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Research article

Sustainable trade policies and export competitiveness: A cross-country empirical analysis

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Abstract: In this study, we examined the relationship between sustainable trade policies and export competitiveness using a balanced panel of 20 countries from 2015 to 2020, comprising 120 country-year observations. Export competitiveness was assessed through three dimensions: export growth, world market share, and revealed comparative advantage in environmental goods (RCA-EG). Sustainable trade policy was represented by Environmental Policy Stringency, Green Trade Agreements, and Environmental Technology Support, while GDP, trade openness, and innovation were incorporated as control variables. Panel-data estimation with country and year fixed effects was employed to account for country-specific heterogeneity and common time-related shocks. Our findings indicated that the three sustainable trade policy instruments did not exhibit statistically significant within-country relationships with the selected measures of export competitiveness during the study period. Their joint effects were also statistically insignificant, suggesting that sustainability-oriented trade policies may not translate immediately into measurable improvements in export performance. The findings emphasize that competitiveness outcomes may depend on longer adjustment periods and complementary structural, technological, and economic conditions. The study contributes cross-country empirical evidence on the multidimensional relationship between sustainable trade policy and export competitiveness and highlights the importance of evaluating policy effects across different dimensions of trade performance.

Keywords: sustainable trade policies; export competitiveness; environmental policy stringency; green trade agreements; environmental technology support; Revealed Comparative Advantage in Environmental Goods (RCA-EG)

JEL Codes: F14, F18, Q56, Q58

1. Introduction

In recent years, the meeting point of environmentally sustainable development and international trade has become a key focus of discussion in the world economy. Against the backdrop of a deepening climate crisis and international commitments, such as the Paris Agreement and the Sustainable Development Goals (SDGs), national and international policy frameworks have increasingly had to adapt to align with environmentally sustainable economic growth (OECD, 2020). Within this context, sustainable trade policies, broadly defined to encompass environmental standards, green trade agreements, and environmental or nature-friendly subsidies, have been highlighted for their dual aim of addressing development and environmental challenges by reducing or halting environmental damage, while preserving or improving economic capacity.

The conventional wisdom has been that strict environmental policies would impede trade and industry by imposing higher compliance costs (Copeland & Taylor, 2004). However, the "Porter Hypothesis" indicates the opposite picture: Well-designed environmental protection measures can encourage innovation and improve long-term efficiency and competitiveness (Porter & van der Linde, 1995). This idea has become topical again in the contemporary literature, notably with a number of economies investing in green innovation and renewable technology as trade performance catalysts (Shapiro & Walker, 2018; Fabrizi et al., 2024).

This is a matter of relevance, and increasing empirical work is beginning to explore the trading effects of environmental regulations. For instance, Dechezleprêtre and Sato (2017) suggested that more stringent environmental policies in developed countries are correlated with higher export performance in green sectors. Moreover, Wang and Zhang (2022) demonstrated that carbon-pricing policies and eco-labels enhanced the ability of exporters to access the green market, with the EU and North America serving as the typical example. Yet, the evidence is mostly based on specific, country- or sector-level studies, and there are few cross-country empirical studies that comprehensively control for heterogeneous policy settings and stages of development.

In this respect, green trade agreements have become a powerful tool. These include unequivocal environmental stipulations, dedication to climate targets, as well as instruments to stimulate sustainable production and trade. The analysis of Monteiro and Trachtman (2022) also shows that not only is the environmental governance promoted by them but they become trade facilitators in high-standard markets. In the same vein, Brandi et al. (2020) also highlighted that participation in green trade pacts can send signals about environmental credentials, thereby limiting non-tariff barriers (NTBs) and reducing the cost of market access. Little is known in an empirical sense about how they are affecting export competition.

Green subsidies supporting renewable energy, forestry, agriculture, and related sectors represent another policy instrument for promoting sustainable growth. While these subsidies may spur innovation and reduce the cost of entering green export markets, subsidies that are not well-designed may distort trade and create market inefficiencies (OECD, 2022; Antimiani et al., 2023). Since such subsidies raise concerns regarding their consistency with trade rules, their implications require careful evaluation by policymakers and the World Trade Organization (WTO).

