verified to apply in the underdeveloped areas of developing countries (Nie et al., 2021).

Concerning the second group of studies that explored the effect of environmental regulations on trade, some of them found a strong effect (positive or negative) of environmental regulations on trade patterns, whereas the rest of these studies found either a weak effect or no effect.

Numerous studies found a strong positive relationship between the two variables. Among them is the study of Mangee and Elmslie (2010) who found evidence against the race to the bottom hypothesis. He explained that increasing environmental regulations in both high and low standard countries improves bilateral trade volume (Mangee & Elmslie, 2010). Another study by Tsurumi et al. (2015) clarified the effects of regulation on trade flows by distinguishing between the indirect and direct effects. The results indicate an observed non-negligible indirect effect of regulation, implying that appropriate regulation benefits trade flows (Tsurumi et al., 2015). Additionally, Jobert et al. (2016) claimed that the probability of having pollution-intensive foreign direct investments increases with a decrease in stringency; however, the opposite is true for higher levels of regulatory stringency. This suggests that pollution havens may only exist if environmental regulations are lax or nonexistent (Jobert et al., 2016). Furthermore, Bertarelli and Lodi (2019) confirmed that the environmental tax would positively affect eco-innovation propensity and, indirectly, export propensity across the largest and most productive firms (Bertarelli & Lodi, 2019). More recently, Onwachukwu et al. (2021) concluded that developing countries often use lax regulatory standards as a means of attracting investments and making their exports more competitive, which compromises environmental performance (Onwachukwu et al., 2021). Additionally, Cai et al. (2022) found out that stringent environmental regulations could also foster the demand for environmentally-friendly products (Cai et al., 2022).

In brief, all of these studies revealed the same result, which is an increase in environmental regulations stringency would benefit trade flows.

Conversely, a variety of studies found that an increase in environmental regulations stringency leads to a reduction in trade flows. However, this result may change according to the data particularity of each article. For instance, we mention the work of McLaughlin and Coffey (2010), which concluded that the increase of environmental regulations leads to a dramatic decrease in intra-EU exports originating in low-income countries, while it does not statistically affect intra-EU exports originating in high-income countries (McLaughlin & Coffey, 2010). Similarly, Abay et al. (2003) claimed that stringent environmental regulation could negatively affect the export competitiveness of "dirty" domestic industries, leading to the emergence of "pollution havens" in countries with lax environmental regulation. The empirical results showed heterogeneity across sectors and countries in the impact of environmental regulation stringency on net exports (Abay et al., 2003). More recently, the study of Du and Li (2020) found that environmental regulation could restrain export-intensive and pollution-intensive margins, with stronger negative effects on pollution-intensive enterprises. It could also shorten the export duration for these firms (Du & Li, 2020). Besides, the work of Wang et al. (2020) claimed that environmental regulations in China inhibit trade liberalization in most industries, with innovation compensation benefits not evident in less than half of the industries studied (Wang & Wang, 2020). Lastly, the work of Singh (2023) concluded that environmental regulation has a significant impact on trade liberalization. Strict environmental policies can impede trade, particularly in terms of environmental goods listed in APEC compared to those listed in OECD (Singh, 2023).

Besides all the studies mentioned before, we can set other studies that revealed a weak effect of environmental regulations on trade patterns. We can mention the study of Van Beers & Van Den Bergh (2003) where the aggregate results for 1975 and 1992 showed no significant impact on international trade caused by stricter national environmental policies (van Beers & van den Bergh, 2003). In addition, the work of Eliste and Fredriksson (2002) claimed that compensation obtained by producers neutralizes the effect of environmental policy on output and trade flows. This may explain why previous empirical research found weak evidence of environmental regulations affecting trade patterns (Eliste & Fredriksson, 2002).

Lastly, some studies found no effect of environmental regulations on trade flows. First, the work of Mani et al. (1996) concluded that the impact of the environmental tariff on trade flows is estimated to be negligible, even as a percentage of pollution-intensive exports (Mani, 1996). Additionally, the study of Xu et al. (2003) found that the export performance of ESGs remained unchanged between the 1960s and the 1990s despite the introduction of stringent

environmental standards in most developed countries (Xu, 2000). Moreover, we mention the work of Cole and Elliott (2003), whose study found no significant relationship between environmental regulations and 'dirty' net exports. However, when considering the 'new' trade model, the study found that environmental regulations are a statistically significant determinant of the share of inter-industry trade (net trade), and this significance increases when controlling for endogeneity (Cole & Elliott, 2003).

