Climate Regulatory Risk, Asset Stranding and Foreign Investors *

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Abstract

We study Boston's sustainable building regulations, one of the largest carbon abatement programs in terms of assets impacted. Property-level difference-in-differences analysis demonstrates two robust results: i) the emergence of stranded assets with large declines in both prices and volume; and ii) a compositional shift in asset ownership towards foreign investors. For example, relative to the control group, prices in Boston's most affected buildings fell by 63% while transaction volume dropped by 70%. Foreign ownership of the regulated Boston properties increased by more than 1,000 basis points since the policy introduction. Overall, these results reveal significant financial consequences of decarbonization policy design.

Keywords: Climate regulation; transition risk; stranded assets; real estate; foreign investment; capital flows

JEL Classification: Q58, R33, G12, G32

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1 Introduction

Buildings account for about 35 percent of global carbon emissions,[1] placing the real estate sector at the center of decarbonization efforts. Many jurisdictions are now adopting performance-based climate regulations that shift responsibility for emissions from governments to asset owners. This shift generates a distinct regulatory risk, highlighting the fundamental tension between near-term market stability and long-term carbon reduction. Recent surveys indicate that firms now view regulatory uncertainty as the most salient short-term climate-related threat, often exceeding the perceived importance of physical climate risk (Stroebel and Wurgler 2021).

Boston's Building Emissions Reduction and Disclosure Ordinance (BERDO) offers an early and comprehensive example of such regulation. Introduced in 2013 as a disclosure mandate and later strengthened with carbon emission limits, BERDO requires large buildings to report annual energy use and to meet progressively stricter emissions caps with a goal of achieving net-zero emissions by 2050. The ordinance applies to more than 5,000 large buildings, representing an asset value in excess of $180 billion.[2] Thus, BERDO is one of the largest regulatory mandates in terms of assets covered in the United States, creating a quasi-experimental setting to study how carbon abatement regulation interacts with real assets pricing.

Based on our review of BERDO reports, from the time the regulations came into effect through 2025, the weighted average energy use intensity of Boston's regulated buildings declined by roughly 20 percent, an average annual reduction of about 2 percent. Continued improvements in grid efficiency and building operations are expected to sustain these gains, but even under optimistic assumptions, Boston must roughly double its pace of efficiency improvement, reducing energy use by about 4 percent per year relative to 2025 levels, to meet its 2050 net-zero target. The climate transition burden therefore falls heavily on large buildings, which must retrofit and decarbonize at a rate nearly twice that achieved over the past decade.[3]

This paper asks three questions. How do building-level emissions mandates affect property values and market liquidity? How does ownership composition evolve as investors absorb

[1] Source: International Energy Agency (IEA).

[2] The $180 billion figure corresponds to the assessed value of BERDO-regulated buildings, based on the City of Boston Assessing Department (FY2025). Boston's total assessed real-estate tax base is $227.5 billion, of which commercial and industrial parcels account for $147.6 billion (Classes 3 and 4). Because BERDO also covers large multifamily, mixed-use, institutional, and exempt properties, the total regulated asset base exceeds the strictly commercial segment, amounting to approximately $180–200 billion in assessed value.

[3] All EUI calculations are performed by the authors using the City of Boston's BERDO dataset for reporting years 2015–2025.

regulatory risk? How does the design of decarbonization policies shape the magnitude and distribution of these market impacts?

We construct a new dataset linking three sources: (i) annual emissions disclosures for the regulated buildings between 2015 and 2025; (ii) transaction-level data from CoStar covering over 100,000 sales of large properties across Boston and comparable U.S. markets; and (iii) firm-level investor characteristics compiled from CoStar ownership records, SEC filings, Orbis, and other public registries. Empirically, we exploit variation in exposure across time and geography using a difference-in-differences design comparing Boston's regulated buildings with unregulated but similar properties in national and nearby control markets as well as with unregulated buildings within Boston.

We find three main results. First, BERDO is associated with large price effects. Among the least expensive properties, transaction prices decline by roughly 63 percent relative to comparable unregulated markets following BERDO's approval. Second, liquidity deteriorates sharply in the same segments: transaction volumes fall by about 70 percent, signaling the emergence of stranded-asset dynamics. Third, we document a sharp shift in investor composition. Following BERDO's approval, foreign acquisitions in Boston's regulated market increased by roughly $16 billion and over 1,000 basis points. Taken together, the evidence reveals BERDO has accelerated the internalization of climate risk into property prices and has shifted ownership.

A growing literature shows that climate transition risk is capitalized into asset values, with regulatory pressure acting as a forward-looking shock to expected cash flows. Empirical evidence indicates that carbon-intensive assets face higher required returns and lower valuations as transition policy becomes more salient (Ilhan et al. 2021, Bolton and Kacperczyk 2021). Complementing this evidence, an equilibrium framework demonstrates that sustainability preferences and transition risk jointly determine expected returns, generating a discount for green assets and a premium for transition-exposed ones (Pastor et al. 2022). Additional work shows that climate-risk disclosures themselves have valuation consequences, as investors update beliefs about firms' transition exposure and reprice expected future cash flows (Ilhan et al. 2023).

Environmental performance is also found to be capitalized into asset values when it affects operating costs or demand. Evidence from green-certified and energy-efficient buildings shows that environmental attributes command valuation premia consistent with market recognition of cost savings and tenant sorting (Eichholtz et al. 2010, Kahn and Kok 2013).

A related strand of papers documents that institutional investors adjust portfolios in response to transition risk, reducing positions in assets with uncertain or unmanaged climate exposure and reallocating toward firms with credible adaptation strategies (Krueger et al.

2020). Evidence from engagement activity further shows that environmental risks influence active ownership, shaping both capital flows and the distribution of ownership across investors (Hoepner et al. 2024). Together, these findings imply that transition shocks generate heterogeneous investor responses with the potential to amplify price adjustments.

A complementary literature shows that foreign and nonlocal investors play a distinct role in absorbing local shocks. International capital-flow models demonstrate that cross-border investors rebalance into markets where domestic investors pull back, providing liquidity when local funding conditions tighten and risk premia rise (Hau and Rey 2002). Equilibrium models of equity flows further show that heterogeneous foreign investors adjust positions in response to return differentials and perceived mispricing, building stakes gradually and behaving differently from local investors when uncertainty increases (Albuquerque et al. 2007).

