

The Impact of EU Carbon Border Regulation Mechanism on the Export Market Structure of China's Steel Industry

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Abstract

The EU carbon border regulation mechanism was formally passed in May 2023 and officially implemented in January 2026. As the world's largest steel exporter, China is facing the expected impact of external carbon costs. Using the monthly export data of steel products in Chapter HS72 of China from January 2015 to December 2025, this paper uses the double difference method (DID) to study the impact of CBAM on the export market structure of China's steel industry. The study found that after controlling for the exchange rate, the comprehensive PMI of the euro area, the steel price index and the GDP of the importing countries, the DID coefficient changed from positive to negative. The results show that after the CBAM legislation was passed, China's steel exports to the EU decreased by about 10.9% compared with non-EU countries. After further adding the time fixed effect, the conclusion is still robust. This provides new empirical evidence for understanding the carbon tariff transmission mechanism. And it also provides enlightenment for China's steel industry to cope with the impact of CBAM and accelerate the low-carbon transformation.

Keywords

EU carbon border regulation mechanism, steel export, double difference method, market structure, trade crowding out

1. Introduction

The EU carbon border regulation mechanism is a unilateral trade policy tool launched by the EU to balance the internal and external carbon emission reduction costs and prevent carbon leakage. In May 2023, the text of the CBAM bill was officially announced, marking the completion of the legislative process of the mechanism. In October 2023, the mechanism entered a transitional period. During this period, importers need to fulfill the declaration obligation but do not need to pay taxes temporarily. CBAM officially entered the tax period on January 1st, 2026. Importers of relevant commodities need to purchase and pay for the corresponding amount of CBAM certificates. At present, CBAM mainly covers six categories of products, including steel, aluminum, cement, fertilizer, electricity and hydrogen, of which steel has the most prominent impact on China [1]. In this context, how CBAM will affect the export cost and trade structure of China's iron and steel products is an important issue in the current academic research.

Scholars generally believe that in the long run, the implementation of the CBAM policy will reshape the product structure, force China's major industries to accelerate the process of low-carbon development, and provide external pressure for the realization of the goals of “carbon peaking” and “carbon neutralization” [2,3]. Zhang Qingbin and other scholars pointed out from a quantitative point of view that with the reduction of the free allowance share year by year, the cost of the steel industry will continue to increase. By 2031, when the free allowance share is reduced to 39%, the cost of the steel industry will increase by more than 10%. Finally, by 2034, when the free allowance share is reduced to 0%, the cost of the steel industry will increase by 19%, indicating the long-term cost impact [4].

However, there are two major differences in the existing research on the short-term impact of the carbon border regulation mechanism on China's steel industry. Pan Yuhong, Li Tao and others believe that it will have a great impact on China's steel industry during the transition period. This is embodied in increasing the cost of steel products, weakening the international competitiveness of China's steel industry, and promoting the low-carbon transformation of China's steel industry [5,6]. In Liu Xiaoyuan's research, importers expect prices to rise in the short term, which will further cause trade inhibition [7]. While Tang Huiyu and others focused on the subsidy effect of the system, the free allowance share had not completely withdrawn in the early stage of policy implementation. According to this, it is pointed out that if the national carbon market is included in the steel industry before 2026, the carbon tariff to be paid by Chinese steel enterprises in 2026 will be very low or even zero [8]. Yan Qing further explained the reason why carbon tariffs have little impact on the market price of China's steel products from the perspective that the European Union is not the main export market of China's steel products [9].

Existing studies have been relatively sufficient in the quantitative calculation of CBAM's impact on the cost of the steel industry, but have not paid enough attention to the changes in the export market structure of China's steel industry under the effect of policies. Based on this, this paper uses the monthly export data of steel products in Chapter HS72 of China from May 2015 to December 2025, with 27 EU countries as the processing group and 23 non-EU countries as the control group, as the data source. Furthermore, the double difference method (DID) is used to investigate the impact of CBAM policy expectation on China's steel export structure from the perspective of market flow, in order to provide evidence for understanding the trade transmission mechanism of carbon tariffs.