3 METHODOLOGY

In order to answer the problem of the study and achieve its goal, the impact of environmental regulation on trade liberalization will be estimated. One reliable indicator of the degree of trade liberalization is the Trade Freedom Index. It is a composite economic indicator that evaluates the degree of openness and freedom in a country's trade policies and practices. It measures the extent to which a country allows goods and services to flow across its borders without significant barriers or restrictions. The index takes into account various factors related to trade policies including tariffs, non-tariff barriers, customs procedures, and regulatory measures that may hinder or facilitate international trade. It is typically used to compare and rank countries based on their trade policies and practices, providing a view of the level of trade freedom within a particular economy, country, or region.

On the other hand, the economic variables indicative of policies, standards, and requirements included environmental taxes, environmental stringency policies, total renewable energy production, and carbon emissions. Environmental stringency policies are a variable that explains environmental standards and requirements because they represent the level of stringency, the stringency with which environmental regulations are implemented and enforced within the scope of a particular country or region. Environmental stringency policies provide an objective measurable way to evaluate the extent of the government's commitment to protecting the environment. It can be quantified through various metrics such as emission limits, pollution control standards, and penalties for non-compliance. Therefore, we can conclude that the standards for stringent environmental policies are considered a tool for translating environmental standards and requirements into concrete procedures and practices. They provide the necessary legal and regulatory framework to ensure that economic activities are conducted in a manner that reflects adherence to standards and requirements in a way that respects, protects, and reduces negative impacts on the environment.

The environmental tax variable was also used. It directly links economic activities to their environmental impacts by including external factors in pricing, as environmental taxes are designed to absorb externalities. Therefore, it can be said that environmental taxes are a political tool used to align economic activities with environmental objectives. They reflect, in their levels, the levels of the environmental standards and requirements applied in the country and the environmental goals to be achieved. Furthermore, carbon emissions are viewed as a measure to evaluate compliance with environmental standards and requirements. In addition, they are considered as a tangible reflection of how environmental standards and requirements are applied and followed. It is a primary measure to evaluate the commitment of countries, regions, organizations or companies to mitigate climate change and meet local, international, and global environmental commitments. Finally, the increase in the use and production of renewable energies is a clear and tangible indicator of commitment to environmental standards and requirements. It also represents a fundamental shift towards clean and more sustainable energy production methods, which are linked to maximizing innovation activities and associated products that result from environmental regulation.

Accordingly, the models aim to estimate the impact of environmental regulation on trade liberalization by considering the impact of environmental policy stringency (EPS), environmentally related tax revenue (ETR), research and development expenditure (RDE), patent applications residents (PAR), CO2 emissions (CO2EME), and environmentally adjusted multifactor productivity growth (EAMPG). They also consider, total renewable energy production (TRE), household spending (Households and NPISHs) final consumption expenditure (FCE), gross fixed capital formation (GFCF) on the composite index, and Trade Freedom (TF). The economic variables related to environmental regulation were extracted from the OECD database, freedom of trade from the Heritage Foundation database, and the rest of the explained economic variables were extracted from the World Bank database.

The estimation methodology is based on unconditional quantile regression methods presented by Firpo et al. (2007). It aims to search for the effects of independent variables on the distribution of the dependent variable, which allows for several effects of the independent variables on the dependent variable. This type of regression avoids problems of heterogeneity in the distribution of data. Additionally, this type of regression is stronger than the OLS approach due to the presence of problems of heterogeneity, outliers, and structural change. It is not based on firm assumptions of the error term where the parameters of $\beta\hat{}\_\tau$ represent the marginal effects on the quantile τ of Y. It does not take into account the changes occurring in

the remaining independent variables, where the parameters are estimated based on a recentered influence function (RIF), which is written in the following form:

$$RIF\left(y, q_\tau, F_y\right) = q_\tau + \frac{\tau - I(y \leq q_\tau)}{f_y(q_\tau)} \qquad (1)$$

where:

q_τ represents the value of the dependent variable with the rank corresponding to the quantile τ and estimated through the non-parametric approach provided by Kernel;

F_y represents the distribution function of the dependent variable; and

$f_y(q_\tau)$ represents the marginal density function of the dependent variable at the quantile τ, $I(y \leq q_\tau)$, a function defined for values of the dependent variable that are lower than the quantile τ.

