Carbon Borders and Currency Markets:

Exchange-Rate Volatility Effects of CBAM Announcements for G20

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Abstract

This paper examines whether climate-trade policy affects currency markets by analyzing the impact of the European Union's Carbon Border Adjustment Mechanism (CBAM) on exchange-rate volatility. Using a high-frequency panel of daily exchange rates for G20 economies over 2021–2026, we construct a novel CBAM Trade Exposure Index to capture cross-country vulnerability. Exploiting major policy announcements as exogenous shocks, we estimate both fixed effects and Difference-in-Differences models. We find that key CBAM milestones—particularly the initial proposal and legal entry into force—are associated with significant declines in exchange-rate volatility, with stronger effects in more exposed economies. These results support an uncertainty-resolution mechanism, whereby policy clarity stabilizes financial markets despite introducing future regulatory costs. In contrast, later implementation stages generate no significant effects, suggesting that markets are forward-looking and rapidly incorporate policy information. The findings reveal a previously unexplored financial transmission channel of climate policy, linking carbon border measures to macro-financial stability.

Keywords: CBAM, Exchange rate volatility, G20 Countries, Trade exposure, Two-way fixed Effects, Difference-in-Difference

JEL Nos.: F31, F36, Q54, Q56, G15

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Introduction

The intersection of climate policy and international trade has entered a new phase with the emergence of carbon border measures. Among these, the European Union's Carbon Border Adjustment Mechanism (CBAM) represents a structural shift in the global trade architecture by embedding carbon pricing into cross-border transactions. By levying charges on the embodied emissions of imported goods, CBAM seeks to mitigate carbon leakage while preserving the competitiveness of domestic industries subject to stringent climate regulations. While the implications of such policies for trade flows, production structures, and welfare have been widely discussed, their impact on financial markets—particularly currency markets—remains largely unexplored. This omission is striking. Exchange rates are a central macro-financial variable, influencing export competitiveness, capital flows, inflation dynamics, and monetary policy responses. More importantly, exchange-rate volatility serves as a real-time barometer of uncertainty faced by market participants. If climate-trade policies such as CBAM alter expectations about future trade costs, regulatory regimes, and global demand patterns, they should, in principle, be reflected in currency markets. Yet, the existing literature has largely treated climate policy as a real-sector phenomenon, abstracting from its potential financial transmission channels.

This paper argues that CBAM operates not only through trade and production channels but also through a financial channel, affecting exchange-rate dynamics via uncertainty and expectations. Specifically, we posit that policy announcements associated with CBAM alter the information environment faced by investors and traders. In the presence of policy uncertainty, exchange rates embed risk premia and exhibit heightened volatility (Pastor and Veronesi, 2012; Bloom, 2009). Credible policy announcements—even when they imply future economic costs—can reduce uncertainty by clarifying the policy trajectory, thereby stabilizing financial markets. This uncertainty-resolution mechanism suggests that the impact of CBAM on currency markets may be counterintuitive: greater regulatory stringency need not increase volatility if it enhances policy credibility.

Our paper contributes to three strands of literature. First, it relates to the growing body of work on climate policy and international trade. Existing studies have examined the effects of carbon border adjustments on trade flows, competitiveness, and welfare distribution (e.g., Böhringer et al., 2022; Branger and Quirion, 2014; Bellora and Fontagné, 2023). However, these analyses are largely confined to real economic outcomes and computable general equilibrium frameworks, leaving financial market responses unaddressed. Second, the paper contributes to

the literature on exchange-rate volatility and its determinants. A vast body of research has identified macroeconomic fundamentals, global risk factors, and policy uncertainty as key drivers of currency fluctuations (Engel and West, 2005; Rey, 2015; Miranda-Agrippino and Rey, 2020). In particular, global financial cycles and risk sentiment—often proxied by indicators such as the VIX—play a dominant role in shaping exchange-rate dynamics. Yet, the role of climate-related policy shocks as a source of exchange-rate volatility has not been systematically examined. Third, the paper connects to the literature on policy uncertainty and financial markets. Prior work shows that uncertainty regarding fiscal, monetary, and regulatory policies affects asset prices, investment decisions, and volatility (Baker, Bloom, and Davis, 2016; Pastor and Veronesi, 2013). We extend this framework to the domain of climate-trade policy, highlighting that CBAM announcements constitute a novel class of policy shocks with both real and financial implications.