In real estate markets, out-of-town and foreign buyers are shown to act as marginal investors who respond differently to local shocks and constraints, expanding their ownership share when domestic demand contracts (Favilukis and Van Nieuwerburgh 2021). These buyers can increase prices in expansionary periods but also absorb supply when local households and investors face elevated risks or balance-sheet pressures. Together, these findings suggest that globally diversified investors are well positioned to acquire transition-exposed assets when regulatory shocks reduce the willingness or ability of local investors to bear risk. Collectively, these findings clarify the channels through which climate regulation can influence asset values, trading activity, and ownership patterns, motivating the framework developed below.

Together, these mechanisms imply that binding emissions policies can depress values for transition-exposed assets, constrain liquidity where compliance burdens exceed incomes, and reallocate ownership toward investors better positioned to absorb regulatory risk. In markets with greater pricing power, some buildings may partially pass compliance costs to tenants or preserve premia through higher-quality attributes. These dynamics provide clear predictions for how climate regulation should operate in real estate markets.

Boston's early and comprehensive adoption of binding building-emissions standards makes it the first major setting in which these dynamics can be observed for high-value, long-lived real assets. Its long implementation horizon and extensive coverage enable the first causal evidence on how carbon limits affect real estate prices, market liquidity, and ownership patterns. With similar building regulations now emerging in New York, London, and other global cities, the mechanisms we document offer broader insight into how climate-transition policy design reallocates capital and reshapes markets.

2 Theory Intuition

This section develops the economic intuition for how climate regulations such as BERDO affect building owners' decisions to hold, retrofit, or sell. The core mechanism is that a heterogeneous regulatory shock interacts with cross-sectional differences in rent pass-through ability, energy efficiency, and owner constraints. These interactions determine which buildings become unprofitable, which owners exit, and how ownership reallocates.

Cash Flows and Sell Decisions. Building regulations introduce a new layer of operating costs. Owners can comply by either paying penalties for excess emissions or investing in energy-efficiency upgrades. Owners compare expected net income under these obligations to the price they could obtain by selling. Higher retrofit costs and limited pricing flexibility push buildings toward a sell threshold, while buildings with greater pricing power may partially preserve premia. Upgrades require both capital and know-how, and smaller or more constrained owners may be unable to execute them even when cost-effective. Because BERDO's caps ratchet downward and future technologies and rules are uncertain, some owners can delay and exercise a wait-and-see option, while others with tighter liquidity, higher discount rates, or shorter horizons reach the sell threshold sooner.

Stranded Assets. When the market anticipates that a building will be costly to bring into compliance and unlikely to generate sufficient income to offset these obligations, its value declines relative to comparable non-regulated properties. If expected compliance costs exceed buyers' willingness to pay, transactions are delayed or do not occur, and the asset becomes effectively *stranded*. These dynamics imply that the lower end of the value distribution, particularly energy-inefficient, lower-rent assets, should experience the earliest and most pronounced price declines and missing trades.

Investor Heterogeneity and Ownership. Large and diversified institutions typically discount future cash flows at lower rates and possess greater expertise in executing energy upgrades. Some also view decarbonization as an opportunity and actively seek assets they can reposition. Smaller or local owners face tighter constraints and limited capacity to absorb or manage compliance costs. Buildings that become unprofitable for constrained owners may therefore remain attractive to better-capitalized or retrofit-oriented investors, leading to ownership reallocation as regulation tightens.

This framework yields four market-level predictions. (i) Price declines should be concentrated in buildings with low income relative to compliance costs, especially energy-inefficient and non-differentiated lower-value assets with limited pricing power. (ii) Liquidity should deteriorate where compliance obligations exceed projected income, generating missing trades and stranded assets. (iii) Ownership should reallocate toward large and diversified investors with lower discount rates and greater retrofit capacity. (iv) High-quality or already-efficient buildings should exhibit limited price or volume effects because their compliance costs are modest relative to rents.

3 The BERDO Regulation and Transition Risk

The ordinance was enacted in 2013 and required all covered buildings to report their 2014 annual energy and water use beginning in 2015. The initial requirements focused on disclosure rather than performance limits and applied to properties of at least 50,000 square feet or 50 units. The reporting threshold expanded in 2016 to include buildings of at least 35,000 square feet or 35 units. It was understood even at this early stage that non-compliance could eventually carry penalties.

In 2021, the City of Boston strengthened the ordinance by expanding coverage to buildings of at least 20,000 square feet or 15 units and introducing binding carbon intensity caps by property type. These emissions limits begin to apply at different times for different building sizes: larger buildings are subject to the standards in 2025 and medium-sized buildings in 2030. The caps also tighten over time at rates that differ across property types such as hospitals, residential buildings, industrial facilities, and others. Each use category is assigned its own carbon intensity cap for every five-year compliance period, meaning that hospitals, residential buildings, industrial facilities, offices, and other property types face different allowable emissions levels in 2025, 2030, 2035, 2040, and 2045. These limits decline over time, requiring progressively lower emissions in each successive five-year interval until all covered buildings reach net-zero operational emissions by 2050.

Compliance can be achieved by: (1) meeting the applicable carbon intensity limit through efficiency upgrades and electrification; (2) procuring qualifying renewable electricity; or (3) maintaining high-performance certifications such as an Energy Star score of at least seventy-five for at least three of the prior five years or LEED Silver with at least fifteen Energy and Atmosphere points.

Properties failing to meet their applicable emissions requirements must either: (1) make Alternative Compliance Payments (ACP), which are assessed at a rate of $234 per metric ton of CO_2e and directed to a city fund supporting equitable decarbonization; or (2) pay daily monetary penalties that scale with building size. Properties under 35,000 square feet face fines of $300 per day, those between 35,000 and 50,000 square feet are fined $600 per day, and buildings exceeding 50,000 square feet incur fines of up to $1,000 per day. Inaccurate or false reporting may result in additional penalties.

4 Database

We construct a database that combines property-level, transaction-level, and investor-level information to analyze how building regulation affects real estate prices, liquidity, and ownership. The dataset integrates three main sources: (i) the actual annual disclosures under Boston's BERDO, (ii) property transaction records from CoStar, and (iii) firm-level investor characteristics compiled from CoStar ownership data, SEC filings, Orbis, and other public sources.

