Effects of the EU Carbon Border Adjustment Mechanism on Abnormal Stock Returns in Taiwan

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Abstract

This study investigates the capital market reactions of Taiwan's carbon-intensive industries to major CBAM-related policy developments. Using event study methodology, the research focuses on the cement and steel sectors—two key industries covered by the EU' s Carbon Border Adjustment Mechanism (CBAM) and Taiwan's emerging carbon fee framework. Three policy events were selected: the announcement of the carbon fee draft regulation (December 1, 2023), the official carbon fee rate announcement (October 7, 2024), and the launch of the trial declaration phase (May 1, 2025). Abnormal returns (AR) and cumulative abnormal returns (CAR) were estimated using the market-adjusted model and tested for statistical significance. The results reveal significant industry-specific responses: the steel industry exhibited stronger negative reactions to rate announcements, while the cement industry showed positive responses during implementation. These findings highlight the importance of regulatory timing, content, and sectoral sensitivity in shaping investor behavior under climate-related policies. The study contributes to the literature on sustainability disclosure and financial market dynamics and offers implications for policymakers managing carbon transition risks.

Keywords: Carbon Border Adjustment Mechanism (CBAM), Event Study, Abnormal Returns, Carbon-Intensive Industries.

JEL Classifications: G1, G14, G18

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1. Introduction

As the 2030 global carbon reduction target draws near, countries and corporations face increasing pressure to cut greenhouse gas emissions by at least 45% to meet the 1.5°C goal. In this context, governments have accelerated climate regulation, and companies are implementing carbon neutrality pledges and phased emissions targets. Among these global efforts, the European Union's Carbon Border Adjustment Mechanism (CBAM) stands out as a key initiative. Starting with emission reporting in 2023 and carbon charges in 2026, CBAM aims to prevent carbon leakage and ensure fair competition among EU-based and foreign producers.

Taiwan, as an export-driven economy with energy-intensive industries, is particularly sensitive to the impacts of CBAM. Over 70% of Taiwan's energy consumption stems from industrial activities. From 2016 to 2020, the country exported an average of 1.17 million metric tons of CBAM-covered products annually to the EU, valued at around USD 1.2 billion—98% of which was steel. Based on the EU's carbon price, CBAM compliance could increase export costs (Erdogdu, 2025). In 2023, the export value of CBAM-covered products reached USD 900 million, highlighting growing exposure.

Beyond the EU, countries including the U.S., Japan, South Korea, and China have also introduced carbon pricing schemes and net-zero commitments. Taiwan passed the Climate Change Response Act in 2023, initiating a phased carbon fee system applicable to direct and indirect emissions as well as carbon-intensive imports. These measures pose compliance and competitiveness risks to energy, manufacturing, and heavy industry sectors.

Environmental policies are increasingly shown to influence capital markets. Carbon emissions are negatively associated with firm value, particularly in strict environmental regulation (Choi & Luo, 2021). Proactive climate strategies may yield positive investor sentiment, while failure to adapt may result in divestment or abnormal return volatility. CBAM-related compliance costs, especially in early implementation stages, may affect firm profitability and investor behavior(Bolton et al., 2022; Kuo & Chou, 2023).

While prior studies have examined environmental disclosures and ESG behavior, few have investigated how markets respond directly to CBAM policy announcements—particularly in the Taiwanese context. This study addresses that gap using an event study methodology. It analyzes the market responses of Taiwan's carbon-intensive industries, focusing on cement and steel, to three major CBAM-related announcements: the draft regulation release (December 1, 2023), the official rate announcement (October 7, 2024), and the launch of the trial declaration phase (May 1, 2025).

This study aims to answer two research questions:

(1) Do different stages of CBAM policy development (draft announcement, fee rate release, and trial implementation) result in significantly different abnormal stock returns?

(2) Do the market responses differ in Taiwan's cement and steel industries?

Empirical findings reveal that policy stage and industry type play important roles in shaping market responses. For cement, the draft stage elicited no significant response, while the fee rate announcement led to significantly negative returns (CAR = –4.45%). The trial phase, however, saw a positive reaction (CAR = +3.15%). The steel industry reacted positively to the draft (CAR = +2.24%), strongly negatively to the fee rate (CAR = –6.07%), and showed mixed responses during the trial period—indicating variations in industry readiness.

2. Literature Review and Hypothesis Development

The economic implications of environmental policies have long been a focus of both policymakers and financial markets. Traditional views suggest that such policies—at least in the short term—tend to impose burdens on firms by increasing compliance costs, limiting technological options, and restricting output, often without immediate gains in productivity(Kozluk & Zipperer, 2015). However, more recent evidence highlights that the adoption of environmental management systems, such as ISO 14001, can reduce carbon intensity and enhance profitability, particularly for large enterprises(Arocena et al., 2021).