Against this backdrop, this paper provides, to the best of our knowledge, the first empirical evidence that climate-trade policy affects currency markets. We construct a novel CBAM Trade Exposure Index (TEI) capturing country-level vulnerability to CBAM based on export composition and combine it with a high-frequency panel of daily exchange rates for G20 economies over the period 2021–2026. Exploiting major CBAM policy milestones as quasi-exogenous events, we estimate both a two-way fixed effects model and a Difference-in-Differences specification to identify the impact of policy announcements on exchange-rate volatility. Our findings reveal a consistent and economically meaningful pattern. The initial CBAM proposal in 2021 and the legal entry into force in 2023 are associated with significant declines in exchange-rate volatility, particularly in countries with higher exposure to CBAM. These results support the uncertainty-resolution mechanism: markets respond more strongly to the reduction of policy ambiguity than to the anticipated costs of regulation. In contrast, intermediate milestones—such as political agreement and transition phases—generate weaker and statistically insignificant effects, suggesting that financial markets react primarily to events that convey new and credible information. Difference-in-Differences estimates further show that high-exposure economies experience larger volatility reductions relative to low-exposure counterparts during key policy announcements. Taken together, the results uncover a previously overlooked dimension of climate policy: its ability to influence macro-financial stability through currency markets. By demonstrating that carbon border measures have measurable effects on exchange-rate volatility, this paper highlights the importance of integrating financial channels into the analysis of climate-trade policies.

The rest of the papers proceeds as follows. Section 2 discusses the theoretical standpoint and generates the hypotheses we will evaluate. The empirical analysis is carried out in Section 3 with sub sections on data sources and variables, methodology and model specification. Section 4 discusses the results obtained and policy implications and Section 5 concludes the paper with planning future research agenda.

2. Theoretical standpoint

A micro-founded theoretical framework would assist to formalize how climate-trade policy—specifically the Carbon Border Adjustment Mechanism (CBAM)—affects exchange-rate volatility through a risk and uncertainty channel. Consider a small open economy that exports a continuum of differentiated goods to the European Union (EU). Let $\theta_i \in [0,1]$ denote the share of exports that falls under carbon-intensive sectors covered by CBAM, capturing the country's structural vulnerability to the policy. Exporting firms are competitive in international markets and invoice their exports in euros. Denoting the nominal exchange rate by E_t(units of domestic currency per euro), export revenues in domestic currency are given by $R_{it} = E_t \cdot P^* \cdot X_{it}$, where $P^*$is the exogenous euro price and $X_{it}$is export volume.

CBAM introduces a per-unit carbon cost $\tau_t$on covered exports. Crucially, this cost is not perfectly known ex ante and evolves with policy announcements and regulatory developments. We model this as $\tau_t = \bar{\tau} + \varepsilon_t$, where $\bar{\tau}$is the long-run carbon price and $\varepsilon_t$captures policy uncertainty with time-varying variance $\sigma^2_{\tau,t}$. This formulation allows us to explicitly incorporate uncertainty about climate policy into firms' decision-making environment. So a representative exporting firm in country i will earn profits given by:

$$\Pi_{it} = E_t \cdot P^* \cdot X_{it} - C(X_{it}) - \theta_i \tau_t X_{it}.$$

Firms are assumed to be risk-averse and maximize mean-variance utility, $U = \mathbb{E}[\Pi_{it}] - \frac{\gamma}{2}\mathrm{Var}(\Pi_{it})$, where $\gamma > 0$denotes the degree of risk aversion. Under this structure, profit variability arises from two distinct sources: exchange-rate fluctuations and uncertainty surrounding the carbon cost. Importantly, the latter is scaled by θ_i, implying that firms in more exposed economies face greater sensitivity to policy uncertainty.

To link firm-level risk to exchange-rate dynamics, we embed this structure in an asset-market framework in which exchange rates are determined by global investors allocating capital across countries based on expected returns and risk. In reduced form, the exchange rate can be

expressed as a function of expected profitability and its variance, alongside global financial conditions. A log-linear approximation yields a relationship in which exchange-rate movements depend negatively on changes in profit variance: higher uncertainty leads to greater exchange-rate volatility as investors demand compensation for risk. Substituting the expression for profit variance shows that, in addition to standard exchange-rate risk, policy uncertainty contributes directly to overall risk, with its effect amplified by the exposure parameter θ_i.

