The impact of Technical Barriers to Trade on China's environmental goods exports to CPTPP

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Abstract. In the context of rising global environmental awareness and increasingly stringent non-tariff trade measures, Technical Barriers to Trade (TBT) have become a crucial factor shaping international trade flows, particularly for products with high technological and environmental content. As China seeks accession to the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), understanding the relationship between TBT imposed by CPTPP members and China's environmental goods exports has significant policy relevance. This study examines the extent to which TBT implemented by CPTPP countries influence China's exports of environmental goods from 2010 to 2024, drawing on the APEC Environmental Goods List as the basis for product classification. The findings consistently demonstrate that TBT exert a statistically significant and positive impact on China's environmental goods exports to CPTPP member states. They have meaningful implications for China's CPTPP accession efforts, suggesting that aligning domestic standards with high-level international norms may transform TBT compliance into a competitive advantage in global green trade.

Keywords: export trade, Technical Barriers to Trade, environmental goods, CPTPP, China.

1. Introduction

Despite economic globalization and regional economic integration being the prevailing trend in the world, there remains the trade protectionism in actual global trade practices. The adoption of non-tariff barriers has become a widespread phenomenon in international trade, reflecting a discernible trend where countries systematically intensify local market safeguards and employ indirect import constraints. Technical Barriers to Trade refer to trade obstacles arising from mandatory and non-mandatory technical regulations, standards, and conformity assessment procedures for commodities. As a representative of non-tariff measures, TBT are commonly used by countries to control the inflow of foreign products into domestic markets. In 2024, 16.28% of Chinese export enterprises were affected by foreign technical trade measures to varying degrees. The direct loss caused by foreign technical trade measures to Chinese export enterprises was 319.197 billion yuan (WTO/TBT-SPS National Notification and Enquiry of China, 2025). Technical trade barriers have become an important obstacle to China's exports.

Entering into force in 2018, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is a Free Trade Agreement between 12 members: Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, the United Kingdom and Vietnam. Together, these economies encompass more than 15 % of global GDP (Chloe Yeung, 2024). CPTPP has become an important platform strengthening economic cooperation among Asia-Pacific countries, which will promote a more seamless flow of goods, services and investment in the future. In September 2021, China submitted its application to join CPTPP. CPTPP member countries have always been important trading partners of China. According to statistics from the World Bank, from 2010 to 2023, China's total exports to CPTPP countries showed a fluctuating upward trend, from US$3,196.534 billion to US$4,787.065 billion. On the other hand, as the world's second-largest economy, the ascension of China will bring considerable economic benefits to CPTPP. However, as another highly influential free trade territory spanning the Pacific Ocean, the CPTPP's entry thresholds are perceived to be set at high level. For non-member economies like China, the intricate

regulatory environment within the CPTPP, particularly its stringent Technical Barriers to Trade (TBT), poses significant challenges.

The significance of this investigate is profound. Firstly, the desire to construct an environment-friendly society has prompted countries to pay more attention to the development of environmental industries. Thus, environmental goods such as solar panels and wind turbine components are significant to both global climate goals and China's green industrial development. Secondly, CPTPP members, as a bloc of advanced economies with high environmental standards, represent a crucial market for environmental goods. In the context of China's eager application to accede to CPTPP, the significance of this inquiry is profound. Therefore, this paper seeks to address the following research question: To what extent do Technical Barriers to Trade (TBT) imposed by CPTPP member states hinder the export of Chinese environmental goods? This research investigates the impact of Technical Barriers to Trade on the export trade volume of Chinese environmental goods to CPTPP countries from 2010 to 2024. The strong evidence indicates that green trade barriers have a positive effect on improving the export trade volume of Chinese environmental goods to CPTPP. This conclusion remains robust through multiple robustness tests.