The BERDO component provides annual energy and emissions disclosures for all regulated buildings from 2015 to 2025, covering over 20,000 building-year observations across roughly 5,800 properties. These data include square footage, address, sector classification, and emissions intensity. The CoStar transaction data include more than 100,000 large property sales from 1995 through 2024, with information on sale price, building size, type, class, quality rating, and timing in the Boston area and across the United States. The investor component identifies over 750 distinct buyers and sellers active in the Boston market between 1995 and 2024, with linked firm-level indicators such as revenues and number of employees.

Table 1 reports descriptive statistics for the CoStar transactions of BERDO-treated properties during the 2009 to 2021 period. More information on the database can be found in the Appendix.

Based on reported 2025 emissions and efficiency metrics, we classify 5,290 buildings representing roughly 74 percent of total regulated floor areas compliant with at least one pathway. For nearly all non-compliant properties (98 percent), the ACP of $234 per excess ton of CO_2e exceeds the implied cost under the maximum daily fine schedule. Our simulations using future BERDO thresholds indicate that at the current emission levels, the share of non-compliant properties rises to more than 90 percent by 2045, with almost universal non-compliance by 2050 in the absence of significant retrofit activity.

5 The Emergence of Stranded Assets

This section analyzes how BERDO influenced asset values and market functioning, beginning with transaction prices and then examining liquidity effects. The empirical design compares regulated Boston properties with similar assets in a control group referred to as Control Group I, consisting of Austin (Texas), Nashville (Tennessee), and San Antonio (Texas). Although these markets exhibit valuation premia relative to the national average, they operate in states without building-emissions mandates comparable to BERDO, making them a clean benchmark for identification.

5.1 Price Effects

We first study dynamic adjustment around the policy shock and test for pre-trends. To do so, we estimate an event-time specification with leads and lags of the treatment indicator, following standard practice (Sun and Abraham 2021). This approach traces the evolution of prices around BERDO's approval and allows visualization of both pre-trends and post-policy adjustments. The coefficients β_k trace the year-by-year differential between Boston and the control cities, with the final pre-approval year as the omitted reference.

$$\log P_{ist} = \alpha + \sum_k \beta_k \big(Boston_c \times \mathbf{1}\{\text{Year} = k\} \big) + X_i' \gamma + \mu_c + \tau_t + \varepsilon_{ist}. \tag{1}$$

where i indexes transactions, s submarkets, c cities, and t years. Each submarket s belongs to a unique city c, and μ_c and τ_t denote city and year fixed effects, respectively.

For this analysis, we segment the treatment group into price tiers. The tiers are defined using Boston's own price distribution by targeting the tenth, twenty-fifth, and fiftieth percentiles. We construct an annual real-price cutoff for each percentile using Boston's pre-shock median growth rate and then apply the corresponding thresholds to Control Group I, ensuring that each tier reflects a consistent real-price benchmark across locations and over time. Boston's higher average prices are comparable to those in other major metropolitan areas such as Washington, D.C. and New York, but those cities also impose building-emissions regulations and therefore cannot serve as untreated controls. Our selected comparison cities operate in states without such mandates, making them appropriate policy counterfactuals for isolating the effect of BERDO. Although building stocks inevitably vary across markets, conditioning the analysis on building tiers ensures that comparisons are made across similar segments of the value distribution.

Figure 1 presents the dynamic event-time specification for the bottom decile, estimated using interactions between year indicators and the Boston treatment indicator. The coefficients trace the annual evolution of relative price changes between Boston and the control markets. All regressions include city and year fixed effects and control for property type, building class, building age, and total floor area, thereby accounting for differences in quality, scale, and depreciation across assets. The pre-policy coefficients are statistically indistinguishable from zero, confirming the absence of differential pre-trends across Boston and the control cities, while the post-2013 estimates display a sharp and persistent decline in

Boston's relative prices.

Having confirmed the parallel pre-trends, we then estimate the impact of BERDO on transaction prices using a standard difference-in-differences framework. Our baseline model compares Boston to Control Group I before and after the introduction of the regulation, absorbing time-invariant cross-city differences and common shocks with city and year fixed effects.

At the transaction level i in submarket s and year t,

$$\log P_{ist} = \alpha + \beta(Boston_c \times post2013_t) + \delta\, Boston_c + \theta\, post2013_t + X_i'\gamma + \mu_c + \tau_t + \varepsilon_{ist}, \quad (2)$$

where μ_c and τ_t denote city and year fixed effects. The control vector X_i includes indicators for property type and building class, as well as building age and size, to account for differences in quality, scale, and depreciation across assets. The coefficient β on the interaction term $Boston_c \times post2013_t$ measures the average post-2013 change in log price per square foot for Boston's properties relative to comparable assets in the control cities.

Table 2 reports difference-in-differences estimates of price effects across these progressively broader market tiers. The results show that post-policy price declines are largest among low-priced properties, with estimated reductions of roughly 63 percent for the bottom decile and smaller yet significant declines across higher price tiers. All specifications include city and year fixed effects and property-level controls, and report heteroskedasticity-robust standard errors.

5.2 Transaction Volume

We next examine how transaction activity and asset turnover responded to the policy shock. The literature does not fully establish whether regulatory shocks induce rapid selling or, conversely, suppress trading activity, making this an informative setting for evaluating market responses. To do so, we aggregate transactions to the submarket–year level, as a single citywide series would mask the substantial heterogeneity within commercial real estate markets. Submarket-level aggregation follows standard practice in institutional real estate research, where transaction data are organized into economically coherent market segments to preserve meaningful spatial variation (Fisher et al. 2007).

Let s index CoStar submarkets, t years, and p property types. Define USDVolume_{stp} as the total dollar value of all transactions occurring in submarket s, year t, and property type p. Formally,

$$\text{USDVolume}_{stp} = \sum_{i \in \{s,t,p\}} \text{SalePrice}_i, \quad (3)$$

where the summation is taken over all property-level transactions i located in submarket s, sold in year t, and belonging to property type p.

For building characteristics, we compute the corresponding averages:

$$\text{AvgChar}_{stp} \;=\; \frac{1}{N_{stp}} \sum_{i \in \{s,t,p\}} X_i, \tag{4}$$

where X_i denotes building size, age, class, or property attributes as appropriate, and N_{stp} is the number of transactions in submarket–year–type group (s, t, p).