CBAM policy announcements are introduced as information shocks that reduce uncertainty about the future path of carbon costs. Specifically, we assume that the variance of the policy shock declines discretely at announcement dates, such that $\sigma_{\tau,t}^2 = \sigma_{\tau,0}^2 - \kappa_k D_{k,t}$, where $D_{k,t}$denotes a policy event and $\kappa_k > 0$captures the credibility and informational content of that announcement. Substituting this into the variance expression implies that credible announcements reduce the uncertainty faced by firms, with the magnitude of the reduction increasing in the degree of CBAM exposure.

The central implication of the model is that policy announcements—by resolving uncertainty—lead to a decline in exchange-rate volatility, and that this effect is systematically stronger in economies with higher exposure to CBAM. In other words, while CBAM introduces a future cost component, its announcements can stabilize financial markets by clarifying expectations. This generates a testable prediction that the response of exchange-rate volatility to CBAM events is negative and increasing in exposure. The theoretical framework yields primarily two testable hypotheses:

H_1: *exchange-rate volatility should respond systematically to CBAM policy announcements, with the magnitude of the response depending on a country's exposure to the policy.*

H_2: *the volatility response to CBAM announcements is heterogeneous — high-exposure countries respond significantly differently from low-exposure countries, even after accounting for global macroeconomic conditions.*

These predictions directly motivate our empirical strategy, which exploits cross-country variation in exposure and temporal variation across policy events to identify the financial effects of climate-trade policy. While Hypothesis H1 is tested using a two-way fixed effects baseline model, we deploy a simple Difference in Difference approach for robustness analysis as in Hypothesis H2.

3. Empirical Analysis

This section outlines the empirical framework used to test the theoretical predictions regarding the impact of CBAM policy announcements on exchange-rate volatility. Guided by the model, our identification strategy exploits two key sources of variation: (i) cross-country differences in exposure to CBAM, and (ii) the timing of discrete policy announcements that alter the information environment faced by market participants.

3.1 Methodology

To this end, we adopt an event-based panel framework that exploits both the time-series variation generated by discrete policy announcements and the cross-sectional variation in exposure to CBAM. The identification strategy treats major CBAM milestones as exogenous information shocks that alter market expectations regarding future carbon costs. These events—such as the initial proposal, political agreement, and legal enactment—represent points at which new and credible information becomes available to financial markets. In line with the theoretical framework, such announcements are expected to reduce policy uncertainty, even if they imply future regulatory costs.

A key advantage of using high-frequency (daily) data is that it allows us to isolate the short-run response of exchange-rate volatility within narrow event windows, thereby minimizing contamination from confounding macroeconomic developments. This event-study logic is embedded within a panel regression framework, enabling us to control for both country-specific heterogeneity and common global shocks. To capture the heterogeneity in responses, we exploit variation in countries' structural exposure to CBAM using the Trade Exposure Index (TEI). This allows us to test whether economies that are more vulnerable to carbon border measures exhibit stronger financial market reactions to policy announcements. The empirical approach therefore combines elements of event study analysis, panel fixed effects estimation, and Difference-in-Differences (DiD) to provide a comprehensive assessment of the hypothesized mechanisms.

3.2 Model specification

We begin with a two-way fixed effects specification that directly maps the theoretical model into an estimable equation:

$$| r_{it} | = \beta_0 + \sum_{k=1}^{5} \beta_k (D_{k,t} \times tei_i) + \gamma | r_{i,t-1} | + \alpha_i + \lambda_t + \epsilon_{it}$$

where, $| r_{it} |$ is the dependent variable denotes exchange-rate volatility measured as the absolute difference between current day real effective exchange rate of i[th] country from that of its previous day:

$$| r_{it} | = | \ln (E_{it}) - \ln (E_{i,t-1}) | \quad (1)$$

On the right-hand side, we have the constant term β_0 followed by $D_{k,t}$ $(k = 1 \ldots 5)$ which are event indicators corresponding to the five specific CBAM policy milestones. This is interacted with the trade exposure measure tei_i that captures the differential impact of policy announcements across countries based on what share of their exports of CBAM identified product groups are going to the EU. The corresponding coefficients β_k are the primary parameters of interest: they measure how the effect of each policy event on exchange-rate volatility varies with trade exposure. Consistent with the theoretical framework, we expect these coefficients to be negative for events that credibly reduce uncertainty, with larger magnitudes for more informative announcements. We also include a lagged dependent variable, $| r_{i,t-1} |$, to account for persistence in volatility and path dependence, which is a well-documented feature of exchange-rate dynamics. Financial volatility is well-documented to cluster over time —periods of high volatility tend to persist, and calm periods also tend to persist. This property, called volatility clustering, means that if we omit this control, the CBAM event dummies might spuriously absorb some of this natural autocorrelation — particularly if a CBAM announcement happens to coincide with a period of elevated or suppressed volatility for unrelated reasons.