From a capital market perspective, environmental policy announcements—especially those introducing stricter regulations or higher uncertainty—have been shown to trigger adverse investor responses. The European Union's Carbon Border Adjustment Mechanism (CBAM) is a notable case. Investors are increasingly attentive to how carbon-intensive firms respond to emerging cross-border pricing mechanisms and regulatory compliance risks.

According to Makol et al.(2025) and White et al.(2025), countries are expected to bear disproportionately higher CBAM adjustment costs. In Taiwan's case, exporters of high-emission products to the EU must purchase carbon allowances and establish mechanisms for verifying product-level carbon footprints. Eicke et al. (2021)emphasize that goods entering the EU must undergo lifecycle carbon assessments, and companies may incur penalties for insufficient allowance coverage. These requirements necessitate additional spending on external audits, compliance systems, and disclosure reports—raising operational costs and potentially eroding international competitiveness.

Xia et al. (2024) further argue that when stricter environmental regulations are announced, markets anticipate reduced profitability and future cash flows, leading to negative abnormal stock returns. The uncertainty surrounding CBAM implementation may also exacerbate information asymmetry between firms and investors. To compensate for this risk, investors may demand higher premiums, while creditors may require additional collateral or impose higher interest rates (Zhou et al., 2025). These financial constraints can significantly affect firm performance and valuation.

Based on these insights, this study proposes the following hypothesis:

Hypothesis 1 (H1): CBAM-related policy announcements by regulatory authorities will lead to negative abnormal stock returns for affected firms.

Furthermore, policy announcements unfold in multiple stages, each conveying different levels of clarity, urgency, and regulatory commitment. Draft-stage announcements typically offer preliminary information and ambiguous details, leading to limited market reactions. In contrast, official fee rate announcements signal tangible financial impacts and are likely to prompt stronger investor responses. The trial declaration phase, while operational in nature, may reduce uncertainty and foster more neutral or even positive sentiment due to enhanced policy transparency(Shen et al., 2023).

These time-specific effects warrant differentiated hypothesis development. Accordingly, the study proposes the following:

Hypothesis 2a (H2a): The announcement of the official carbon fee rate will lead to significantly negative abnormal stock returns due to anticipated compliance costs.

Hypothesis 2b (H2b): The launch of the trial declaration phase will lead to neutral or positive abnormal stock returns as a result of improved regulatory clarity and reduced uncertainty.

In addition to policy timing, industry characteristics also shape investor behavior. The steel industry, due to its high carbon intensity and strong dependence on EU exports, is likely to face more severe risks and thus stronger stock market reactions (Li et al., 2023). In contrast, the cement industry may exhibit more moderate responses due to its relatively domestic market orientation and longer adjustment horizon. Therefore, this study proposes the following:

Hypothesis 3 (H3): Stock market reactions to CBAM announcements will differ significantly between industries, with the steel industry showing stronger abnormal returns (positive or negative) compared to the cement industry.

3. Research Design

This study adopts an event study methodology to investigate the impact of the European Union's Carbon Border Adjustment Mechanism (CBAM) policy on Taiwan's corresponding legislative developments from 2019 to 2024. The analysis specifically focuses on the cement and steel industries, assessing the abnormal stock returns triggered by key policy announcements.

The event study approach examines whether financial markets exhibit abnormal returns in response to specific events, and it has been widely applied in top-tier finance journals—particularly in studies evaluating regulatory changes, policy implementations, and legislative actions. This method helps to capture investor reactions and assess the market's perception of government interventions. Based on prior literature, this study uses Cumulative Abnormal Returns (CAR) to estimate the market response to selected CBAM-related events.

3.1 Key Event Dates and Policy Announcements

This study investigates how key legislative milestones in the development of the EU Carbon

Border Adjustment Mechanism (CBAM) have influenced the formulation of related regulatory frameworks in Taiwan. It aims to analyze the potential implications and policy responses in the Taiwanese context. Table 1 outlines the major CBAM-related events that have shaped Taiwan's regulatory landscape.

Table 1. Key Policy Milestones Affecting Taiwan's Steel and Cement Industries in Response to the EU CBAM

Number	Date	Event Description
1	December 1, 2023	Taiwan's Ministry of Environment released the "Guidelines for the Carbon Fee Rate Review Committee" and announced the draft regulation for carbon fee collection. Companies in the power sector and large manufacturing industries—such as steel and cement—with annual emissions exceeding 25,000 metric tons of CO_2 equivalent are designated as fee payers. This marks Taiwan's formal transition into a carbon-pricing regime.
2	October 7, 2024	The carbon fee rate was officially announced following a prior notice period, providing regulatory clarity and enabling firms to assess future cost impacts.
3	May 1, 2025	The trial declaration phase of the carbon fee system begins. Although no actual payment is required during this stage, companies must report their carbon emissions and simulate corresponding carbon fee calculations. This represents the operational commencement of carbon fee implementation.