This type of regression provides us with two types of parameters. The first type represents the marginal effects of variable X on the quantile τ of the Y distribution. The second represents the effects of the overall changes in the distribution of independent variables (policy effect) on the quantile τ of the Y distribution, in addition to the model containing the constant effects of each country.

4 RESULTS AND DISCUSSIONS

Table 1

Trade Freedom Non-Robust Estimation

Variables	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**
Environmental policy stringency	0.033***	0.018***	0.044***	0.015***	0.012***
Environmentally related tax revenue	0.049***	0.011***	-0.002	0.002	-0.0004
CO2 Emissions	0.166***	0.057***	-0.036**	-0.008	-0.006
Environmentally adjusted multifactor productivity growth	0.0004	0.0004	0.0004	0.0004***	0.0004
Patent applications	-0.007	-0.004	-0.003	-0.007*	-0.004
Research and development expenditure	0.006	-0.008	-0.005	-0.012**	-0.011**
Total renewable energy production	-0.002	-0.004*	0.005	0.005**	0.002
Households consumption expenditure	0.082**	0.056***	0.159***	0.112***	0.037***
Gross fixed capital formation	-0.002	-0.018**	-0.054***	-0.066***	-0.025***
Constant	-.011	2.694***	1.961***	3.292***	4.235***
Observations	1024	1024	1024	1024	1024

*** P-Value<0.01, ** P-Value <0.05, * P-Value <0.1

Source: Prepared by the authors based on the outputs of the STATA16.0 program.

Table 2

Trade Freedom Bootstrap Estimation:

Variables	Q10	Q25	Q50	Q75	Q90
Environmental policy stringency	0.033**	0.018***	0.044***	0.015***	0.012***
Environmentally related tax revenue	0.049***	0.011***	-0.002	0.002	-0.0004
CO2 Emissions	0.166***	0.057***	-0.036*	-0.008	-0.006
Environmentally adjusted multifactor productivity growth	0.0004	0.0004	0.0004	0.0004***	0.0004
Patent applications	-0.007	-0.004	-0.003	-0.007	-0.004
Research and development expenditure	0.006	-0.008	-0.005	-0.012*	-0.011***
Total renewable energy production	-0.002	-0.004	0.005	0.005**	0.002
Households consumption expenditure	0.082	0.056***	0.159***	0.112***	0.037**
Gross fixed capital formation	-0.002	-0.018**	-0.054***	-0.066***	-0.025**
Constant	-0.011	2.694***	1.961***	3.292***	4.235***
Observations	1024	1024	1024	1024	1024

*** P-Value<0.01, ** P-Value <0.05, * P-Value <0.1
Source: Prepared by the authors based on the outputs of the STATA16.0 program.

4.1 RESULTS

The study found the following statistical results:

Estimates of unconditional quantile conventional standard errors showed a significant positive effect of stringent environmental policies on trade liberalization in all quantiles. These results maintained their statistical significance with the estimates: bootstrapped standard errors.

The econometric estimation also demonstrated a significant positive effect of environmental tax revenues on trade liberalization in quantile Q10 and quantile Q25 related to the distribution of trade liberalization. These results maintained their statistical significance with bootstrapped standard errors, indicating that environmental tax revenues contribute to increasing trade liberalization in countries with weak and below-average levels of trade liberalization.

The estimates also showed a significant positive effect of carbon emissions on trade liberalization in the quantile Q10 and quantile Q25 associated with the distribution of trade liberalization. Meanwhile, in the intermediate quantile Q50, there was also a notable adverse impact of carbon emissions on trade liberalization. These results maintained their statistical significance with the estimates: bootstrapped standard errors. This shows that carbon emissions contribute to increasing trade liberalization in countries with weak and below-average levels of trade liberalization; simultaneously, they contribute to reducing trade liberalization in countries with moderate trade liberalization.