The term α_i captures country fixed effects, controlling for time-invariant structural differences such as financial depth, exchange-rate regimes, and institutional characteristics. The inclusion of time fixed effects λ_t absorbs global shocks common to all countries, including shifts in global risk appetite, monetary policy surprises in major economies, and geopolitical developments. Finally, the error term ϵ_{it} captures idiosyncratic shocks. In this dataset, two specific dependence structures exist. First, within a currency over time — today's residual for INR is correlated with yesterday's and tomorrow's (serial correlation). Second, across currencies on the same day — all 13 currencies are simultaneously buffeted by global shocks not fully captured by the model, creating cross-sectional dependence. The standard solution of two-way clustering requires a large number of clusters in both dimensions. With only 13 currencies, two-way clustering produces a non-positive-definite covariance matrix (mathematically, negative variance estimates), making the standard errors invalid. Driscoll-Kraay (1998) standard errors use a Newey-West spatial kernel that accounts for both serial

correlation and cross-sectional dependence without requiring a large number of entities. They are the theoretically correct choice for panels with small N and large T which is precisely our situation with N=13 and T»1,300.

The identification of causal effects relies on the assumption that CBAM announcements are exogenous to short-run exchange-rate movements in partner economies, and that, absent these events, volatility in high- and low-exposure countries would have evolved similarly within narrow time windows. The inclusion of time fixed effects and global controls mitigates concerns arising from common shocks, while the high-frequency nature of the data reduces the scope for omitted variable bias. To ensure robust inference, we compute Driscoll–Kraay standard errors, which are robust to heteroskedasticity, serial correlation, and cross-sectional dependence. This is particularly important in a macro-financial panel context, where global shocks may induce correlation across countries.

3.3 Data and variables

The dataset is a balanced panel of 13 G20 currencies observed at daily frequency from January 4, 2021, to January 30, 2026 — approximately 1,300 trading days per currency, giving roughly 16,900 total observations. Each row in the dataset represents one currency on one trading day. The list of 13 currencies is provided in the Appendix. The choice of starting the sample in 2021 is to align with the first CBAM event (the proposal in July 2021) and is extended through early 2026 to capture the definitive implementation date. Bilateral daily exchange rate, E_{it}, of each of the 13 currencies versus the Euro (EUR) is taken from Federal Reserve Economic Data (FRED) of St Louis and the European Central Bank (ECB). EUR is chosen because CBAM is an EU policy, so EUR-bilateral rates most directly capture the EU trade-related financial channel. Volatility is measured as in equ (1). This measure captures realized volatility in a simple and transparent manner and is widely used in the empirical finance literature. It is particularly suitable for high-frequency event analysis, where the objective is to capture immediate market reactions. Three common volatility measures are used in the literature: absolute return (|r|), squared return (r^2), and GARCH conditional volatility. Absolute return is chosen here for two reasons. First, it is less sensitive to extreme outliers than squared return — the Russia sanctions episode in 2022 produced very large single-day returns and squaring them would give those days disproportionate influence on the regression. Second, absolute return is a transparent, directly interpretable measure that does not require model-based estimation (unlike GARCH), making the results easier to communicate and replicate.

To operationalize the exposure parameter θ_i from the theoretical model, we construct a CBAM Trade Exposure Index (tei_i). This index is defined as the share of a country's exports to the European Union out of total exports that fall within CBAM-covered sectors, including aluminium, iron & steel, cement and fertilisers. Data is taken from World Bank UN Comtrade database. The index is time-invariant and reflects structural differences in export composition across countries. This time-invariant nature is what makes it interact powerfully with event window dummies: the only thing that varies is whether we are inside or outside an event window, and the exposure score scales how strongly each country should respond. Higher values of the index indicate greater vulnerability to CBAM and, consequently, greater sensitivity to policy uncertainty. This variable plays a central role in both the fixed effects and DiD specifications, capturing the heterogeneity predicted by the model.