3.2 Event Window and Estimation Method

As previously described, this study identifies 3 major policy events related to the EU CBAM legislative process and its influence on Taiwan's carbon fee regulation. These events primarily reflect milestones in Taiwan's carbon pricing legislation and signal either the advancement or uncertainty of regulatory implementation.

To estimate abnormal returns, this study adopts the market-adjusted model, which compares individual stock returns against market index returns. Following the recommendation of Asthana and Balsam (2001), the event window is defined as five trading days, spanning from one day before to three days after the event date (i.e., [−1, +3]). This relatively short window captures the immediate market response while minimizing external noise.

3.3 Definition and Estimation of Abnormal and Cumulative Abnormal Returns

This study employs the Market-Adjusted Returns Model to estimate abnormal returns, following established practices in event study literature. In the absence of an event, the expected return of security i during the event window E is expressed as:

$$E(\hat{R}_{iE}) = \hat{\alpha}_i + \hat{\beta}_i R_{mE},\ \text{E} \in \text{W}, \tag{1}$$

where R_{mE} denotes the market return (i.e., TAIEX), and $\hat{\alpha}_i$, $\hat{\beta}_i$ are parameters estimated during the estimation window.

Given the highly concentrated industrial structure of Taiwan's stock market—where firms within the same industry often exhibit co-movement in returns—this study further applies the Two-Index Market Model as proposed by Langetieg (1978), to control for industry-specific effects:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \beta_{xi} R_{xt} + \varepsilon_{it}\ ,\ \text{t} = t_1, \cdots t_2\ ,\ \text{i} = 1, 2, \cdots, \text{N}. \tag{2}$$

In Equation (2), R_{xt} represents the return of a peer company or industry index associated with firm *i*. This adjustment accounts for common shocks within sectors such as steel and cement, thereby enhancing the model's explanatory power.

After estimating expected returns, the abnormal return (AR) is calculated as the difference between actual return and expected return during the event period:

$$AR_{iE} = R_{iE} - E(R_{iE}). \tag{3}$$

To reduce firm-specific noise from unrelated corporate announcements or market movements, the abnormal returns of all sample firms are averaged to derive the Average Abnormal Return (AAR) across *N* firms:

$$AR_{iE} = \frac{1}{N}\sum_{i=1}^{N} AR_{iE}. \tag{4}$$

The Cumulative Abnormal Return (CAR) over the event window is then obtained by summing the average abnormal returns across all days T in the event window:

$$CAR = \sum_{E=t_1}^{t_2} AR_E. \tag{5}$$

Finally, to test whether the average abnormal return is statistically significant, a cross-sectional t-test is employed. This method evaluates whether the estimated AAR or CAR is significantly different from zero, thus determining whether the event has a measurable impact on stock prices.

4. Empirical Result

4.1 Overall Stock Market Reaction

This section analyzes the abnormal stock return patterns of Taiwan's cement and steel industries in response to three CBAM-related policy events, which represent major stages in the development of Taiwan's carbon fee system. These events include the announcement of the carbon fee draft regulation on December 1, 2023, the official fee rate announcement on October 7, 2024, and the launch of the trial carbon fee declaration on May 1, 2025.

The results are estimated using the market-adjusted model, with statistical significance assessed through both the cross-sectional t-test (CS Test) and the sign test. Each table reports daily abnormal returns (AR) and cumulative abnormal returns (CAR) over a five-day event window (−1, +3), with

asterisks denoting levels of statistical significance. Tables 2 through 4 present the empirical results for the cement industry, while Tables 5 through 7 summarize the findings for the steel industry.

Table 2. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Cement Industry on the December 1, 2023 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	-0.0148	-0.0396	-1.1339	(-1,-1)	-0.0148	-0.0396	-1.1339
0	-0.4182	-2.0189**	-2.6458***	(-1,0)	-0.433	-1.6644*	-1.1339
+1	0.2341	0.7018	1.1339	(-1,1)	-0.1989	-0.6316	-1.1339
+2	0.7733	1.9995**	2.6458***	(-1,2)	0.5743	1.2681	1.1339
+3	-0.0884	-0.5123	1.1339	(-1,3)	0.486	1.4259	1.1339

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 3. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Cement Industry on the October 7, 2024 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	-0.0341	-0.1017*	-0.378	(-1,-1)	-0.0341	-0.1017	-0.378
0	-1.118	-1.9709**	-1.1339	(-1,0)	-1.1521	-1.6583**	-1.1339
+1	-0.6065	-2.8928***	-1.8898*	(-1,1)	-1.7586	-2.7014***	-1.8898*
+2	-1.0988	-4.4328***	-2.6458***	(-1,2)	-2.8573	-4.2806***	-2.6458***
+3	-1.591	-8.4533***	-2.6458***	(-1,3)	-4.4483	-7.853***	-2.6458***