Estimates revealed a significant positive effect of total renewable energies on trade liberalization in Q75. These results maintained their statistical significance in Q75 with the

estimates: bootstrapped standard errors, which suggests that total renewable energies contribute to increasing trade liberalization in countries with above-average levels of trade liberalization.

The results indicated that trade liberalization in Q75 significantly benefited by environmentally adjusted multifactor productivity growth. These results maintain their statistical significance with estimates: bootstrapped standard errors, which means that environmentally adjusted multifactor productivity growth contributes to increasing trade liberalization for countries with above-average trade liberalization. The results also showed a significant adverse effect of the number of patents on trade liberalization in Q75, which means that patents contribute to increasing trade liberalization for countries with trade liberalization above the average.

Additionally, the findings also showed that spending on research and development had a significant negative impact on quantile Q90 and quantile Q75. This means that spending on research and development harms trade liberalization in countries with high and above-average trade liberalization. These results maintained their statistical significance with estimates: bootstrapped standard errors. The data also showed that household consumption has a significant beneficial impact on trade liberalization across all categories. These results retained their statistical significance in all quantiles other than the Q10 quantile with estimates: bootstrapped standard errors.

The results also indicated that investment has a significant negative effect on trade liberalization in all categories other than the Q10 quantile, which means that investment does not contribute to hindering trade liberalization in countries with weak trade liberalization. These results maintained their statistical significance with estimates: bootstrapped standard errors.

Additionally, the results revealed that both environmental policy stringency and higher environmental tax revenues are associated with increased trade liberalization. The specific quantitative effects indicated that the relationship between environmental tax revenues and trade liberalization may vary depending on the initial level of trade liberalization in a country. Focusing on countries with weak or low trade liberalization suggests that environmental tax policies may be particularly effective in promoting trade liberalization in these contexts. Accordingly, the results of the study indicated a precise relationship between environmental policies, tax revenues, and trade liberalization with the need to emphasize the difference in impact depending on the progress of levels of trade freedom in the country.

4.2 DISCUSSION

Given the impact of stringent environmental policies, it is worth noting that they have an effect on increasing trade freedom, regardless of the levels of liberalization in the countries under study. However, the movement that supports freedom of trade believes that the stringency of environmental policies and the stringency in their standards restricts freedom of trade and flows of goods and services. The previous view holds that environmental arrangements harm free trade in connection with a package of arguments and justifications that go beyond the direct impact related to the disintegration of price advantages because of the additional costs borne by the producer. These include problems related to the weakness and poor design, the application of environmental systems, their excessive exhaustion, as well as stress or the imbalance and selectivity of application.

However, the results of this study confirm that it is possible to formulate policies that balance environmental protection and trade facilitation as smart regulation can enhance competitiveness rather than hinder it. A group of theories, approaches, and theses have indicated this trend, as the Environmental Kuznets Curve Approach (EKC) indicates that environmental degradation initially increases with economic development. However, it eventually decreases when a country reaches a certain level of wealth, high rates of economic growth, and high levels of income and per capita income. This approach means that as countries develop more, they are more likely to invest in environmental protection. Therefore, strict environmental policies may be more feasible and acceptable for economically developed countries, and they will likely have a less restrictive impact on trade.

The study results also confirm Porter's hypothesis, which is that stringent environmental regulations that stimulate innovation and enhance efficiency within industries. In the context of trade liberalization, companies in countries with stringent environmental policies will be forced to develop cleaner and more efficient technologies. As these technologies gain competitive advantages, industries may become more export-oriented, contributing to greater trade liberalization. According to the pollution haven hypothesis, industries may move from countries with strict environmental regulations to those with lax ones. This move is due to the desire to reduce compliance costs and regulatory burdens. As a result, countries with strict environmental policies may witness increased trade liberalization as they attract industries seeking to comply with these regulations.