We identify a set of major CBAM policy milestones that serve as exogenous shocks to the information environment. First is the proposal as on July 14th, 2021, when European Commission formally published its CBAM legislative proposal — the first concrete legal text detailing which sectors, which countries, and what carbon pricing mechanism would apply. This was followed by the political agreement on December 13th, 2022, when the European Parliament and the Council of the EU reached a provisional political agreement on the final text — effectively sealing the legislative deal between the two co-legislators. After that the CBAM Regulation was officially published in the EU Official Journal and entered into force as binding EU law as on May 17th, 2023. Next the transition phase started from October 1st, 2023, wherein EU importers were required to report embedded emissions in CBAM goods, but no financial payments were yet required. Finally, the definitive implementation phase started from January 1st, 2026, since which full CBAM obligations came into effect; importers must purchase CBAM certificates equivalent to the carbon price of imported goods. For each event, a dummy variable D_{kt} (k denotes the events) equals 1 for all trading days within a ±10 calendar days window around the event date, and 0 on all other days. This window captures market anticipation (days before) and continued adjustment (days after) around each announcement. A ±10-day window — 21 trading days total — is chosen because CBAM is a legislative, gradualist policy (not a surprise shock), so markets process these announcements over a wider horizon than, say, an unexpected central bank decision.

To account for global factors affecting exchange-rate volatility, we include a set of control variables drawn from trade literature that will be utilised in the robustness check model to test Hypothesis H2. While the model specification has been discussed in the relevant section, we

introduce the variables and data sources here. We have daily change in the CBOE (Chicago Board Options Exchange) Volatility Index (vix_{it}) to control for global investor risk appetite. Daily log return of Brent crude oil prices (oil_{it}) is used as a control for commodity-price-driven forex movements. Daily log return of the EUR/USD exchange rate controls for broad euro movements that mechanically affect all bilateral pairs. These data are taken from the FRED[1]. These controls help isolate the effect of CBAM announcements from broader macro-financial dynamics. By combining high-frequency data with cross-country heterogeneity, the analysis provides a rigorous test of the financial channel of climate-trade policy.

4. Results and Discussions

4.1 Event Study Evidence

We begin by presenting visual evidence on the behaviour of exchange-rate volatility around major CBAM policy announcements. Figures 1–3 in the Appendix plot daily volatility within a ±10-day window around key events, providing a non-parametric assessment of market responses.

Figure 1 examines the period surrounding the CBAM political agreement. The dynamics reveal substantial cross-country heterogeneity, volatility declines following the announcement, with high-exposure countries exhibiting a sharper reduction compared to low-exposure countries. Pre-event trends appear broadly similar, supporting the validity of the difference-in-differences design. Figure 2 shows how volatility changes compared to what was normal before the event. After the CBAM proposal, countries that are more exposed to CBAM show a bigger drop in volatility than less exposed countries. This means the policy announcement had a stronger calming effect on the more exposed countries. This pattern is consistent with the uncertainty-resolution mechanism emphasized in the theoretical framework: the formal enactment of CBAM reduces ambiguity about future policy implementation, thereby lowering the risk perceived by market participants. Figure 3 presents volatility dynamics of high and low-exposure countries at each stage of CBAM. At the proposal stage, countries more exposed to CBAM saw a larger drop in volatility. In later stages, there isn't a clear difference between the

[1] These data on control variables from FRED does not report values on US federal holidays because US financial markets are closed. However, Forex markets in Europe and Asia continue trading on these dates, so the panel has observations on those days but the controls do not. To handle this, the control values from the most recent trading day are carried forward for up to two consecutive days — a standard approach for isolated holiday gaps. Only 14 trading days out of 16,904 total observations remain missing after this fill (0.08%) which is negligibly small.

two groups, which suggests that most of the impact happened when the policy was first announced. This aligns with the forward-looking nature of financial markets, where anticipated policy changes are priced in well before their actual implementation.

Taken together, the event-study evidence provides preliminary support for the central hypothesis that only policy announcements that significantly alter the information set—such as initial proposals or legal enactment—generate meaningful financial market responses.