2. Literature Review and Hypotheses

The impact of technical trade barriers on product exports has always been a topic of concern by scholars. By reviewing a series of literature, Ronald Fischer and Pablo Serra (2000) theoretically studied how TBT can be an implicit protectionist tool. At present, there are two main standards for measuring TBT by scholars: (1) The number of TBT notifications by each country to the WTO for a specific sector or product (2) Tariff equivalence. The tariff equivalence method is more accurate but difficult to calculate. Therefore, at present, scholars usually use the former as a measure of technical trade barriers.

Many researchers constructed models like Gravity Model and Multiple Linear Regression model to empirically test the impact of technical trade barriers on export.

As for the trade effect of technical trade barriers, most studies believe that technical trade barriers will have a negative impact on export trade, that is, the implementation of technical trade measures will cause an increase in export costs, affect the number of exports, and then inhibit exports. At the country level, Jacob Wood, Jie Wu, Yilin Li and Jungsuk Kim (2019) used TBT notifications to perform a descriptive statistical analysis of technical trade barriers. Nguyen Thi Thu Thuong, Doan Thi Hong Thinh, Nguyen Tien Long and Dinh Hong Linh (2021) confirmed that technical barriers to trade have a significant negative impact on Vietnam's tea exports from the Gravity Model and further revealed that the inhibitory effect of TBT implemented by developed countries on exports is much higher than that of developing countries. However, some scholars put forward different views. Shumin Chen (2024) illustrated that TBT have a positive effect on improving the export trade volume of Chinese photovoltaic products to ASEAN. Xiaoming Chen, Xin Shan, Peng Xin and Jian Xu (2025) studied the binary marginal effect of technical barriers to trade on the export of shellfish and aquatic products in China. The findings revealed that technical barriers to trade positively influence the extensive margin by increasing export types but have a less significant effect on the intensive margin.

According to the study of environmental goods, environmental goods refer to equipment and facilities that provide benefits for ecosystem. Common environmental products include pollution control facilities, renewable energy generation facilities and environmental monitoring facilities, etc. By reviewing a series of literature, there is no unified definition of EGs and there still exists the dual-use problem, which means dual-use products that have both environmental and non-environmental applications. Additionally, with the rapid development of technologies, the classification process of EGs tends to lag. Currently, several proposed lists coexist such as the APEC list and the Organization for Economic Co-operation and Development (OECD) list.

At present, many scholars prefer to use trade gravity models to achieve a quantitative analysis of the impact of exports. Among these, the number of TBT notifications submitted to the WTO is the

most widely used method for quantifying technical barriers to trade. This paper will also adopt this approach to further explore the effects of technical barriers to trade. Furthermore, 10 member states of the CPTPP as well as China are APEC members. Therefore, this paper plans to adopt the APEC List of Environmental Goods List in HS 2022, including 61 kinds of commodities in total. The list includes renewable and clean energy technologies, water and waste treatment products, air pollution control technologies, and environmental monitoring and assessment equipment.

Although the study of TBT has been a popular topic, limitations still exist. Firstly, the research on the impact of technical trade barriers on the export of products from different sectors mainly focuses on agricultural products and high-tech products, while there has been limited attention given to technical trade barriers concerning environmental goods. Secondly, previous research has predominantly focused on developed countries, Belt and Road Initiative countries, ASEAN countries and RCEP countries, with less attention given to the CPTPP.

Common environmental products include pollution control facilities, renewable energy generation facilities and environmental monitoring facilities, etc. There is no unified definition of environmental goods and there still exists the dual-use problem, which means dual-use products that have both environmental and non-environmental applications. Additionally, with the rapid development of technologies, the classification process of EGs tends to lag. Currently, several proposed lists coexist such as the APEC list and the Organization for Economic Co-operation and Development (OECD) list. In my research, because the 10 member states of the CPTPP as well as China are APEC members, I plan to adopt the APEC List of Environmental Goods List in HS 2022, including 61 kinds of commodities in total. The list includes renewable and clean energy technologies, water and waste treatment products, air pollution control technologies, and environmental monitoring and assessment equipment.