To trace dynamic effects, we first estimate an event-time difference-in-differences specification:

$$\log(\text{USDVolume}_{stp}) = \alpha + \sum_k \beta_k \big(\mathbf{1}\{\text{Year} = k\} \times Boston_s\big) + X'_{stp}\gamma + \mu_c + \tau_t + \varepsilon_{stp}. \tag{5}$$

where s indexes submarkets, t indexes years, and p indexes property types, and $Boston_s = 1$ for submarkets physically located within the City of Boston. The control vector X_{stp} includes the submarket–year–type aggregates derived from equations (3)–(4), including averages of building age, total floor area, and average building class for each submarket–year–type combination. The coefficients β_k trace the year-specific differential between Boston and the control markets, with 2013 serving as the reference year. As shown in Figure 2, Boston and Control Group I exhibit parallel trends in bottom-decile transaction volume prior to 2013. Following the policy's introduction, Boston experienced a sharp and persistent contraction in market activity.

To obtain a precise measure of the post-shock decline, we then estimate:

$$\log(\text{USDVolume}_{stp}) = \alpha + \beta(Boston_s \times post2013_t) + \delta\, Boston_s + \theta\, post2013_t + X'_{stp}\gamma + \mu_c + \tau_t + \varepsilon_{stp}. \tag{6}$$

where s indexes submarkets, t indexes years, and p indexes property types. Each submarket s belongs to a unique city c, and μ_c and τ_t denote city and year fixed effects, respectively. The coefficient β on the interaction term $Boston_s \times post2013_t$ measures the causal post-2013 change in log transaction volume for Boston's low-priced submarkets relative to comparable submarkets in Control Group I, conditional on the control vector X_{stp}.

Table 3 reports difference-in-differences estimates of transaction volume across different market price tiers. The results show a pronounced post-2013 contraction in market activity: transaction volumes for Boston's low-priced properties declined by roughly 70 percent relative to comparable assets. All regressions report heteroskedasticity-robust standard errors to maintain comparability across specifications.

6 The Arrival of Foreign Investors

Having documented large and persistent declines in prices and trading volume, we next examine who absorbed the regulatory risks. This section analyzes ownership reallocation, focusing on how foreign investors increased purchases following BERDO's introduction.

We measure cumulative foreign investment as the total value of property acquisitions by foreign buyers over time:

$$\text{CumulativePurchases}_{\text{foreign},t} = \sum_{\tau=t_0}^{t} \text{PurchasesValue}_{\text{foreign},\tau}, \tag{7}$$

where $\text{PurchasesValue}_{\text{foreign},\tau}$ denotes the transaction value of properties acquired by foreign investors in year τ. Foreign status is system-generated by CoStar based on buyer headquarters location; joint ventures are classified as foreign if any participant is foreign.

Figure 3 plots the cumulative value of property purchases by foreign investors in Boston's real estate market through 2024. The measure captures the total inflow of foreign capital into BERDO-regulated assets over time. Foreign acquisition activity was modest and stable through the early 2000s and mid-2010s but began to rise sharply around 2013 with the BERDO approval. The pace of purchases accelerated further after 2021, despite stricter performance requirements and higher expected compliance costs. By 2024, cumulative foreign acquisitions exceeded $20 billion, reflecting a substantial increase in international capital inflows into Boston's regulated property market. The timing and magnitude of this growth suggest that global investors expanded their participation as local climate regulatory risk became more salient.

We next examine how foreign participation evolved across market segments following BERDO's introduction in comparison with the control groups. Figure 4 reports the share of cumulative purchases by foreign investors, computed separately for each price tier and using three-year averages across four study periods (2010–2012, 2013–2015, 2016–2018, and 2019–2021). Formally, for tier g and year t, the cumulative foreign share is defined as:

$$\text{ForeignShare}_{g,t} = \frac{\sum_{\tau=t_0}^{t} \text{Purchases}_{\text{foreign},g,\tau}}{\sum_{\tau=t_0}^{t} \text{Purchases}_{\text{total},g,\tau}} \times 100, \tag{8}$$

where $\text{Purchases}_{\text{foreign},g,\tau}$ and $\text{Purchases}_{\text{total},g,\tau}$ denote, respectively, the cumulative transaction values (in billions of U.S. dollars) of foreign and all investors within price tier g up to year t.

Foreign participation in Boston's real estate market rises sharply after BERDO's 2013 approval. As shown in Figure 4, cumulative foreign purchase shares increase substantially from the pre-policy period (2010–2012) to the enforcement period (2019–2021). In the bottom quartile, foreign share rises from 5.3% to 13.7% (an increase of 833 basis points). In the bottom half, foreign share increases from 11.9% to 17.6% (567 basis points). For the full market, foreign participation grows from 18.2% to 28.5% (1,023 basis points). In contrast, foreign shares remain low and flat in the control cities and decline slightly among Boston's unregulated properties (Control Group III). This divergence indicates that foreign investors increasingly absorbed regulated Boston assets following disclosure and subsequent enforcement.

6.1 Difference-in-Differences Analysis

We next examine the dynamic evolution of foreign investment flows using an event-time difference-in-differences specification that interacts Boston with year indicators. This approach traces how foreign purchase values in Boston evolve relative to comparison cities around the introduction of BERDO without imposing a single post-policy break.

We begin by constructing foreign acquisition flows at the buyer–city–submarket–year–property-type level. Let i index buyer companies, c cities, t years, s CoStar submarkets, and p property types. Define USDBought_{icstp} as the total dollar value of all purchases made by foreign buyer i in city c, year t, submarket s, and property type p. Formally,

$$\text{USDBought}_{icstp} = \sum_{j \in \{i,c,s,t,p\}} \text{SalePrice}_j, \tag{9}$$

where the summation is taken over all property-level transactions j made by buyer i in submarket s, city c, year t, and property type p.

For building characteristics, we compute cell-level averages for each buyer–city –submarket–year–type combination:

$$\text{AvgChar}_{icstp} = \frac{1}{N_{icstp}} \sum_{j \in \{i,c,s,t,p\}} X_j, \tag{10}$$

where X_j denotes building size, age, building class, location type, and property type. Property type therefore enters both as a cell-defining category (indexed by p) and as an attribute within X_j via its indicator variables. N_{icstp} is the number of properties purchased by buyer i in submarket s, city c, year t, and property type p.