In this context, the goal of our research is to provide some "fuel" to the discussion and to bolster the policies and relationships between sustainable trade and export competitiveness about which we reflexively speak in empirical terms using a panel of different countries. In comparison with researchers who often focus on individual policy instruments, specific countries, or particular sectors, we adopt a comparative framework that examines sustainable trade policies across countries and evaluates export competitiveness through three complementary dimensions: export growth, world export market share, and Revealed Comparative Advantage (RCA).

Given the growing trend toward green economies globally and the proliferation of trade reforms oriented at sustainability, it is important to understand the effects of these policies on export performance in advanced and emerging economies. The analysis of panel data over multiple years helps examine the effects of sustainable trade policies on competitiveness and provides policy-relevant evidence for policymakers seeking to reconcile environmental objectives with trade expansion (Harrison, 2023; Brandi et al, 2020).

The study contributes to the literature in several ways. First, we evaluate sustainable trade policy through Environmental Policy Stringency, green trade agreements, and Environmental Technology Support within a common empirical framework. Second, rather than relying on a single indicator of export performance, export competitiveness is examined through export growth, world market share, and the RCA in Environmental Goods (RCA-EG), thereby capturing changes in export performance, international market position, and comparative advantage. Third, the cross-country panel framework enables the analysis to account for differences across economies and changes over time. Finally, the inclusion of GDP, trade openness, and technological innovation helps distinguish the relationship of sustainable trade policies with export competitiveness from broader economic and technological conditions.

2. Background

These two conflicting pressures of being competitive in the trade and having to address the looming environmental challenges of the 21st century have been impacting the global economy and the ship industry. Trade is also being reshaped in the light of environmentally sustainable growth, as countries confront the challenges arising from climate change, and the depletion and disappearance of biodiversity (UNCTAD, 2021). The mainstreaming of sustainability in trade policies fits into this broader movement of making economic instruments consistent with ecological imperatives and establishes a trajectory toward greener, low-carbon economies (OECD, 2022). This transition is particularly relevant in that it takes place in an era of international undertakings such as the Paris Agreement and of 2030 Agenda for sustainable development, which underline the need of policy coherence between the environmental and economic arenas (United Nations, 2020).

Sustainable trade policies have become an important focus of international economic governance, encompassing trade instruments and principles explicitly oriented toward environmental objectives. These policies can be manifested in different ways, such as the implementation of environmental instruments on production and on export, conclusion of green trade agreements, provision of environmental subsidies, or environmental incentives (Monteiro & Trachtman, 2022). There is a growing understanding that there do not have to be trade-offs between trade success and environmental sustainability with more of these kinds of measures. As such, academics and policy makers are

exploring the need for the idea of protecting the environment as a competitive advantage in the global arena (Shapiro & Walker, 2018; Harrison, 2023).

One of the conflicts, however, is that the policies could lead to compromises in the future. On the other hand, environmental regulations can push up production costs and create compliance costs especially for exporters in developing and emerging countries (Copeland & Taylor, 2004; WTO, 2022). However, such regulations can also drive innovation, technological upgrading, and improved brand reputation (Porter and van der Linde, 1995; Dechezleprêtre and Sato, 2017), which can also boost the competitiveness of exports. Empirical evidence also shows that environmental policy can be strategically used to access green high-value added markets and satisfy the growing environmental standards of consumers and trade partners (Wang & Zhang, 2022; Fabrizi et al., 2024).

One additional crucial element of sustainable trade policy is green trade agreements. These deals have integrated environmentally oriented commitments, such as reduction of carbon, clauses of conservation, and promotion of renewable energy, directly into the framework of trade-liberalization (Monteiro & Trachtman, 2022). These agreements have the potential to reduce trade friction and provide an incentives framework for sustainable investment while encouraging cooperation on sustainability criteria and providing a rules-based approach to green trade. Being a member of such agreements is an indicator of environmental credibility and may contribute to business success in environment-conscious markets (Brandi et al., 2020). That said, it is not well studied how much green trade agreement can lead to the actual improvements of export performance in the cross-country context.

One policy tool that is also becoming popular is environmentally friendly subsidies, in this case, subsidies for renewable energy, green infrastructure, or sustainable agriculture. These subsidies can help reduce cost barriers to cleaner production, encourage innovation, and facilitate the adoption of cleaner technology (OECD, 2022). They are not without controversy, however, as critics argue that poorly designed subsidies can lead to a wasteful allocation of resources and also may be in violation of international trade rules, which affect the environmental aims as well as market stability (Cima & Esty, 2024; WTO, 2022). The overall effect of these subsidies on export competitiveness, particularly in comparison between economies of varying institutional capacities, remains unproven.