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 4. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Cement Industry on the May 1, 2025 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	-0.064	-0.2186	0.378	(-1,-1)	-0.064	-0.2186	0.378
0	-0.5621	-0.7581	-1.1339	(-1,0)	-0.6261	-0.803	-1.1339
+1	3.3806	8.9321***	2.6458***	(-1,1)	2.7545	2.9246***	1.8898*
+2	0.1114	0.2788	0.378	(-1,2)	2.8659	3.6344***	2.6458***
+3	0.2875	1.4406	1.8898*	(-1,3)	3.1534	4.1836***	2.6458***

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 5. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Steel Industry on the December 1, 2023 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	-0.1263	-0.7499	-2.1429**	(-1,-1)	-0.1263	-0.7499	-2.1429**
0	0.3748	1.9433*	2.7143***	(-1,0)	0.2485	1.3133	-0.1429
+1	1.0673	4.9495***	4.1429***	(-1,1)	1.3158	3.8411***	2.7143***
+2	0.6137	3.3814***	3***	(-1,2)	1.9296	4.7074***	3.5714***
+3	0.3096	1.0726	0.1429	(-1,3)	2.2391	4.1406***	4.4286***

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 6. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Steel Industry on the October 7, 2024 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	0.671	3.284***	2.5456**	(-1,-1)	0.671	3.284***	2.5456**
0	-1.8793	-10.206***	-6.2225***	(-1,0)	-1.2083	-4.7495***	-3.9598***
+1	-1.2531	-5.483***	-4.5255***	(-1,1)	-2.4613	-7.5088***	-5.9397***
+2	-1.7166	-7.6432***	-5.374***	(-1,2)	-4.1779	-10.0916***	-6.2225***
+3	-1.8881	-7.9676***	-6.2225***	(-1,3)	-6.066	-11.848***	-6.7882***

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

Table 7. Abnormal Returns (AR) and Cumulative Abnormal Returns (CAR) for the Steel Industry on the May 1, 2025 Event Day

Date	AR	CS Test	Sign Test	Event Window	CAR	CS Test	Sign Test
-1	-0.8263	-3.2992***	-1.9799**	(-1,-1)	-0.8263	-3.2992***	-1.9799**
0	-1.1431	-4.1745***	-4.5255***	(-1,0)	-1.9693	-6.5417***	-5.374***
+1	0.0271	0.0884	0.5657	(-1,1)	-1.9423	-4.5351***	-5.6569***
+2	1.0539	3.5538***	2.5456**	(-1,2)	-0.8884	-1.5361	-4.2426***
+3	-0.2517	-1.0671	-1.1314	(-1,3)	-1.1401	-1.7262*	-3.1113***

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

4.2 Key Findings and Research Contributions

This study conducts an event analysis of the stock price reactions in Taiwan's cement and steel industries in response to three CBAM-related policy events, and presents the following key findings and research contributions.

For the cement industry, the market showed no significant reaction to the announcement of the carbon fee draft regulation on December 1, 2023, indicating limited investor sensitivity during the

early policy formation stage. However, following the official announcement of the carbon fee rate on October 7, 2024, the industry exhibited significantly negative abnormal returns (CAR = –4.45%, significant at the 1% level), suggesting strong investor concerns about rising compliance costs. By May 1, 2025, when the trial declaration period began, the cement industry showed a significantly positive reaction (CAR = +3.15%), likely reflecting reduced uncertainty and improved market confidence as policy implementation became clearer.

In contrast, the steel industry responded positively to the draft announcement on December 1, 2023 (CAR = +2.24%, significant at the 1% level), possibly interpreting the policy as delayed or manageable. However, upon the formal rate announcement on October 7, 2024, the industry experienced a sharp and significant negative response (CAR = –6.07%, highly significant), reflecting expectations of substantial financial impact. During the trial phase on May 1, 2025, the steel industry's response was mixed—initially negative, followed by partial recovery by day +2—suggesting variability in industry readiness and policy adaptation.

The empirical results show that market reactions to climate-related regulatory policies depend on the timing, specificity, and perceived severity of the announcements. Draft-stage signals often generate muted responses, while official implementation or rate announcements tend to produce significant abnormal returns. The comparative analysis further reveals clear sectoral heterogeneity in sensitivity to carbon cost exposure, providing a useful basis for policy calibration and industry-specific risk assessments.

Overall, this study contributes to the growing body of literature on the intersection of sustainability regulation and financial market behavior. By applying event study methodology to cross-industry CBAM-related events, it offers new insights into investor responses to carbon pricing policies and provides actionable implications for policymakers, firms, and investors managing climate transition risks.

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