At the company i, city c, and year t level, we estimate:

$$\log(\text{USDBought}_{ict}) = \alpha + \sum_k \beta_k \big(\mathbf{1}\{\text{Year} = k\} \times Boston_c\big) + \mu_c + \tau_t + \varepsilon_{ict}. \tag{11}$$

The sample is restricted to foreign buyers ($is\_foreign_i = 1$). City fixed effects μ_c capture time-invariant differences across locations, and year fixed effects τ_t absorb aggregate shocks. Standard errors are heteroskedasticity-robust. The coefficients β_k trace year-specific differentials in foreign purchase activity in Boston relative to the control cities.

Figure 5 plots the estimated β_k with 95-percent confidence intervals. The trajectory is approximately flat before 2013, consistent with parallel pre-trends, and rises sharply after the 2013 approval. The increase persists in later years, confirming that the cumulative inflows shown in Figure 3 reflect a sustained and statistically significant expansion of foreign investment in regulated Boston assets.

We then estimate the average post-policy effect of foreign buyer purchases. The dependent variable is the same buyer–city–year aggregate used in the event-time specification, constructed from the underlying buyer–submarket–type cells per equations (9)–(10). We estimate a difference-in-differences model:

$$\log(\text{USDBought}_{ict}) = \alpha + \beta_3(\text{post2013}_t \times \text{Boston}_c) + \beta_2\,\text{Boston}_c + \beta_1\,\text{post2013}_t + X_i'\gamma + \mu_c + \tau_t + \varepsilon_{ict}. \tag{12}$$

The coefficient β_3 captures the average post-BERDO differential in foreign purchase values for Boston relative to the control cities. Standard errors are heteroskedasticity-robust. Table 4 reports large and statistically significant positive estimates, consistent with a post-policy reallocation of foreign capital toward regulated Boston assets.

These findings show that local climate policies transmit through asset markets into broader capital-allocation channels. Because real estate is tightly integrated with national and international capital markets, performance standards influence not only urban property prices but also cross-border investment flows and the allocation of regulatory risk across investors. More broadly, the results underscore that the economic consequences of the low-carbon transition depend as much on the distribution of ownership and risk bearing as on the environmental performance of the regulated assets.

7 Robustness

We assess the robustness of our main results along two complementary dimensions: (i) alternative control groups that capture both regional and within-city counterfactuals; and (ii) reweighting to address compositional differences across our Control Group I.

7.1 Alternative Control Groups

We test the robustness of our main price and volume results to alternative control groups. In addition to the Control Group I comparison, we consider two alternative control groups that provide regional and within-market benchmarks.

Control Group II. The first alternative control group consists of nearby cities in the Greater Boston area: Revere, Quincy, Malden, Attleboro, and Taunton. These municipalities, all located in Massachusetts, share Boston's regional economic fundamentals yet were not subject to BERDO or any similar building-emission regulations. They vary in their proximity to Boston, and this spatial separation further limits the risk of direct regulatory spillovers. Importantly, we exclude Cambridge and other localities that adopted parallel energy-performance ordinances to maintain a clean counterfactual. This control group helps isolate the effect of BERDO from broader regional dynamics.

Control Group III The second robustness analysis exploits within-city variation by comparing regulated and non-regulated properties within Boston. The non-regulated group consists of smaller buildings that fall below the reporting thresholds. To avoid contamination from properties that were initially exempt but later covered in 2021, we restrict the sample to buildings that remained unregulated throughout. This within-Boston comparison controls for city-specific shocks and real estate market dynamics, providing a tighter test of whether the observed price and liquidity effects are attributable to the regulatory treatment rather than local macroeconomic trends. Because the comparison does not rely on selecting external control cities, it avoids subjective sample choices and serves as a natural additional benchmark for isolating regulation-specific effects.

Figure 6 reports event-study coefficients for transaction prices across these alternative control groups, and Figure 7 shows the corresponding results for transaction volumes in the lower decile. The associated difference-in-differences estimates are presented in Tables 5 and 6. Across all specifications, post-2013 price declines for bottom-decile properties remain large and statistically significant: approximately 63 percent relative to Control Group I, 64 percent relative to Control Group II, and 58 percent relative to non-regulated Boston properties. Volume effects are similarly robust, with estimated declines of roughly 62–75 percent across both external and within-city controls, in line with the 70 percent decline computed relative to Control Group I.

7.2 Inverse-Probability Weighting

Because Boston, like other major U.S. metropolitan markets, has a high share of expensive buildings, and most comparable peer cities have already introduced building-emissions regulations, we focus on a more conservative set of non-regulated cities in Control Group I. However, differences in market composition between Boston and these cities could still influence the results. To address this question, we estimate a weighted version of the difference-in-differences model using inverse-probability weights derived from a logit regression of Boston assignment on pre-policy property characteristics (price, building age, class, size, and type) Hirano et al. (2003). To construct the inverse-probability weights, we first estimate a logit model predicting the likelihood that a property belongs to Boston based solely on its pre-policy characteristics. For each property i, we estimate

$$\Pr(\text{Boston}_i = 1 \mid X_i) = \Lambda\big(\alpha + \beta_1 \log \text{Price}_i + \beta_2 \text{Age}_i + \beta_3 \text{Class}_i + \beta_4 \log \text{BuildingSF}_i + \beta_5 \text{Type}_i\big). \tag{13}$$

where X_i includes the property's observable pre-policy characteristics (price, size, age, class, and type), and $\Lambda(\cdot)$ is the logistic link function that transforms these characteristics into a predicted probability between 0 and 1. The fitted values $\hat{p}_i = \Pr(\text{Boston}_i = 1 \mid X_i)$ serve as the propensity score, capturing the probability that property i "resembles" a Boston property in observable pre-policy attributes.

We construct inverse-probability weights following the standard formulation:

$$w_i = 1/\hat{p}_i \quad (\text{Boston}_i = 1), \qquad w_i = 1/(1 - \hat{p}_i) \quad (\text{Boston}_i = 0). \tag{14}$$

These weights rebalance the Boston and control samples so that the joint distribution of pre-policy characteristics is comparable across groups. By upweighting control properties that are similar to Boston properties, the weighted difference-in-differences estimator provides a cleaner "apples-to-apples" comparison across cities.