In this context, understanding the relationship between sustainable trade policies and export competitiveness is crucial for policymakers. While the environmental effects of trade measures have been widely studied, little is known about their economic implications, especially in a comparative international dimension (UNEP, 2021). In addition, empirical studies have tended to focus on single-country case studies or sectoral analyses, which limits the generalization (Dechezleprêtre & Sato, 2017; Wang & Zhang, 2022). The assessment of international trade performance also requires consideration of the structural and diversification characteristics of foreign trade. Popov et al. (2022) emphasized the importance of evaluating foreign trade diversification across economies, indicating that trade performance cannot be adequately understood through a single dimension. A multi-country panel-data analysis is therefore needed to capture variations in policy contexts and structural settings that may affect the effectiveness of sustainable trade policies. We fill this gap by empirically examining the effects of key sustainable trade policy instruments, namely Environmental Policy Stringency, green trade agreements, and Environmental Technology Support, on export competitiveness using a cross-country panel. Hence, to control and isolate the unique role of sustainable-based trade measures in determining export outcomes, the analysis also includes control variables such as GDP, trade openness, and technology innovation. The results are anticipated to produce strong contribution to the understanding of the ways in which countries can

craft trade policies that support environmental protection and global economic integration at the same time, again to aid building a more resilient and sustainable global trading system (Harrison, 2023; Brandi et al, 2020).

An additional gap concerns the measurement of export competitiveness, which is multidimensional and may not be adequately represented by a single trade-performance indicator. We therefore consider export growth, world market share, and RCA simultaneously to distinguish changes in export performance, international market positioning, and structural comparative advantage. The expanded cross-country panel further enables these relationships to be examined across heterogeneous economic settings and over time.

3. Need for the study

The growing worldwide focus on environmental sustainability has motivated several nations to implement sustainable trade policies, but there are few empirical studies about the effect of these policies on the competitiveness of exports in various economic settings. Some argue that green measures may discourage trade by increasing compliance costs, while others view them as an opportunity to stimulate innovation and create market opportunities for green products and services. The literature available, however, focuses on single country or sector studies, and does not offer a wide cross-country perspective to the variation of policy design and economic structure. This study is therefore opportune and significant to fill this gap through an empirical investigation into the relationship between sustainable trade policies and export performance in several countries, particularly, for policy makers, when sustainable trade policies must be linked with economic growth.

4. Objectives

1. To examine the impact of Environmental Policy Stringency on export competitiveness.
2. To assess the influence of green trade agreements on export competitiveness.
3. To evaluate the effect of Environmental Technology Support on export competitiveness.
4. To examine the joint influence of sustainable trade policy instruments on export competitiveness.

5. Literature review

Environmental sustainability and international trade have been theoretically linked in several ways. A cornerstone of this research is the Porter Hypothesis, which suggests that well-designed environmental regulation is not necessarily detrimental to a country's competitiveness but can enhance it by promoting innovation, efficiency, and technological improvement (Porter & van der Linde, 1995). From this point of view, environmental standards are a trigger for a technological upgrading of the production processes and the products by firms earning an eventual trade performance advantage. In contrast to the conventional wisdom, which sees complying with regulations as increasing production costs and reducing global competitiveness, the Porter Hypothesis suggests an ecological-economic win-win situation where environmental protection can improve economic profitability.

This is consistent with the comparative advantage and trade theory generally applied to describe how countries specialize in producing goods and services in which they have a comparative productive

advantage over other markets (Ricardo, 1817). In relation to sustainable commodities, countries investing more in green technologies and production processes that have less impact may develop a new type of comparative advantage on low carbon and eco-certified goods (Costantini & Mazzanti, 2012). The incorporation of environmental policy into trade theory has therefore generated new discussions about how green-oriented regulations can alter competitive patterns in global markets (Shapiro & Walker, 2018).

The evidence on the influence of sustainable trade policies has accumulated in the last few years, but they present mixed findings. Dechezleprêtre and Sato (2017) studied OECD countries and found that strict environmental policy resulted in better export trends for green industries leading to strengths of the Porter Hypothesis in certain cases. By the same token, Eskeland and Harrison (2018) found that Latin American cleaner production regulation has led to innovation by exporting firms, enabling them to sustain their market share in pollution-intensive industries. Moreover, Wang and Zhang (2022) observed that environmental labeling and carbon taxes in East Asia significantly increased the market access of exporters to Europe by explaining environmental compliance.