4.2 Baseline Two-way Fixed Effects Model

We now turn to the regression-based analysis to formally test Hypothesis 1. Table 1 in the Appendix reports the results from the two-way fixed effects specification, where exchange-rate volatility is regressed on interactions between CBAM event indicators and the Trade Exposure Index.

The results reveal a clear and consistent pattern. A coefficient of 0.26 of lagged volatility means that a 1 percentage point increase in yesterday's absolute return predicts a 0.26 percentage point increase in today's. The extremely high significance validates that the data behaves as financial economics theory predicts. The interaction term corresponding to the CBAM proposal stage is negative and statistically significant: the t-statistic of -4.34 at 1% level of significance mean there is essentially zero probability this result is due to random chance. The negative sign means that during the ±10-day window around the July 2021 proposal, currencies with higher CBAM exposure experienced significantly lower volatility than their own historical average, beyond what can be explained by global shocks or country-specific baselines. For example India with trade exposure to EU of 0.0395, (-0.0430 x 0.0395 = -0.0017), meaning INR daily volatility fell by 0.17 percentage points. Given that average daily volatility is 0.41%, this represents a 41% reduction for the most exposed currency. This is the uncertainty resolution effect that aligns with the theoretical prediction that early-stage announcements, which introduce new information about the policy trajectory, reduce uncertainty and stabilize financial markets. This is the strongest and most significant finding in the entire study. A similar, though somewhat smaller, effect is observed for the entry into force event. The negative coefficient of 2.19 at 5% level of significance suggests that the formal legal adoption of CBAM further reduced uncertainty, reinforcing the credibility of the policy framework. This is consistent with the model's prediction that the magnitude of volatility reduction depends on the informational content and credibility of the announcement. The economic logic is identical to the proposal: legal certainty anchors market expectations. Once CBAM became law, the 'will this actually

happen?' uncertainty was permanently resolved, reducing the volatility premium that exposed currencies had been carrying.

No statistically significant average effect on volatility is detected around the December 2022 agreement. However, this result requires careful interpretation — it does not mean nothing happened. Rather, across the full sample of 13 currencies, there was no systematic relationship between exposure level and volatility change. Robustness analysis for Hypothesis 2 will reveal that this masks important heterogeneity between high and low exposure country groups. By October 2023, when the reporting phase began, markets had already fully adjusted to CBAM at the two earlier credibility events. The transition start added no new information generating statistically insignificant coefficients. Similarly, the t statistic for the definitive start in January 2026 is essentially noise. The date falls at the very edge of the data sample, so few post-event observations are available to estimate the effect precisely. Also, time fixed effects in Model 1 absorb the common component of early-2026 variation. This result primarily reflects data limitations as much as economic reality.

From a theoretical perspective, the results reflect diminishing marginal informational content: once the policy path becomes sufficiently clear, subsequent milestones do not generate additional uncertainty resolution. Importantly, the magnitude of the estimated coefficients implies economically meaningful effects. A one-unit increase in exposure (i.e., moving from low to high TEI) is associated with a measurable reduction in daily exchange-rate volatility during key policy events. This highlights the relevance of the exposure channel in amplifying the financial impact of climate-trade policy. The within R-squared of 0.074 means the model explains 7.4% of the within-currency, within-day variation in volatility. This appears low but is entirely normal for daily Forex data i.e., log returns are notoriously close to a random walk and inherently difficult to predict. The F-statistic (robust) of 17.84 with $p = 0.000$ confirms that the variables jointly explain significant variation. The between R-squared of 0.453 is considerably higher, confirming that the model captures cross-country structural differences in volatility levels well.

5. DiD Robustness Specification

Our baseline model 1 uses a continuous exposure variable (tei_i) and estimates a single average effect across all 13 currencies to test Hypothesis 1. This imposes a linearity assumption that the effect scales smoothly and proportionally with the exposure score. It does not separately show what happened to the group of most-exposed countries versus the least-exposed group. In the

robustness analysis, we relax this by splitting currencies into two discrete groups and using a Difference-in-Differences (DiD) design to test whether the two groups respond differently. This provides a complementary and more intuitive perspective on the same underlying question. Countries are split at the median trade exposure index value (= 0.00468). across the 13 currencies. Countries above the median form the treatment or high-exposure group, and those at or below form the control low-exposure group[2].