Tables 7 and 8 report the weighted estimates. With the inverse-probability weights applied, the estimated effects remain large and statistically significant across all tiers, including the full sample. Although the bottom segment continues to exhibit the largest reductions, the weighted results show that meaningful declines occur throughout the distribution. By rebalancing observable differences between Boston and the control markets, the weighting procedure reinforces our baseline finding that BERDO's effects are strongest in the lower segment while also indicating that meaningful, though smaller, effects extend across the broader distribution.

8 Conclusions

This paper examines how performance-based carbon-emission regulations affect asset pricing and the allocation of ownership in commercial real estate markets. Using Boston's BERDO ordinance as the first large-scale decarbonization policy implemented in a major U.S. city, we combine property-level difference-in-differences with predictive analyses to document how regulatory exposure is capitalized into market outcomes.

We find that BERDO led to pronounced declines in property values and a substantial contraction in transaction volumes, with the sharpest effects concentrated among lower-priced and energy-inefficient buildings. The joint collapse in prices and liquidity, together with the withdrawal of local investors, suggests the emergence of regulatory stranding: assets whose market values fall sharply as rising compliance obligations outstrip their expected operating returns. These dynamics indicate that some buildings are becoming increasingly difficult to trade except at distressed prices.

Regulation-induced price declines are accompanied by a marked reallocation of ownership. Foreign investors significantly increased their acquisitions of regulated Boston assets following the policy's introduction. This shift implies that climate regulations can alter the distribution of transition risk, transferring exposure from domestic to internationally diversified investors. Such flows illustrate how global capital markets may partially absorb local regulatory shocks, while also relocating long-term compliance risk outside the local investor base.

The heterogeneity we document across building types and market segments suggests that policymakers may wish to consider calibrating penalties and compliance obligations to property values and local submarket conditions, allowing regulatory burdens to scale with an asset's economic capacity to absorb them. More broadly, as cities worldwide design similar emissions standards, our findings highlight the importance of understanding how climate-policy-induced regulatory risk interacts with asset stranding, market liquidity, and investor composition.

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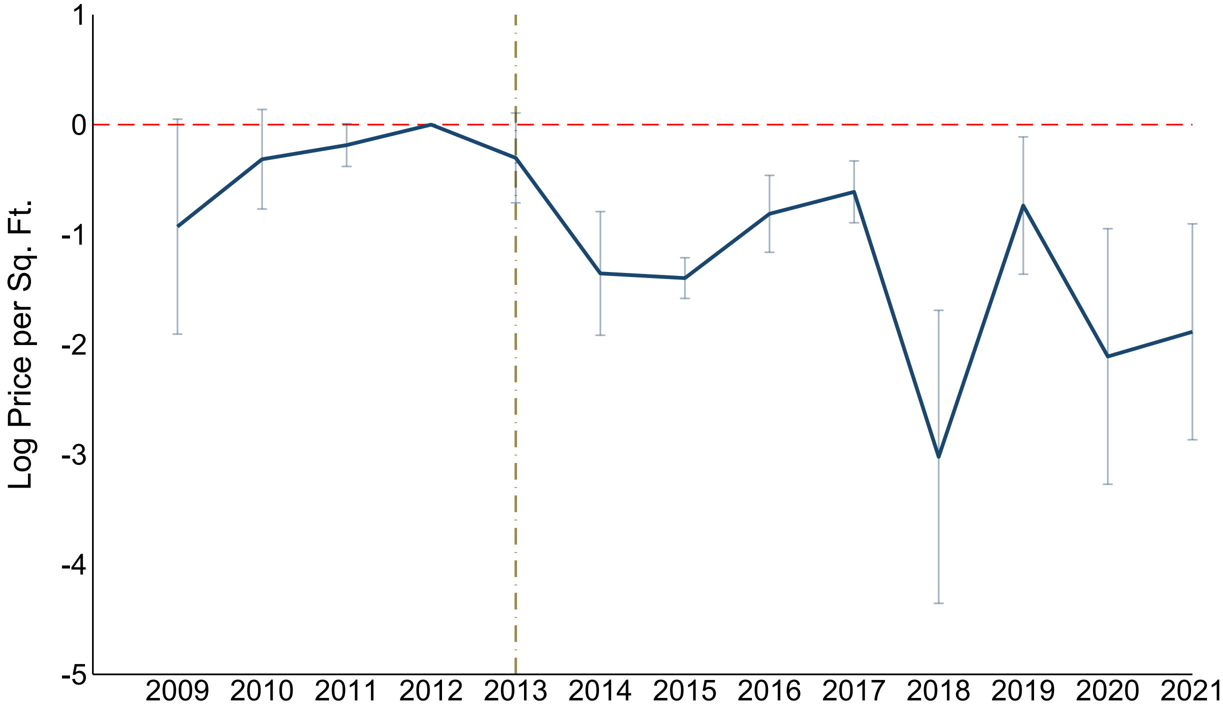


Figure 1. Difference-in-Differences in Prices: Boston vs Control Group I (Lower Decile)

This figure plots estimated coefficients and 95% confidence intervals from regression (1) of log price per square foot, comparing two groups. The treatment group is Boston, and the control group (Control Group I) is a basket of three cities in non-regulated states: Austin (Texas), Nashville (Tennessee), and San Antonio (Texas). The specification includes city and year fixed effects, along with property-level controls for building age, class, size, and property type. The vertical line at 2013 marks the BERDO approval. Transactions in both groups are restricted to properties below the cutoff price corresponding to Boston's lower decile.