Green trade agreements have also come into spotlight as a vehicle to move sustainable trade flows forward. Monteiro and Trachtman (2022) examined more than 300 trade agreements, finding that those with stronger environmental provisions were associated with trade in green goods. Moreover, as (Brandi et al., 2020) noted, these (groups of) countries benefited from an improved reputation and had easier flows of trade with other (groups of) countries that cared about the environment. However, emerging research warns that environmental provisions in trade agreements may create a new type of non-tariff constraint for exporters in developing countries that lack regulatory capabilities.

Theoretical literature on environmental subsidies creates a more convoluted situation. On the one hand, the subsidies to renewable energy, sustainable agriculture, or green infrastructures are said to decrease objectively production costs of exporters and to stimulate the growth of green industry (OECD, 2022; Cima & Esty, 2024). Furthermore, attention has been given to the potential trade-distorting impact of these subsides, particularly, if they are not in conformity with WTO rules or are heavily skewed toward some sectors (WTO, 2022). As Elbehri et al. (2020) highlighted, the effectiveness of eco-subsidies in increasing export competitiveness is contingent upon the extent to which the application of such instruments is targeted and transparent in reality.

Both bodies of literature have, however, been highly informative, despite significant shortfalls in the empirical record. Many researchers concentrate on a specific aspect of sustainable trade policy, such as environmental regulations, trade agreements, or subsidies, without taking the joint effect into account (UNEP, 2021). Moreover, there are too many country-specific or sector-specific empirical analyses, making it difficult to generalize findings from specific institutions and economic environments (Fabrizi et al., 2024). Based on this, there are few cross-country panel data studies that simultaneously analyze the multi-dimensional effect of sustainable trade instruments on export performance over time. As noted by (Dechezleprêtre & Sato, 2017), empirical models that contribute to incorporate environmental, economic, and institutional factors enable a better vision of the dynamics of sustainable competitiveness in trade markets.

In this context, our analysis takes a more global view, by raising the main question: Does a combined environmental regulation, green trade agreement, and eco-friendly subsidy have an impact on export competitiveness in a cross-country set of countries? Additionally, by including additional control variables (like GDP, trade openness, and innovation) and employing robust panel data methods,

we aspire to add empirically based perspectives to dynamic discussions of sustainable trade. This not only expands the existing theory, but also addresses methodological shortcomings in the literature and provides a more comprehensive view of the interplay of sustainability and competitiveness in the international marketplace.

Evidence further emphasizes the importance of market-share dynamics in evaluating international trade performance. Scalamonti (2025), examining trade relationships between Italy and MEDA emerging markets, applied constant market share analysis to assess changes in trade flows and competitive positioning. The study demonstrates that export performance and market-share developments are influenced by changing economic and institutional conditions, highlighting the usefulness of market-based indicators in assessing international competitiveness.

6. Research gap

Although research has examined the interaction between environmental policy and trade, many studies are limited in scope and focus on specific policy tools (such as regulations or green trade agreements), countries, or sectors. This disaggregated method of inquiry is not capable of addressing the complex relations of sustainable trade at different levels of economic abstraction. In addition, few empirical studies have employed a comparative panel-data approach across multiple countries and time periods to examine collectively the influence of Environmental Policy Stringency, green trade agreements, and Environmental Technology Support on export competitiveness. Furthermore, trade-performance and sustainability indicators have rarely been examined within a single analytical framework that simultaneously considers export growth, market share, revealed comparative advantage, and sustainable trade policy variables. This study fills these crucial gaps by providing a combined cross-country empirical analysis to be able to offer insights into how sustainable trade policies impact the export competitiveness of countries in the world economy.

7. Methodology

We adopt a quantitative panel data approach to examine the impact of sustainable trade policies on export competitiveness across 20 countries over the period 2015–2020, resulting in a balanced panel of 120 country-year observations. The sample includes Australia, Austria, Brazil, Canada, Czechia, Denmark, Finland, France, Germany, India, Italy, Japan, the Netherlands, Norway, South Africa, South Korea, Spain, Sweden, the United Kingdom, and the United States. The sample incorporates advanced and emerging economies and is determined by the consistent availability of the principal trade, environmental policy, and economic indicators required for the study. The panel structure enables the analysis to account for cross-country heterogeneity and changes over time.