5.1 Model specification and variables

We can write out the full DiD equation as follows:

$$| r_{it} | = \alpha_i + \sum_{k=1}^{5} \delta_k D_{k,t} + \sum_{k} \phi_k \left(D_{k,t} \times High_i \right) + X_{it}' \Gamma + \lambda_t + \epsilon_{it}.$$

Specifically, we define a binary indicator $High_i$, which takes the value one for countries with above-median exposure to CBAM and zero otherwise. In this setup, $\delta_k$captures the average effect of CBAM announcements across all countries, while $\phi_k$measures the differential response of high-exposure countries relative to low-exposure ones. The coefficients ϕ_k correspond directly to Hypothesis 2 derived from the theoretical model. The vector X_{it}includes time-varying controls that account for global financial and commodity market conditions. These typically include proxies for global risk sentiment, commodity price shocks (e.g., crude oil prices), and major exchange-rate movements (such as EUR/USD), which may simultaneously influence multiple currencies.

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5.2 Results and Discussions

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6. Concluding Remarks

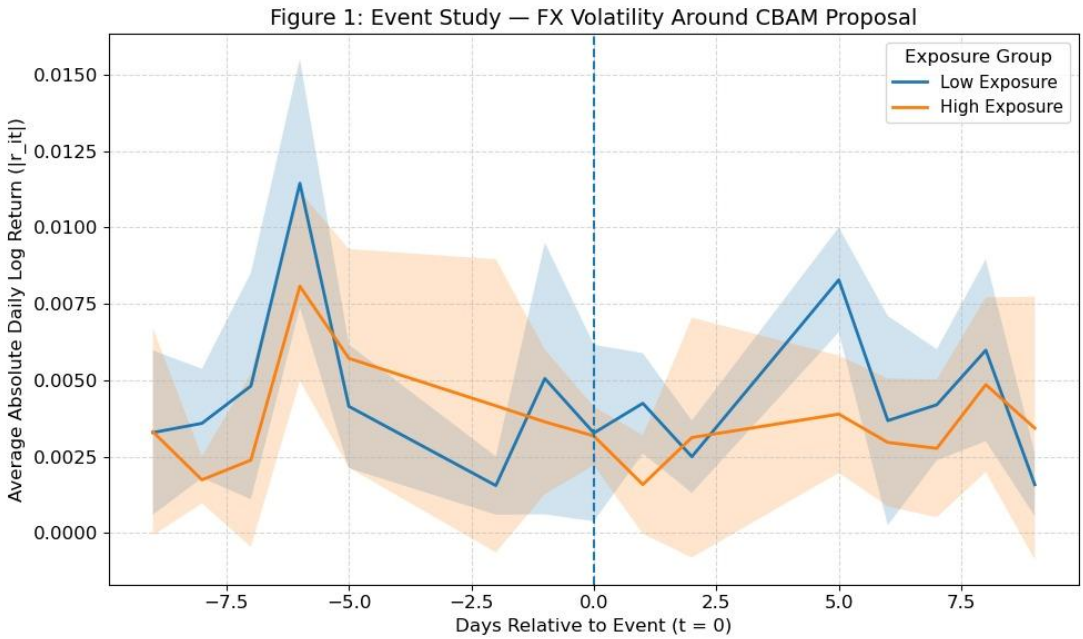
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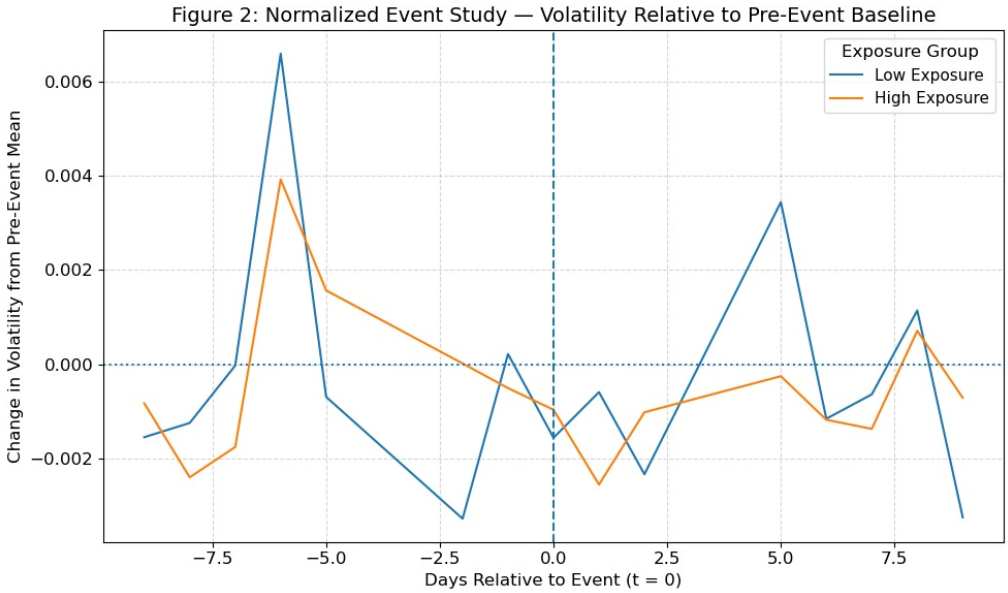
[2] Importantly, the median is computed over the 13 unique country values, not over all panel observations, to avoid a mechanical weighting towards frequently observed values.