2. Research Methods

2.1 Data Sources

The EU Carbon Border Adjustment Mechanism (CBAM) was first proposed in the European Green Deal in 2019. It was formally adopted in May 2023, entered a transitional phase in October 2023, and entered the substantive taxation stage in January 2026. Based on the above evolution process, this study extracted monthly export values of China's HS72 steel products from May 2015 to December 2025. The data is from the Global Trade and Industrial Growth Laboratory. The euro area composite Purchasing Managers' Index (PMI) was obtained from Markit, with post-2025 values based on linear regression forecasts. Monthly average EUR/USD exchange rates were indirectly derived from RMB/EUR and RMB/USD monthly averages provided by China Economic Data ($\text{EUR/USD} = \text{RMB/EUR} \div \text{RMB/USD}$). China's steel bulk commodity price index was sourced from China Economic Data as well. Annual GDP figures for each country were obtained from the World Bank's WDI database and repeated annually in the monthly panel.

2.2 Model Setting and Variable Description

In order to test whether CBAM has changed the market direction of China's steel exports, this paper selects 27 EU countries as the treatment group and 23 non-EU countries as the control group, and constructs a double difference model. In order to correctly screen the control group, this paper follows the following principles: first, select the top countries in China's steel export amount (ranking from the Global Trade and Industrial Growth Laboratory) to ensure that the control group is representative in terms of trade volume. Second, the selected countries cover Southeast Asia, South Asia, the Middle East, Africa, Latin America and other major regions, avoiding the control group being concentrated in a specific region. Third, considering that the United States and Canada have independent steel tariff policies towards China, they should be removed from the control group to eliminate the interference of other trade policies. Based on the above principles, the final 23

non-EU countries are Turkey, South Korea, India, Vietnam, Russia, Ukraine, Thailand, Saudi Arabia, the United Arab Emirates, the Philippines, Malaysia, Egypt, Pakistan, South Africa, Nigeria, Brazil, Chile, Peru, Japan, Oman, the United Kingdom, Australia and Bangladesh. The adoption of EU CBAM legislation in May 2023 is set as the time point of policy impact. The model is set as follows:

$$\ln(\text{export}_{it}) = \beta_0 + \beta_1(\text{Treat}_i * \text{Post}_i) + \gamma X_{it} + \delta_i + \lambda_i + \varepsilon_{it} \quad (1)$$

Table 1: Variable Description

Variable type	Symbol	Definition	Measurement method
explained variable	$\ln \text{export}_{it}$	logarithm of China's steel export amount to region i in t period	take the natural logarithm of export value
explanatory variable	Treat_i	processing group virtual variables	EU=1, non EU=0
	Post_i	policy period virtual variable	After May 2023=1, otherwise=0
	$\text{Treat}_i * \text{Post}_i$	net effect of treatment group before and after policy implementation	$\text{Treat}_i * \text{Post}_i$
control variable	δ_i	control regional characteristics that do not change with time	region virtual variable
	λ_i	control the time trend that does not change with the region	time virtual variable
	ε_{it}	random error term	other influencing factors
	X_{it}	a series of control variables	including exchange rate, PMI, steel price index and GDP
parameters to be estimated	β_0	intercept at reference exit level	model estimation
	β_1	DID estimation factor	model estimation
	γ	coefficient vector of control variables	model estimation

3. Analysis of Changes in Market Structure

3.1 Result Analysis

Table 2 shows the regression results of formula (1) after gradually adding control variables. As the control variable is gradually added, the did coefficient changes from positive to negative. Specifically, model (1) only controls for the national fixed effect and exchange rate, and the did coefficient is 0.3257. After further adding PMI and the steel price index to model (3) and (4), the did coefficient is reduced to 0.2707 and 0.2233, respectively. After model (4) is introduced into the GDP of each country, the DID coefficient is -0.1088, which is significant at the 5% level. This shows that after the adoption of CBAM legislation, China's exports to the EU have declined compared with non-EU countries, showing a certain trade crowding-out effect. After further adding the time fixed effect, the DID coefficient is still significantly negative, indicating that the main conclusion is relatively stable.