The conceptual framework illustrates the relationship between sustainable trade policy instruments and export competitiveness. Export competitiveness is assessed through three dimensions: export growth, world market share, and RCA-EG. The framework includes Environmental Policy Stringency, green trade agreements, and Environmental Technology Support as the principal explanatory variables. GDP, trade openness, and technological innovation are incorporated as control variables to account for broader economic and structural influences on export competitiveness.

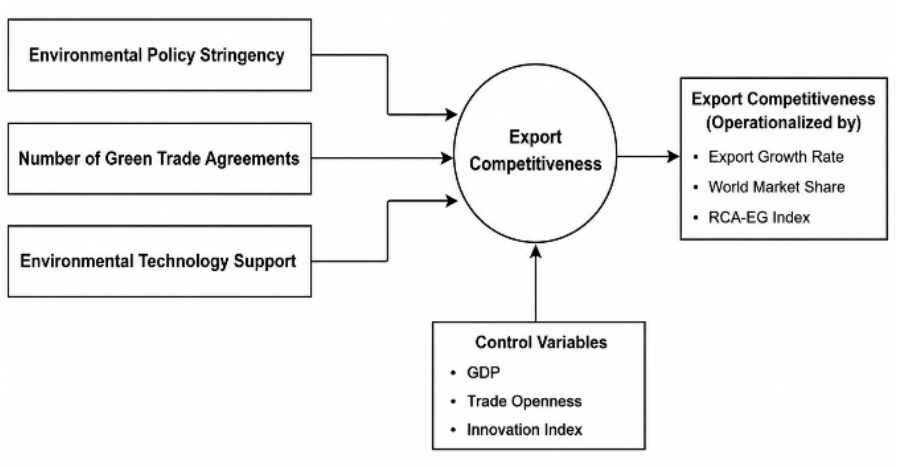


Figure 1. Conceptual Framework.

Export competitiveness is measured using three indicators: annual export growth (%), world merchandise export market share (%), and RCA-EG. The principal explanatory variables are Environmental Policy Stringency (EPS), the number of environment-related Green Trade Agreements (GTA), and Environmental Technology Support (ETS). GDP (US$ billion), trade openness (% of GDP), and the Global Innovation Index are included as control variables. The exceptional trade disruption associated with the COVID-19 pandemic in 2020 is accounted for through the year fixed effects.

GDP is included to control for differences in economic size, while trade openness captures the degree of integration with international markets. Technological innovation is represented by the Global Innovation Index (GII), which captures differences in national innovation capacity. These control variables are included because economic size, international integration, and innovation capacity may independently influence export competitiveness.

7.1. Econometric model specification

The empirical relationship between sustainable trade policies and export competitiveness is specified using the following panel regression model:

$$EC_{it} = \beta_0 + \beta_1 EPS_{it} + \beta_2 GTA_{it} + \beta_3 ETS_{it} + \beta_4 GDP_{it} + \beta_5 TO_{it} + \beta_6 INN_{it} + \mu i + \lambda t + \varepsilon it \quad (1)$$

where EC_{it} represents export competitiveness for country i in year t, estimated separately using Export Growth, World Market Share, and RCA-EG. EPS_{it} denotes Environmental Policy Stringency, GTA_{it} is the number of Green Trade Agreements, and ETS_{it} represents Environmental Technology Support. GDP_{it}, TO_{it}, and INN_{it}represent GDP, trade openness, and the Innovation Index, respectively. μ_i captures country-specific effects, λ_t captures time effects, and ε_{it} is the error term.

The study period is 2020, when the COVID-19 pandemic caused substantial disruptions to international trade and export performance. In the preferred specification, year fixed effects are included to capture common time-specific shocks across countries. Accordingly, the common COVID-19 shock in 2020 is absorbed by the 2020-year effect rather than estimated through a separate COVID-19 dummy

coefficient. The pandemic-related change in export performance is also examined graphically to provide additional context for the regression analysis.

Empirical analysis is conducted using panel regression techniques with country and year effects. Country-clustered robust standard errors are used to account for heteroskedasticity and within-country dependence. Multicollinearity among the explanatory variables is assessed using Variance Inflation Factors (VIF) before estimating the panel models.

The empirical specification uses country and year fixed effects to control for unobserved country-specific characteristics and common time-related shocks that may influence export competitiveness. This specification enables the analysis to focus on within-country changes over time while accounting for common year-specific influences. Country-clustered robust standard errors are employed for statistical inference.