It is also worth noting that harmonized environmental regulations can reduce trade friction and promote fair competition on the global stage. By establishing common environmental standards, countries can reduce the risks of "race to the bottom" scenarios, and harmonization would create a level playing field and support a more open global trading system without discriminatory advantages. In addition to the above, in the context of analyzing the relationship between stringent environmental policies and trade liberalization, it is essential to emphasize the resulting dynamic efficiency gains, as investments in cleaner technologies and practices contribute to long-term cost savings, enhance innovation, and drive technological upgrading, making industries more efficient and competitive in the global market. As a result, trade flows increase. Countries excel in producing and exporting environmentally friendly goods and services, and the international division of labor is being re-divided regarding the nature and levels of the countries' environmental absorptive capabilities. Countries with high absorptive capabilities specialize in the activities and stages of production that are most harmful to the environment; in contrast, countries with lower absorptive capabilities specialize in less polluting industries, yet they are the most profound in of environmental content and connection to renewable and clean energies.

As for the results related to environmental taxes, they provide a critical perspective regarding the choice between environmental regulation tools, as they confirm that the environmental tax tool has a more profound impact in the case of countries with low and below-average levels of trade liberalization.

Economically, designing environmental taxes aims to internalize external costs associated with pollution or resource depletion. By imposing taxes on activities that harm the environment, governments aim to make the prices of goods and services more reflective of their actual social costs. Although the process appears to be a practice of government intervention, which may affect the working mechanisms of free markets, it is worth noting that both environmental taxes and free trade, at their core, depend on market-based methods.

According to the approach based on free market mechanisms and the natural forces generated from it, it is sufficient to allocate resources efficiently as it does not involve direct government control or interference in market transactions. That approach focuses on price signals in order to influence the economic behavior of both the private sector and the household sector (companies and consumers), which are the most responsive sectors to market signals. Concerning market signals, environmental taxes influence firms' production choices by making polluting activities more expensive; consequently, consumers choose greener alternatives.

Alternatively, freedom of trade allows companies decide where to produce, what to produce, and where to sell their goods based on market conditions. It also facilitates the choices of commodity alternatives and their sources for the household sector. These factors would increase the flow of intermediate goods for incoming or outgoing investments to regions with the most environmental absorptive capabilities. Furthermore, they would raise the flow of goods and services that are less harmful to the environment in addition to the flow of environmentally friendly production equipment, supplies, and associated technologies. These are factors that would enhance trade flows and increase international trade liberalization transactions.

In the same context, environmental taxes would help level the playing field in international trade. A country that imposes environmental taxes on its industries reduces the competitive advantage of industries in that country that may have engaged in harmful environmental practices. This promotes fair competition in the global marketplace and reduces unfair natural and environmental competitive advantages that distort international trade paths. This deepens the principles of fair trade and cooperative international specialization in international trade. Therefore, once these three factors interact: environmental taxes and free market mechanisms, within enabling environments for free trade, they contribute to achieving fair trade, increasing international trade flows, and deepening trade liberalization. Moreover, efficient and appropriate design of environmental taxes would complement freedom of trade by reducing barriers associated with environmental concerns, resulting in smoother trade relations and a more significant flow of goods and services. The combination of environmental taxes and freedom of trade also encourages companies to adopt more sustainable practices, as environmental taxes provide economic incentives. In contrast, freedom of trade allows companies to expand markets for their environmentally friendly products and technologies.

Concerning carbon emissions and their impact on trade freedom, the estimation results confirm that in the case of countries where trade liberalization is weak or below average, carbon emissions are associated with increased trade liberalization. This result can be linked to the growth strategies pursued in this category of countries. These countries are likely to prioritize economic growth over environmental concerns. Furthermore, trade liberalization is viewed as a means of attracting foreign investment, encouraging exports, raising aggregate demand, and enhancing economic activity. As a result, in countries with weak levels of trade liberalization, policies aimed at lowering trade barriers and promoting international trade may be viewed as more appropriate, even if they lead to higher levels of carbon emissions. In countries with moderate levels of trade liberalization (in the median quantile Q50), the negative effect of

carbon emissions on trade liberalization indicates a shift in priorities. These countries may be more aware of the environmental impacts of economic activities; consequently, the balance of economic growth and sustainability may be given more consideration.