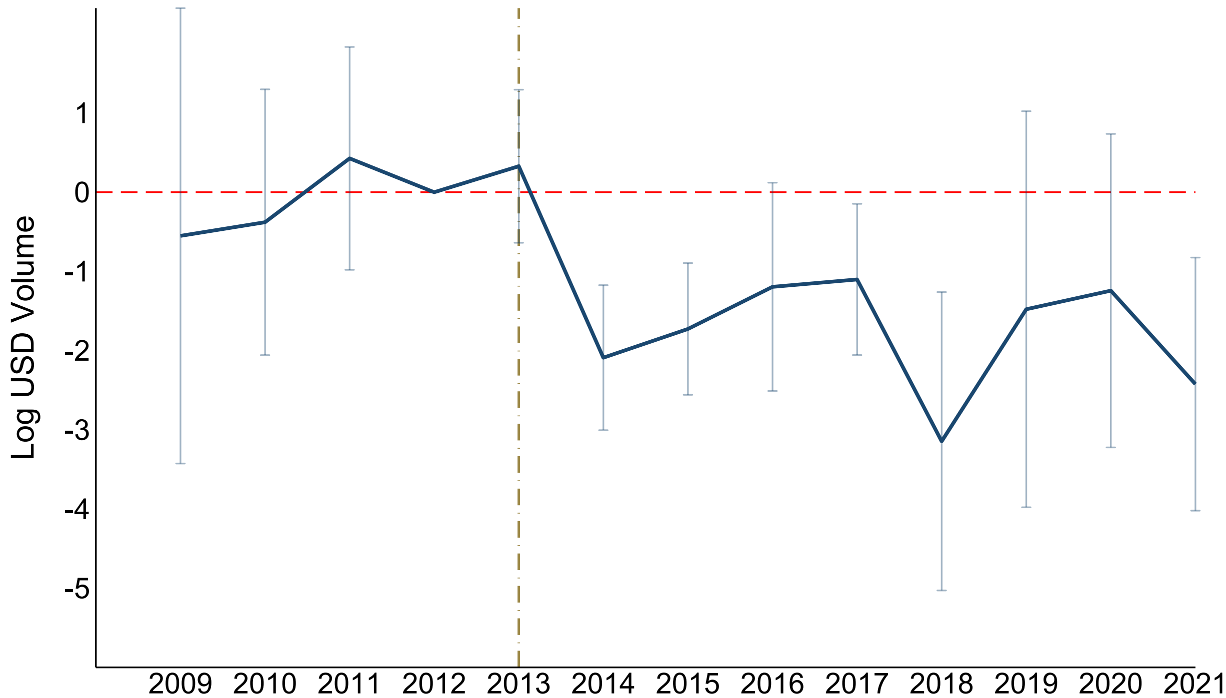


Figure 2. Difference-in-Differences in Transaction Volume: Boston vs Control Group I (Lower Decile)

This figure plots estimated coefficients and 95% confidence intervals from regression (5) of log USD transaction volume. The dependent variable is USDVolume$_{stp}$, constructed as in equation (3), with building characteristics aggregated according to equation (4). The unit of analysis is therefore the submarket–year–property-type combination. Submarkets physically located within the City of Boston constitute the treatment group. The specification includes city and year fixed effects, along with controls for aggregated building age, total floor area, and average building class. The vertical line at 2013 marks the BERDO approval. Transactions in both Boston and control markets are restricted to properties below the annual cutoff price corresponding to Boston's lower decile.

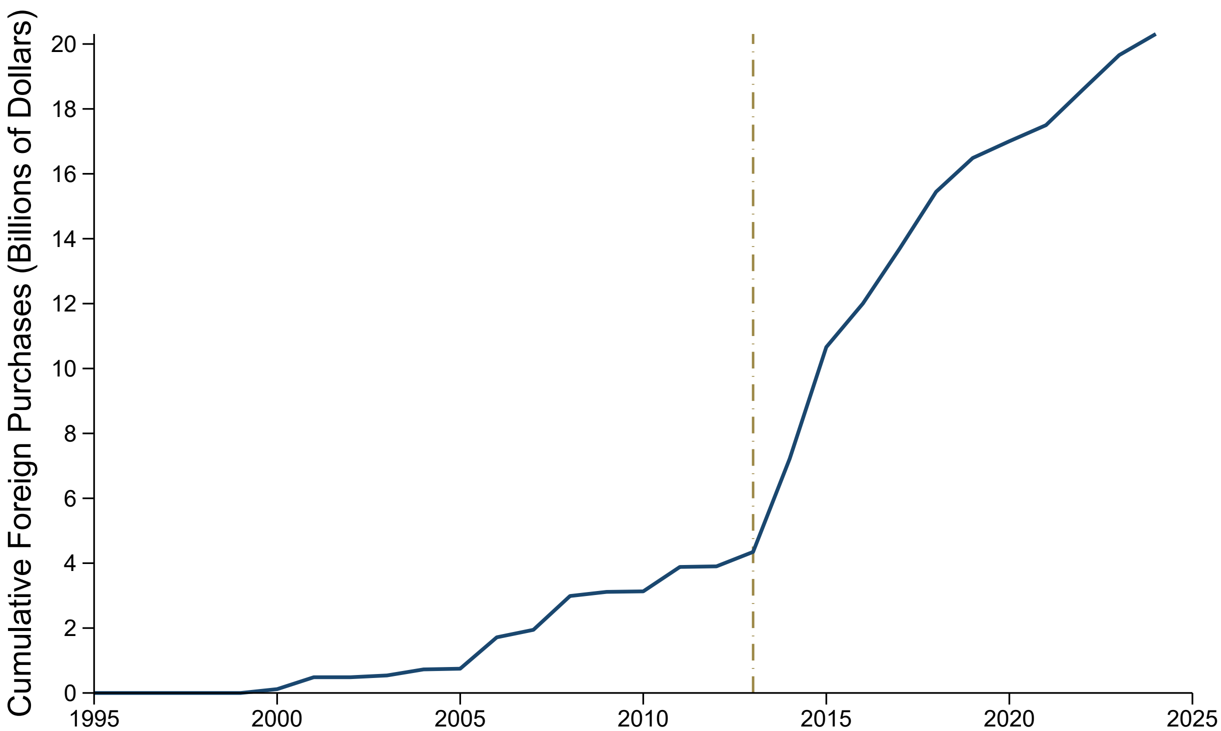
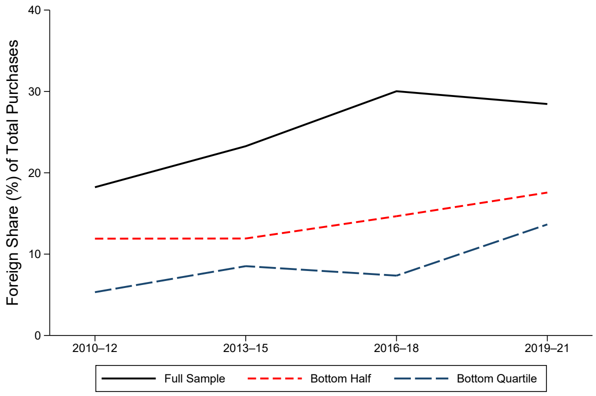
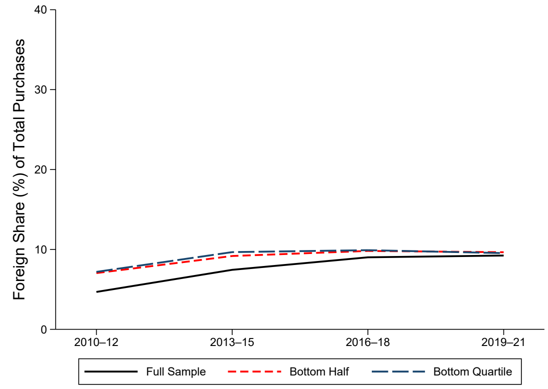