Potential endogeneity may arise from reverse causality, omitted variables, or simultaneity in the relationship between sustainable trade policies and export competitiveness (Cai et al., 2025). The use of country and year fixed effects reduces bias arising from time-invariant country characteristics and common temporal shocks; however, it does not eliminate potential endogeneity. Therefore, the estimated relationships are interpreted as conditional associations rather than definitive causal effects.

This approach makes it possible to have a complete measure of how each tool of sustainable trade policy affects the export competitiveness in the long-run for different countries and their structural and development level. We will highlight lessons that can be generalized, and are policy-relevant, that can be applied to designing trade strategies that maximize environmental benefits and economic gains, from a longitudinal and comparative perspective.

7.2. Hypotheses

H_1: Environmental Policy Stringency has a significant relationship with export competitiveness.

H_2: The number of Green Trade Agreements has a significant relationship with export competitiveness.

H_3: Environmental Technology Support has a significant relationship with export competitiveness.

H_4: Sustainable trade policy instruments jointly have a significant relationship with export competitiveness.

8. Results

Table 1 provides an overview of the central tendencies and variability of the study variables, which helps us understand the data distribution before proceeding to the regression analysis.

Table 1. Descriptive statistics.

Variable	Mean	SD	Minimum	Maximum
Export Growth (%)	1.230	5.483	−20.099	11.932
World Market Share (%)	2.390	2.238	0.357	9.072
RCA Environmental Goods	1.099	0.623	0.201	2.884
Environmental Policy Stringency	3.066	0.921	0.639	4.889
Green Trade Agreements	21.717	11.812	2.000	35.000
Environmental Technology Support	2.371	1.259	0.000	5.000
GDP (US$ billion)	2500.725	4245.704	189.108	21539.982
Trade Openness (%)	71.353	34.361	23.140	163.559
Innovation Index	52.185	8.784	31.740	63.820

Table 1 presents considerable variation across the study variables. Export growth records a mean of 1.230%, with substantial variation across country-year observations, while the average world market share is 2.390%. The mean RCA-EG value of 1.099 indicates that, on average, the sampled countries exhibit a slight comparative advantage in environmental goods. Environmental Policy Stringency averages 3.066, while Environmental Technology Support records a mean of 2.371, reflecting differences in the intensity of environmental policy measures across countries. Green Trade Agreements also vary considerably, with an average of 21.717 agreements. The wide dispersion in GDP, trade openness, and innovation further demonstrates the economic and structural diversity of the countries included in the panel.

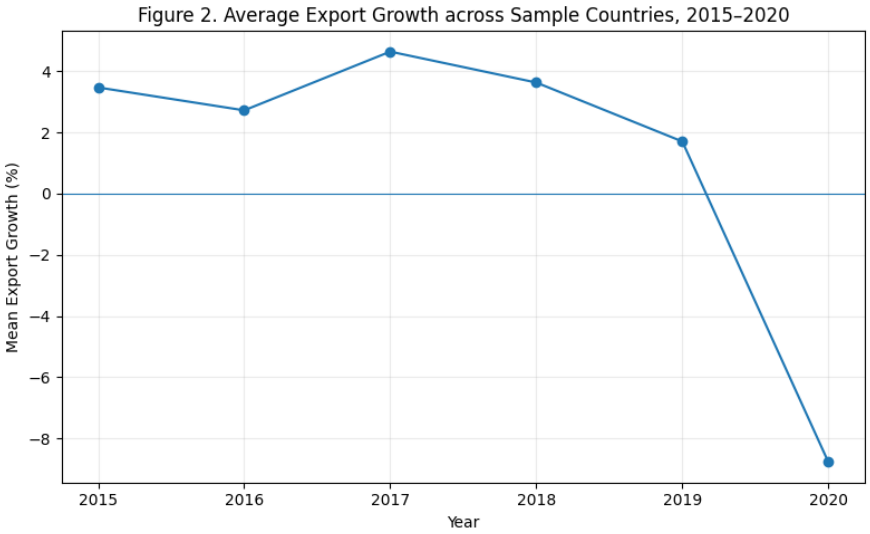


Figure 2. Average export growth, 2015–2020.