The implementation of Technical Barriers to Trade has significant trade effects. In the short term, TBT usually directly increases the fixed and variable costs of exporting enterprises, thereby reducing the export value. However, over time, TBT often promotes the improvement of product quality, improves the export competitiveness of products, and plays a role in promoting exports. Based on the experience of previous studies, this paper proposes the following hypothesis:

H1: Technical Barriers to Trade will have a positive impact on the export of China's environmental goods to CPTPP.

The Environmental Performance Index (EPI) is a tool used to evaluate a country's environmental health and sustainability. In countries with high EPI score, there is often the demand for environmental goods. Therefore, H2 can be proposed:

H2: In countries who have higher score of Environmental Performance Index, green trade barriers have a positive impact on the export trade scale of China's environmental goods.

Because high-income countries tend to have stricter technical regulations and environmental protection requirements, they can better promote the improvement of Chinese product quality.

H3: The role of Technical Barriers to Trade in facilitating trade is mainly concentrated in high-income countries.

3. Methodology

The Gravity Model has long been used to analyze and predict trade flows. By linking trade flows with factors influencing trade resistance such as gross domestic product (GDP), the Gravity Model has been widely applied to estimate international trade flows. Specifically, to examine the impact of Technical Barriers to Trade on export, this study constructs the following benchmark regression model based on the gravity model:

$$lntrade_{it} = \beta_0 + \beta_1 \mathrm{TBT}_{it} + \beta_2 scoreoftradefreedom_{it} + \beta_3 gdpgro_{it} + \beta_4 pop_{it} + \beta_5 expct_{it} + \beta_6 epi_{it} + \varepsilon \quad (1)$$

In this model, the subscripts i and t represent Chinese environmental goods export destination and time (year) respectively. The dependent variable $lntrade_{it}$ is the export value (in logarithm),

and the independent variable is TBT_{it} . The control variables include $scoreoftradefreedom_{it}, gdpgro_{it}, pop_{it}$(in logarithm), $expct_{it}, epi_{it}$. ε means the error term.

lntrade: This study examines the trade volume of Chinese environmental goods exported to CPTPPP countries. By analyzing this variable, we can gain knowledge for the sales volume of Chinese products in markets. The statistics come from the UN Comtrade Database. This paper takes log of the original trade value and defines lntrade as the dependent variable.

TBT: the number of Technical Barriers to Trade (TBT) notifications submitted to the World Trade Organization (WTO) every year. TBT can reflect strict technological requirement to products. The data results from the SPS&TBT Platform, where users can search for the number of TBT in different sector published by every country each year.

scoreoftradefreedom: the Score of Trade Freedom graded by the Heritage Foundation. Trade freedom is a composite measure of the extent of tariff and nontariff barriers that affect imports and exports of goods and services. The data is from the official site of the Heritage Foundation.

gdpgro: GDP growth rate per capita every year, which can be used to represente a country's economic growth rate and consumption capacity of citizens. Countries with high GDP growth rate per capita have higher level of consumption. Those countries may have higher demand for environmental goods. The data is from the World Bank.

Pop: the population of every country. The larger the population of a country, the stronger the spending power of the country. The data is from the World Bank and this paper takes log of the original statistics.

Expct: the exchange rate. This paper chooses official exchange rate (LCU per US$, period average) in world bank. Exchange rate fluctuations directly impact trade costs and revenues. For example, if the yuan depreciates, Chinese products will be more competitively priced in the export country, potentially increasing exports.

Epi: The Environmental Performance Index. This index can give an overview of a country's environmental substantiality. It can be estimated that the country having higher epi may prefer to buy environmental goods.