Table 2: Regression Results

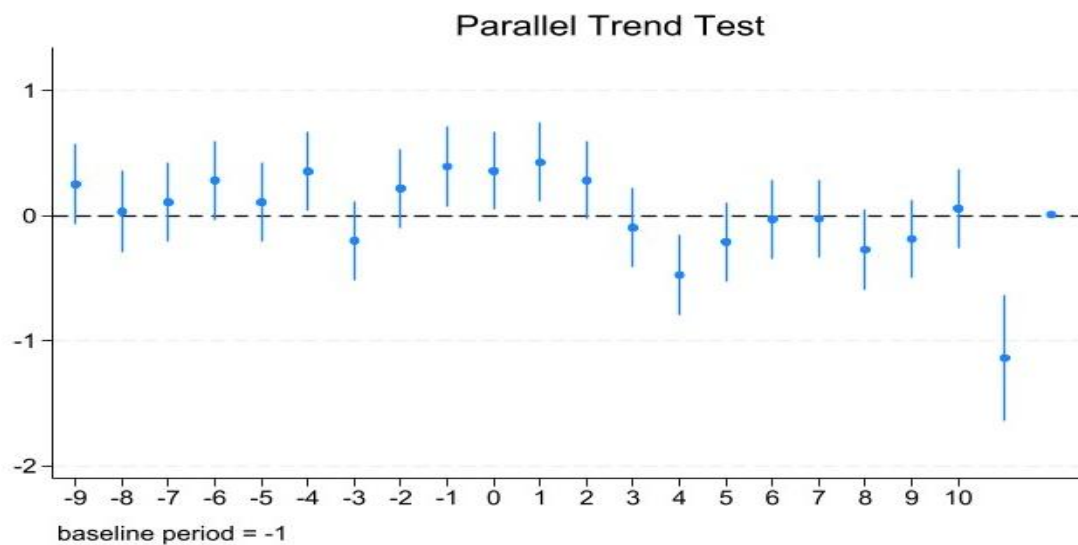
Variables	(1) $\ln \text{ export}$	(2) $\ln \text{ export}$	(3) $\ln \text{ export}$	(4) $\ln \text{ export}$	(5) $\ln \text{ export}$
$\text{Treat}_i * \text{Post}_i$	0.3257*** (0.0314)	0.2707*** (0.0314)	0.2233*** (0.0313)	-0.1088** (0.0433)	-0.1321** (0.0488)
exchange rate	-1.3181*** (0.1940)	-0.7909*** (0.1994)	-1.6204*** (0.2110)	-1.3040*** (0.2451)	34.4377 (43.3818)
PMI		0.0198*** (0.0020)	0.0161*** (0.0020)	0.0113*** (0.0023)	0.4469 (0.8693)
steel price index			0.0036*** (0.0003)	0.0016*** (0.0004)	-0.0126 (0.0260)
GDP				1.1061*** (0.0963)	0.5643*** (0.1281)
Constant	17.5052*** (0.2183)	15.8976*** (0.2684)	16.6199*** (0.2754)	-11.6726*** (2.4885)	-68.6720 (88.4645)
national fixed effect	YES	YES	YES	YES	YES
time fixed effect	NO	NO	NO	NO	YES
Observations	6545	6545	6495	4983	4983
Within R_squared	0.0270	0.0422	0.0626	0.0847	0.1964

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

3.2 Parallel Trend Test

The implicit assumption of using the double difference method is that the control group and the treatment group also have the same time trend without policy impact. If there is a certain difference between the treatment group and the control group in advance, the resulting results can no longer represent the net effect of the policy [10]. In the above analysis, this paper constructs a double difference model to test the impact of the CBAM policy on the export market structure of China's steel industry. Therefore, it is necessary to conduct a parallel trend test to verify whether the sample meets the preconditions of using double difference: even without the impact of the CBAM policy, there is no obvious trend difference between the processing group and the control group. Based on this, this paper conducts a parallel trend test on the regression of export market structure, and the results are shown in Figure 1.