Figure 2 shows that average export growth remains positive during 2015–2019, although it fluctuated across the period. A sharp decline is observed in 2020, reflecting the exceptional disruption to international trade associated with the COVID-19 pandemic. This pattern supports the need to account for the pandemic period in interpreting the empirical results.

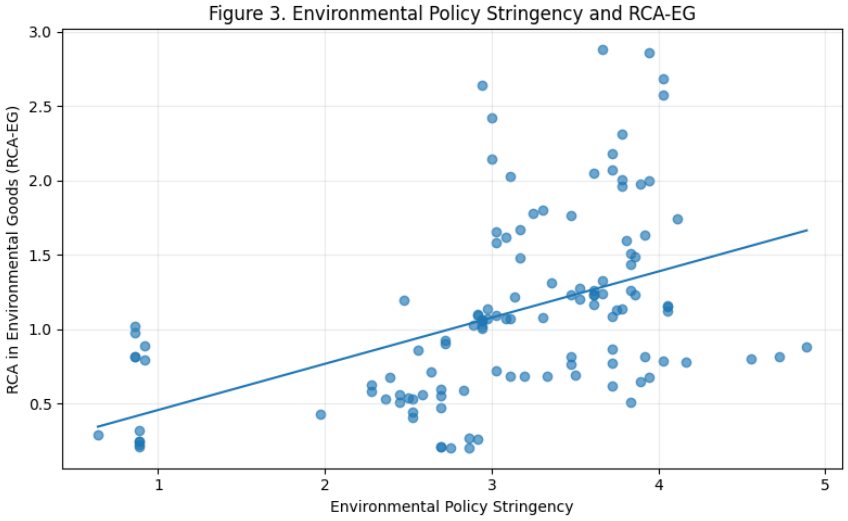


Figure 3. Environmental Policy Stringency and RCA-EG.

Figure 3 indicates a moderate positive bivariate association between Environmental Policy Stringency and RCA-EG ($r = 0.459$). Countries with greater policy stringency generally tend to exhibit higher comparative advantage in environmental goods; however, considerable dispersion is evident across observations. This descriptive relationship should not be interpreted as a causal effect, particularly as the panel regression results do not show a statistically significant effect of Environmental Policy Stringency after controlling for country, time, and other factors.

Table 2. Multicollinearity diagnostics.

Variable	VIF
Environmental Policy Stringency	5.909
Environmental Technology Support	3.111
Innovation Index	3.057
Green Trade Agreements	2.806
Trade Openness	2.335
GDP	1.687

Table 2 indicates that multicollinearity is not severe among the explanatory variables. The VIF values range from 1.687 to 5.909, with Environmental Policy Stringency recording the highest value. Although Environmental Policy Stringency shows a relatively stronger association with the Innovation Index, the diagnostic results do not indicate a level of multicollinearity that warrants excluding variables from the subsequent panel estimations.

Table 3. Panel regression results for export competitiveness.

Variables	Export Growth	World Market Share	RCA-EG
Environmental Policy Stringency	4.778	0.057	0.080
	(6.476)	(0.196)	(0.086)
Green Trade Agreements	−0.492	0.007	0.035
	(0.440)	(0.017)	(0.033)
Environmental Technology Support	−1.446	−0.005	0.081
	(2.210)	(0.071)	(0.064)
GDP (US$ billion)	−0.00050	−0.00020***	0.00005
	(0.00072)	(0.00003)	(0.00007)
Trade Openness	0.314*	−0.003	0.009
	(0.171)	(0.005)	(0.012)
Innovation Index	0.153	0.001	−0.010
	(0.316)	(0.018)	(0.019)
Observations	120	120	120
Countries	20	20	20
Country Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Within R^2	0.126	0.287	0.136

**Note: Country-clustered robust standard errors are reported in parentheses. *p < .10, **p < .05, and ***p < .01. Country and year fixed effects are included in all specifications.

The panel regression results indicate that the effects of sustainable trade policy instruments differ across the three dimensions of export competitiveness. Environmental Policy Stringency, Green Trade Agreements, and Environmental Technology Support do not show statistically significant within-country effects on export growth, world market share, or RCA-EG during the study period. Trade openness shows a positive but marginal association with export growth, suggesting that greater integration with international trade may support short-term export performance. GDP is significantly associated with world market share, highlighting the importance of economic scale in explaining countries' positions in global merchandise trade. Overall, the findings suggest that changes in sustainable trade policy

instruments may not translate immediately into improvements in export competitiveness, and their effects may depend on broader structural and country-specific conditions.