Therefore, the complex relationship between carbon emissions and trade liberalization requires tailored policy responses that are context-specific to the nature and levels of a country's trade openness. Achieving a balance between economic development and environmental sustainability requires careful consideration of each country's current state of trade liberalization. As a result, policymakers may need to adopt a differentiated approach depending on the current level of trade liberalization in a country. For countries with weak or below-average trade liberalization, policies could focus on achieving growth, development, and a gradual transition to clean technologies. In comparison, countries with moderate trade liberalization need policies that maximize economic growth and balance between growth and environmental sustainability.

The positive effect of total renewable energy production on trade liberalization in countries with higher-than-average levels of trade liberalization also indicates that those countries benefit from increased use of renewable energy production in serving contexts associated with trade liberalization. Adopting renewable energy production practices can enhance the competitiveness of industries in those countries. Green technologies and sustainable practices may become a source of comparative advantage, facilitating trade with environmentally conscious partners. It is also a critical factor in responding to market demand, as countries with more liberalized trade may have markets that require cleaner and more sustainable products. The adoption of renewable energy production practices can align with the preferences of consumers and trading partners in these countries, maximizing trade flow and levels of trade liberalization. Countries with a high degree of trade liberalization are generally more open to international cooperation in renewable energy production initiatives. Shared goals of sustainability and environmental stewardship can lead to policies that encourage using renewable energy production sources.

Finally, economic policies can focus on strengthening the relationship between trade liberalization and the adoption of renewable energy production. Incentives, subsidies, and supportive frameworks for companies that adopt sustainable practices could further strengthen the positive relationship observed in these countries. In addition to the importance of international cooperation in renewable energy production initiatives, bilateral or multilateral

agreements between countries that benefit from trade liberalization facilitate the exchange of clean technologies and best practices and investment in renewable energy production projects.

5 CONCLUSION

The present study aimed to reveal the link between environmental standards and requirements and trade liberalization during (1990-2021). It relied on unconditional quantile regression methods where trade liberalization, as a dependent variable, was measured by the trade freedom index. In contrast, environmental regulation was measured using a group of independent variables (environmental taxes, environmental stringency policies, total renewable energy production, and carbon emissions). The study uncovered several findings that are summarized as follow:

First, regarding the impact of stringent environmental policies on freedom of trade, it can be judged that stringent environmental policies -when properly designed and implemented- contribute significantly to increasing freedom of trade in OECD countries through a set of approaches, including stimulating innovation, reducing external factors, enhancing resource efficiency and enhancing international cooperation. These policies create an environment where sustainable industries flourish. This ultimately benefits the dynamics of global trade and the levels of its liberalization by removing the various forms of barriers of the various flows of visible and invisible goods.

Second, by using the environmental tax tool in an environment that incorporates fundamental mechanisms based on the philosophy of the free market side by side, countries can create a framework that supports free trade, sustainable economic development, fair trade practices, and increased international trade flows. This approach helps address global challenges related to environmental sustainability, well-being, economic prosperity, and improved quality of life and health.

The study concludes that regulatory enforcement mechanisms influence the effectiveness of environmental tax policies in promoting trade liberalization. Countries with more stringent and efficient enforcement mechanisms are expected to see a more significant positive impact of environmental tax policies on trade liberalization.

Third, in the case of countries where trade liberalization is weak or below average, carbon emissions are associated with increased trade liberalization. In countries with moderate levels of trade liberalization, carbon emissions are associated with declining levels of trade

liberalization. Therefore, the complex relationship between carbon emissions and trade liberalization requires tailored and context-specific policy responses depending on the nature and levels of trade openness of a given country. Achieving a balance between economic development and environmental sustainability also requires careful consideration of the current state of trade liberalization of any country.

Finally, the positive effect of total renewable energy production production on trade liberalization in countries with higher-than-average trade liberalization levels indicates that these countries benefit from the increased use of renewable energy production in the contexts associated with trade liberalization.

Overall, this study aims to provide a more comprehensive understanding of the interconnections between environmental policies, institutional factors, and trade liberalization. The results are expected to guide policymakers in making informed decisions regarding the selection and harmonization of environmental regulatory instruments based on the institutional context and current levels of trade liberalization of a given country.

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