4. Empirical analysis

A two-way fixed-effects model is used for analysis, where lntrade represents the dependent variable, $\beta_1$represents the estimated coefficient of the key explanatory variable, β_2 to β_n represent the estimated coefficients of all control variables, μ represents the random error term.

$$lntrade_{it} = \beta_0 + \beta_1 TBT_{it} + \mu \quad (2)$$

$$lntrade_{it} = \beta_0 + \beta_1 TBT_{it} + \beta_2 scoreoftradefreedom_{it} + \beta_3 gdpgro_{it} + \beta_4 pop_{it} + \beta_5 expct_{it} + \beta_6 epi_{it} + \varepsilon \quad (3)$$

4.1. Benchmark regression

Table 1. Benchmark regression analysis

VARIABLES	(1) lntrade	(2) lntrade
tbt	0.00985**	0.0110***
	(0.00426)	(0.00220)
scoreoftradefreedom		-0.00701
		(0.0257)
gdpgro		0.0103
		(0.0135)
pop		5.581
		(3.284)
expct		0.658
		(0.825)
epi		0.00365
		(0.0127)

Constant	19.63***	-74.62
	(0.142)	(54.73)
Observations	180	180
R-squared	0.947	0.951
Country FE	YES	YES
Year FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To explore the impact of TBT on the export trade volume of Chinese environmental goods, this study employs a two-way fixed effects model. The results in the Table 1 represent the basic regression results using a two-way fixed effects model. Model (1) controls for country and year fixed effects, and the results show that the coefficient of TBT is significantly positive at the 5% level, with a regression coefficient of 0.00985. Model (2) further includes all control variables, and the coefficient of TBT remains significantly positive at the 1% level, with a slight increase to 0.0110. This indicates that technical barriers to trade (TBT) have a significant promoting effect on international trade, meaning that for each additional unit of TBT, the log of trade volume increases by approximately 0.011 units on average, which is consistent with the expected hypothesis. For the control variables, most are not significant after including two-way fixed effects. The goodness-of-fit for the models is greater than 0.94, indicating that the models have a very strong explanatory power for variations in trade volume.

Table 2. Correlation Analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) lntrade	1.000						
(2) tbt	0.441***	1.000					
(3) scoreoftradefreedom	-0.315***	-0.262***	1.000				
(4) gdpgro	0.101	-0.068	-0.130*	1.000			
(5) pop	0.791***	0.530***	-0.425***	0.096	1.000		
(6) expct	0.118	0.168**	-0.125*	-0.087	0.146**	1.000	
(7) epi	-0.076	-0.116	0.346***	-0.227***	-0.091	0.162**	1.000

*** *p<0.01,* ** *p<0.05,* * *p<0.1*

From the results of the correlation analysis of Table 2, the core explanatory variable TBT has a significant positive correlation with lntrade at the 1% level, with a correlation coefficient of 0.441, which initially aligns with the expected hypothesis. In terms of control variables, pop is highly positively correlated with trade volume at 0.791. scoreoftradefreedom is negatively correlated with trade volume. Looking at the correlations among control variables, their correlation coefficients are all less than 0.6, indicating that the likelihood of multicollinearity among the variables is low.

Considering the potential endogeneity issues between TBT and trade volume, this study selects the distance from the home country to each other country as an instrumental variable and employs the 2SLS method for estimation. The F-statistic of the first-stage regression passes the relevant statistical test, with a value of 5.094 and a corresponding p-value of 0.000, indicating that the instrumental variable is correlated with TBT and is a strong instrument. The results of Model 2 show that the regression coefficient of TBT rises to 0.070 and remains significant at the 5% level. This suggests that, after accounting for endogeneity bias, the positive effect of TBT on trade was somewhat underestimated in the baseline regression. Meanwhile, gdpgro and epi, which were insignificant in the basic regression, become significant, indicating that after addressing endogeneity issues, the overall explanatory power of the control variables for the model is enhanced.

Table 3. Endogeneity Analysis

VARIABLES	(1) first tbt	(2) second lntrade
tbt		0.070**
		(2.529)
scoreoftradefreedom	0.405	-0.002
	(0.887)	(-0.042)
gdpgro	-1.708**	0.213***
	(-2.445)	(2.773)
pop	7.012***	0.360
	(5.392)	(1.395)
expct	91.121**	-6.922*
	(2.469)	(-1.716)
epi	-0.308*	0.032*
	(-1.778)	(1.958)
Constant	-104.029**	8.318*
	(-2.214)	(1.785)
Observations	180	180
R-squared	0.391	0.125
Country FE	YES	YES
Year FE	YES	YES
F	5.094	