Table 4. Summary of hypothesis testing.

Hypothesis	Relationship	Result
H1	Environmental Policy Stringency → Export Competitiveness	Not Supported
H_2	Green Trade Agreements → Export Competitiveness	Not Supported
H_3	Environmental Technology Support → Export Competitiveness	Not Supported
H_4	Sustainable Trade Policy Instruments jointly → Export Competitiveness	Not Supported

The hypothesis-testing results indicate that H_1, H_2, and H_3 are not supported, as the individual sustainable trade policy variables do not show statistically significant associations across the three measures of export competitiveness. The joint significance tests for Environmental Policy Stringency, Green Trade Agreements, and Environmental Technology Support are also statistically insignificant for Export Growth ($p = .465$), World Market Share ($p = .949$), and RCA-EG ($p = .138$). Therefore, H_4 is also not supported.

9. Discussion

The findings provide a more nuanced understanding of the relationship between sustainable trade policies and export competitiveness. Environmental Policy Stringency, Green Trade Agreements, and Environmental Technology Support do not demonstrate statistically significant within-country relationships across Export Growth, World Market Share, and RCA-EG during the study period. The joint significance tests similarly indicate that the three policy instruments do not collectively explain short-run changes in the selected measures of export competitiveness. These results suggest that the adoption or strengthening of sustainable trade policies may not translate immediately into measurable improvements in international trade performance.

The findings can be interpreted in the context of the adjustment processes associated with environmental and trade policies. Environmental regulations and technology-support measures may initially involve compliance, investment, and technological adaptation before their potential competitiveness benefits become visible. Similarly, participation in environment-related trade agreements may create opportunities for greener trade without automatically generating immediate export gains. The results therefore do not imply that sustainable trade policies are economically irrelevant; rather, their effects may operate over longer periods or depend on implementation quality, productive capacity, technological readiness, and country-specific conditions.

Among the control variables, trade openness shows a positive but marginal association with export growth, while economic size is important in explaining world market share. This highlights the role of broader structural characteristics alongside environmental trade policies. Overall, the findings indicate that sustainable trade policy alone may be insufficient to strengthen export competitiveness in the short run and may need to be complemented by improvements in productive capacity, innovation, market access, and the effective implementation of environmental measures.

10. Conclusions

In this study, we examined the relationship between sustainable trade policies and export competitiveness using a balanced panel of 20 countries over the period 2015–2020. Export competitiveness was assessed through Export Growth, World Market Share, and RCA-EG, while Environmental Policy Stringency, Green Trade Agreements, and Environmental Technology Support represented the principal sustainable trade policy instruments.

The empirical findings show that the three sustainable trade policy variables do not have statistically significant within-country associations with the selected measures of export competitiveness during the study period. Their joint association with the selected competitiveness measures is also statistically insignificant. These findings suggest that sustainable trade policies may not generate immediate improvements in export performance and that their potential competitiveness benefits may require longer adjustment periods or depend on complementary economic, technological, and institutional conditions. The results further indicate that broader structural factors, particularly trade openness and economic scale, remain relevant to particular dimensions of export performance.

The study contributes to the literature by demonstrating that the relationship between sustainability-oriented trade policies and export competitiveness is not necessarily immediate or uniform across measures of trade performance. For policymakers, the findings highlight the importance of combining environmental trade policies with measures that strengthen productive capacity, technological capability, market access, and effective policy implementation. Researchers may extend the period of analysis, incorporate post-2020 geopolitical and supply-chain disruptions, and examine lagged policy effects to determine whether the competitiveness benefits of sustainable trade policies emerge over longer horizons.

Author contributions

- Dr. Bora Upendra Rao: Conceptualization, methodology, data collection, data curation, formal analysis, literature review, interpretation of results, writing–original draft, and writing–review and editing.
- Dr. Babu Rao: Conceptualization, review of the manuscript, and critical revision of the intellectual content.
- Dr. Nasa Dhanraj: Review of the manuscript, interpretation of findings, and writing–review and editing.
- Dr. Suhashini A: Review of the manuscript, validation, and writing–review and editing.
- Dr. Sathyanarayana Garadasu: Review of the manuscript, validation, and critical revision of the manuscript.

Use of AI tools declaration

No.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Data availability statement

The data used in this study were obtained from publicly available secondary sources, including international databases and institutional reports. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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