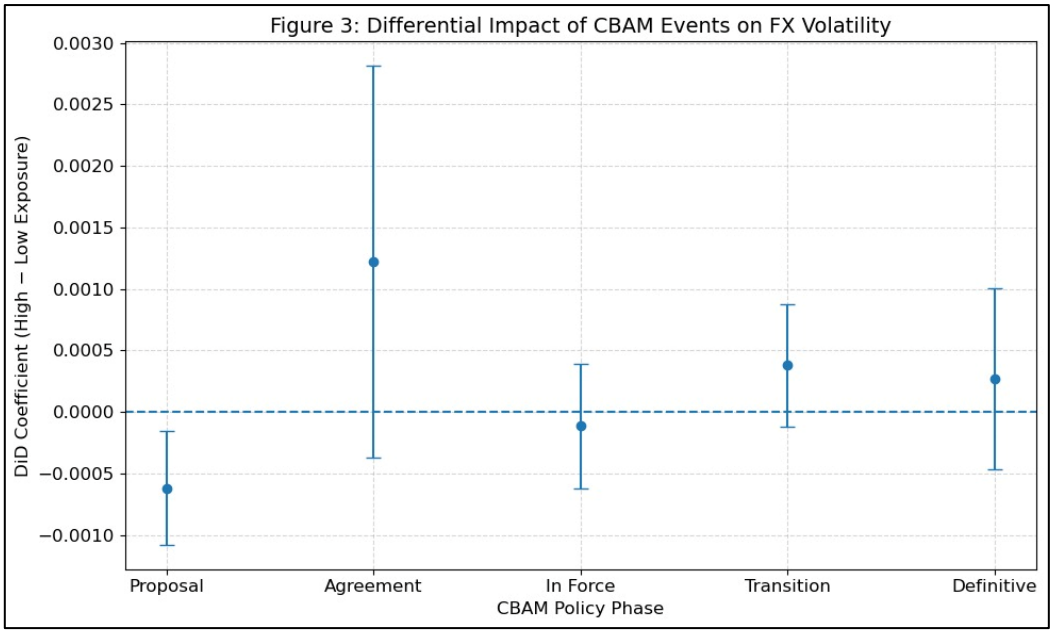
References

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Appendix







Variable	Coefficient	Std. Error	T-stat	P-value	Sig.
Intercept (const)	0.0034	(0.0002)	20.35	0.000	***
Lagged volatility	0.2589	(0.0363)	7.14	0.000	***
Proposal × exposure	-0.0430	(0.0099)	-4.34	0.000	***
Agreement × exposure	+0.0134	(0.0168)	0.80	0.425	—
In Force × exposure	-0.0118	(0.0054)	-2.19	0.029	**
Transition × exposure	+0.0055	(0.0139)	0.40	0.691	—

Table 1: Regression results of Two-way Fixed Effects model for testing Hypothesis 1

Group	Currencies (8)	TEI Range	Rationale
HIGH Exposure TEI > 0.00468	GBP, IDR, INR, RUB, SAR, USD, ZAR, CNY	0.0087 to 0.0395	Substantial CBAM-sector exports to EU; directly in the firing line of carbon border costs
LOW Exposure TEI ≤ 0.00468	AUD, BRL, CAD, JPY, KRW, MXN, TRY	-0.018 to 0.0029	Minimal or negative CBAM-sector exposure; serve as the comparison benchmark in the DiD design

Table 2: classification of G20 countries into High and Low trade exposure groups