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2. Robust Test

To conduct robustness tests, this paper continues to use the panel instrumental variable method for estimation, selecting the core explanatory variable L.TBT as the instrumental variable. To verify the validity of the instrumental variable, unidentifiability tests, weak instrument tests, and overidentification tests were conducted. When the P-value of the unidentifiability test is less than 1%, it indicates that the instrumental variable is identifiable. The weak instrument test exceeding the 5% critical value indicates that the instrumental variable is strong. When the P-value of the overidentification test is less than 0.05, it indicates that there is no overidentification problem. The test results show that the unidentifiability test, weak instrument test, and overidentification test for both models all reject the null hypothesis, indicating that the instrumental variables are valid. The regression results in Model 1, which coefficient of TBT is 0.0302, significantly positive at the 1% level. After adding control variables in Model 2, the regression coefficient of TBT is 0.0180, also significantly positive at the 1% level, consistent in direction with the basic regression and 2SLS results, indicating robustness of the results.

Table 4. Panel Tool Variable Method

VARIABLES	(1) lntrade	(2) lntrade
tbt	0.0302***	0.0180***
	(0.00766)	(0.00460)
scoreoftradefreedom		-0.0136
		(0.0173)
gdpgro		0.00684
		(0.0109)
pop		7.905***
		(0.776)
expct		0.639
		(0.487)
epi		-0.00112

		(0.00387)
Observations	168	168
R-squared	0.063	0.474
Number of id	12	12
Country FE	YES	YES
Year FE	YES	YES
Kleibergen-Paap rk LM statistic	16.443(0.0005)	12.024(0.0005)
Kleibergen-Paap rk Wald F statistic	61.372(16.38)	52.458(16.38)
overidentification test	0.000	0.000

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Additionally, this article adjusts the time window of the study and re-estimates the results. Considering that the global economy was affected to some extent during the pandemic, especially China, the 2020 sample data were excluded and the regression was re-conducted. In Model 1, which only controls for country and year, the regression coefficient of TBT is 0.0101, significantly positive at the 5% level. After adding control variables in Model 2, the regression coefficient of TBT is 0.0116, significantly positive at the 1% level, which is basically consistent with the basic regression results, and the significance level remains unchanged. This indicates that the results of this study are not affected by specific time periods and are robust.

Tbale 5. Adjustment sample period

VARIABLES	(1) lntrade	(2) lntrade
tbt	0.0101**	0.0116***
	(0.00410)	(0.00199)
scoreoftradefreedom		-0.0136
		(0.0292)
gdpgro		0.0171
		(0.0236)
pop		5.731
		(3.310)
expct		0.303
		(0.894)
epi		0.00308
		(0.0130)
Constant	19.60***	-76.61
	(0.136)	(55.10)
Observations	168	168
R-squared	0.947	0.950
Country FE	YES	YES
Year FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This article also lags the core explanatory variable TBT by one period which is L.tbt to mitigate the issue of instantaneous reverse causality. The regression results show that in Model 1, the regression coefficient of the L.tbt is 0.00719, significantly positive at the 10% level. In Model 2, the regression coefficient of the L.tbt is 0.00835, significantly positive at the 1% level, indicating that the one-period lagged TBT still has a significant positive effect on current trade volume. This is consistent with the basic regression results, further confirming the robustness of the baseline regression outcomes.

Table 6. Lagged Core Explanatory Variable

VARIABLES	(1) lntrade	(2) lntrade
L.tbt	0.00719*	0.00835***
	(0.00368)	(0.00269)
scoreoftradefreedom		-0.00490
		(0.0266)
gdpgro		0.0102
		(0.0136)
pop		5.583*
		(3.033)
expct		0.954
		(1.130)
epi		0.00669
		(0.0112)
Constant	19.79***	-74.90
	(0.120)	(50.74)
Observations	168	168
R-squared	0.945	0.948
Country FE	YES	YES
Year FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3. Heterogeneity analysis

To investigate the heterogeneity of the impact of TBT at different trade levels, this paper conducted quantile regression. The results show that at the 20%, 40%, 60%, and 80% quantiles, the regression coefficients of TBT are all significantly positive, and the regression coefficients gradually increase with higher quantile levels, rising from 0.0109 at the 20% quantile to 0.0135 at the 80% quantile. This indicates that the trade-promoting effect of TBT is more pronounced for countries with higher trade volumes, showing that the higher a country's trade level, the more significant the trade-promoting effect of TBT.