Figure 1: Parallel Trend Test



As shown in Figure 1, in most periods before the implementation of the policy (relative to the policy passing time point $t < -1$), the confidence interval of the estimated coefficient contains 0 value. This shows that there is no significant trend difference between the treatment group and the control group in advance, which meets the parallel trend hypothesis, and verifies the effectiveness of the model in this paper. During the transition period of policy implementation, the DID coefficient fluctuates periodically, which may be related to the wait-and-see and exploratory behavior of importers when the policy details are not yet clear, but the overall fluctuation trend is mainly negative and tends to be stable. In March 2024 (relative to the 10th period of the policy time point), the coefficient showed a more obvious downward trend, which may be related to factors such as the tightening of EU carbon market quotas in early 2024. On the whole, the parallel trend test results are consistent with the conclusion of the CBAM crowding out effect in the benchmark regression.

3.3 Robustness Test

3.3.1 Placebo Test

As shown in Table 3, the did coefficients at the time points of the false policy from 2016 to 2019 are all negative, reflecting the trend decline of China's steel exports under the background of Sino-US trade frictions and global steel overcapacity. From 2020 to 2022, the false time point coefficient changed from negative to positive, reflecting the rebound in demand brought about by the reconstruction of the global supply chain after the epidemic. The DID coefficient of the real policy time point (May 2023) is -0.1088 ($p=0.012$), which is significantly negative at the 5% level. That is to say, under the trend of export rebound from 2020 to 2022, the relative growth of China's steel exports to the EU has been significantly reversed after the CBAM legislation was passed, showing a crowding out effect of about 10.9%.

Although some false time point coefficients are also significant, it may be related to multiple external shocks such as Sino-US trade frictions, overcapacity and epidemic fluctuations. Their direction changes are

opposite to the real time point, indicating that the CBAM effect is different from the general demand fluctuation in direction. Combined with robust tests such as changing the control group and adding the fixed time effect, the benchmark conclusion has good reliability.

Table 3: Placebo Test

Virtual policy time point	DID coefficient	P value
May 2016	-0.2376	0.000
May 2017	-0.2141	0.000
May 2018	-0.1498	0.000
May 2019	-0.1444	0.000
May 2020	0.0551	0.130
May 2021	0.2704	0.000
May 2022	0.0958	0.025
True: May 2023	-0.1088	0.012

3.3.2 Replace the Control Group

In the benchmark regression, the control group selected in this paper covers Southeast Asia, South Asia, the Middle East, Africa, Latin America and other major regions. Considering that the American countries' steel trade with China may be affected by the independent trade policy, this paper further limits the control group to Asian countries and re-estimates the benchmark model. As shown in Table 4, the DID coefficient after replacing the control group was -0.1103, which was significant at the 5% level and highly consistent with the benchmark result (-0.1034). This shows that the benchmark conclusion does not change with the selection of the control group, and it passes the robustness test.