Table 7. Quantile Regression

VARIABLES	(1) 0.2 lntrade	(2) 0.4 lntrade	(3) 0.6 lntrade	(4) 0.8 lntrade
tbt	0.0109***	0.0115***	0.0124***	0.0135***
	(0.00328)	(0.00265)	(0.00277)	(0.00426)
scoreoftradefreedom	-0.0223	-0.0199	-0.0166	-0.0125
	(0.0155)	(0.0126)	(0.0131)	(0.0202)
gdpgro	-0.000528	0.00135	0.00395	0.00724
	(0.0154)	(0.0124)	(0.0130)	(0.0200)
pop	8.409***	8.593***	8.848***	9.170***
	(0.903)	(0.731)	(0.766)	(1.175)
expct	0.738	0.667	0.568	0.443
	(0.639)	(0.516)	(0.540)	(0.831)
epi	0.00149	0.000953	0.000208	-0.000735
	(0.00486)	(0.00392)	(0.00410)	(0.00631)
Observations	180	180	180	180
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To examine whether the impact of TBT varies with the level of national economic development, this study divides the entire sample into a "low-income country group" and a "high-income country group" based on the average per capita GDP for sub-sample regressions. The results of the sub-sample regressions show that in the low-income group, the regression coefficient of TBT is 0.0133, but it is not significant; in the high-income group, the regression coefficient of TBT is 0.0105, significant at the 1% level. This indicates that the positive effect of technical barriers to trade on trade is mainly concentrated in high-income countries, which is similar to the conclusions of the quantile regression. The possible reason for this phenomenon is that high-income countries may possess stronger technical capabilities and infrastructure, enabling them to better create TBT requirements, thereby pushing China to accelerate technological progress and converting TBT into trade competitiveness.

Table 8. Subsample Regression

	(1)	(2)
	Low GDP	High GDP
VARIABLES	lntrade	lntrade
tbt	0.0133	0.0105***
	(0.00875)	(0.00165)
scoreoftradefreedom	-0.0280	0.0162
	(0.0266)	(0.0139)
gdpgro	0.0121	0.00666
	(0.0157)	(0.00815)
pop	-4.967	7.664***
	(7.106)	(1.260)
expct	0.288	0.966
	(0.771)	(0.918)
epi	0.00893	0.0141
	(0.0174)	(0.0112)
Constant	101.3	-119.4***
	(116.1)	(22.22)
Observations	105	75
R-squared	0.946	0.949
Country FE	YES	YES
Year FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

In the context of the environmental protection, this study investigates the impact of TBT on the export trade volume of Chinese environmental goods to CPTPP member countries. Based on empirical analysis, the results indicate a significant positive correlation between TBT and the trade volume of environmental goods, suggesting that TBT has facilitated the export of Chinese environmental goods to CPTPP countries.

This study examines the impact of technical barriers to trade on international trade flows using methods such as panel two-way fixed effects models, two-stage least squares, panel instrumental variable approaches and quantile regression. The baseline regression, based on the panel two-way fixed effects model, shows that TBT have a significant promoting effect on trade volume. This conclusion is confirmed after endogeneity tests and various robustness checks, indicating that TBT significantly promote trade volume. Finally, the heterogeneity and quantile regression results reveal significant sample differences in the promotional effect of TBT on trade volume. The heterogeneity results show that the promotion effect of TBT on trade is mainly manifested in high-income countries. The quantile regression results indicate that the promotion effect of TBT is stronger for countries with higher trade volumes.

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