Table 4: Replacement of Control Group

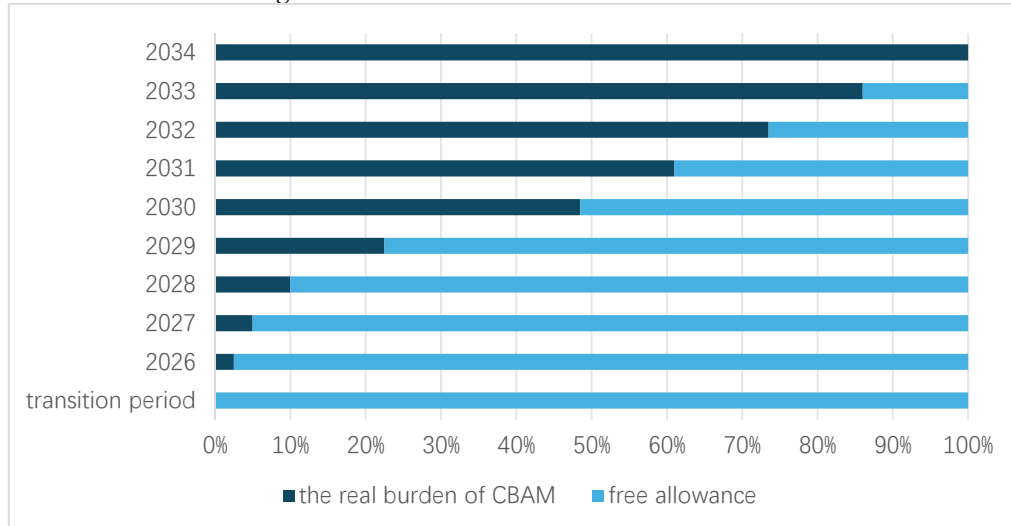
Variables	ln export
Treat _i *Post _t	-0.1112** (0.0458)
exchange rate	-1.2906*** (0.2675)
PMI	0.0120*** (0.0025)
steel price index	0.0010** (0.0005)
GDP	1.1246*** (0.1057)
Constant	-12.4701 (2.7435)
national fixed effect	YES
time fixed effect	NO
Observations	4459
Within R squared	0.0783

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

4. Discussion

The above empirical results show that after the adoption of CBAM legislation, China's steel exports to the European Union fell by about 10.9%, showing a significant crowding out effect. After controlling for demand-side factors such as GDP, exchange rate, PMI, and steel price of importing countries, the DID coefficient changed from positive to negative and remained stable, indicating that the negative impact of CBAM on steel exports is real.

It is worth mentioning that the sample in this paper, as of December 2025, mainly reflects the expected effect during the transition period. Considering that the free allowance share of EU CBAM will decrease year by year and will drop to 0% by 2034, the cost pressure of carbon tariffs will also increase year by year. At present, the crowding out effect of about 10.9% can be understood as a harbinger of long-term impact. With the gradual reduction of free allowance shares, the carbon cost will gradually be transmitted to the export price, and the pressure on China's steel industry to face trade transformation will further increase. It is urgent to accelerate the low-carbon transformation and optimize the export structure.

Figure 2: Free Allowance Share Reduction Ratio

5. Conclusion

Through research, this paper finds that: at the level of market structure, CBAM has a significant crowding-out effect on China's steel exports. After controlling for GDP, exchange rate, PMI and the steel and price index of importing countries, the DID coefficient is -0.1034, which is significant at the 5% level, indicating that CBAM has reduced China's steel exports to the European Union by about 10.9%. After the robustness test of time fixed effects and changing the control group, the conclusion is still robust.

This study also has the following limitations: first, limited by the availability of data, this paper mainly analyzes the data at the product level, which can not be refined to the enterprise level and can not fully cover the differentiated responses of enterprises of different sizes and ownership to CBAM. Second, the annual GDP of all countries is not fully collected in this paper, which leads to a difference in the amount of data between the third experimental group and the fourth experimental group. The conclusion may have a certain impact on the reliability. Third, this paper does not investigate the impact of the policy on the steel industry after its formal implementation, but only selects the data of the transition period for research. Based on the above research limitations, future research can be further expanded in the following aspects: first, introduce relevant data at the enterprise level to analyze the differentiated coping strategies of different enterprises on carbon tariff policies. The second is to track the data of a longer time window after 2026, and investigate whether trade transfer and low-carbon transformation have actually occurred with the gradual reduction of free quotas. The third is to integrate the carbon tariff policies of CBAM and other countries into a unified analytical framework to assess the systematic impact of the carbon tariff pattern on China's exports.

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Conflicts of Interest

The authors declare no conflict of interest.

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