Figure 3. Cumulative Purchases by Foreign Investors in Boston

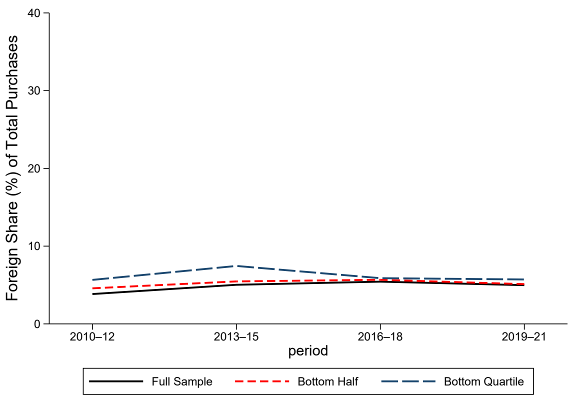
This figure plots the cumulative value of property purchases by foreign investors in Boston's real estate market, measured in U.S. dollars (USD) as defined in equation (7). The vertical dashed line marks the 2013 BERDO approval. Foreign investor purchases increased sharply following the policy approval, rising from roughly \$4 billion in 2013 to over \$20 billion by 2024.



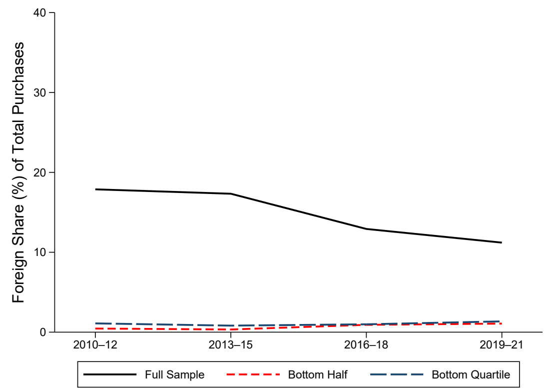
(a) Boston



(b) Control Group I



(c) Control Group II



(d) Control Group III

Figure 4. Cumulative Share of Foreign Purchases

This figure shows the evolution of the cumulative share of foreign capital in total asset purchases across Boston's regulated properties and control groups. The cumulative share measures the proportion of total transaction value in USD accounted for by foreign buyers during three-year periods, beginning in 2010–2012 and accumulating through each subsequent period per specification (8). Control Group I consists of the three cities introduced in Figure 1. Control Group II includes geographically proximate Greater Boston markets: Revere, Quincy, Malden, Attleboro, and Taunton. Control Group III corresponds to Boston's non-regulated properties. All panels apply year-specific price-per-square-foot thresholds that define consistent market tiers corresponding approximately to the lower quartile, lower half, and full Boston distribution. The growth in the cumulative share of foreign purchases post-2013 is only observed in the Boston-regulated market and across the price tiers.

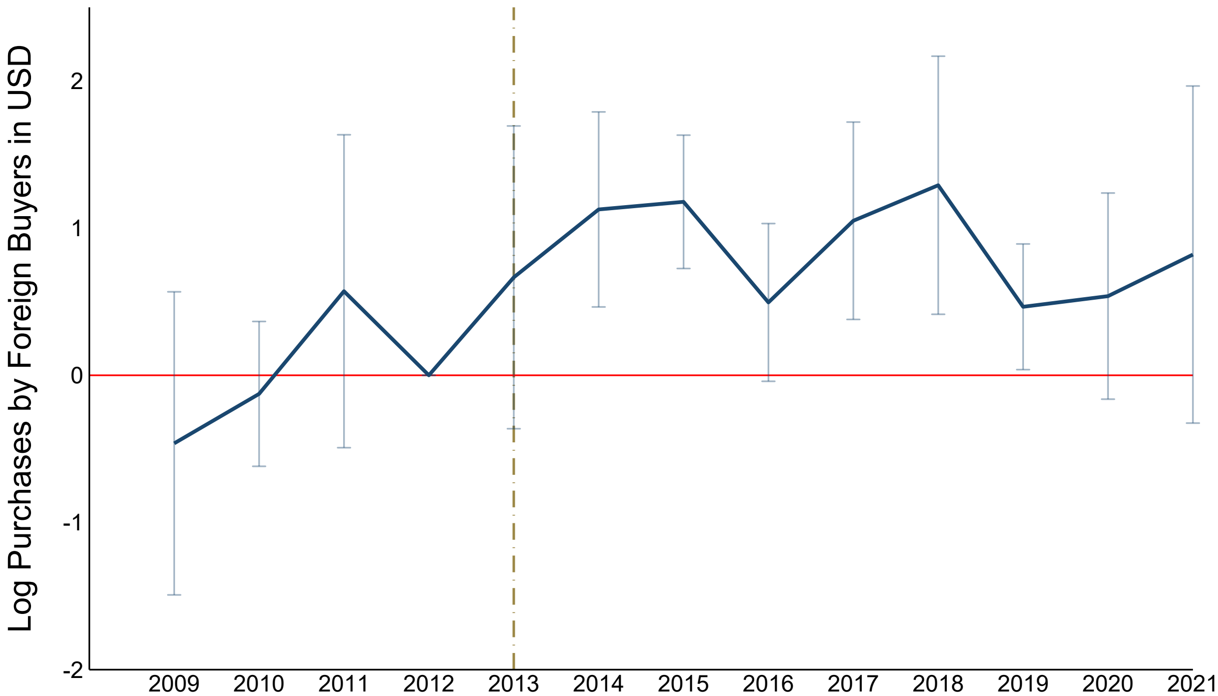
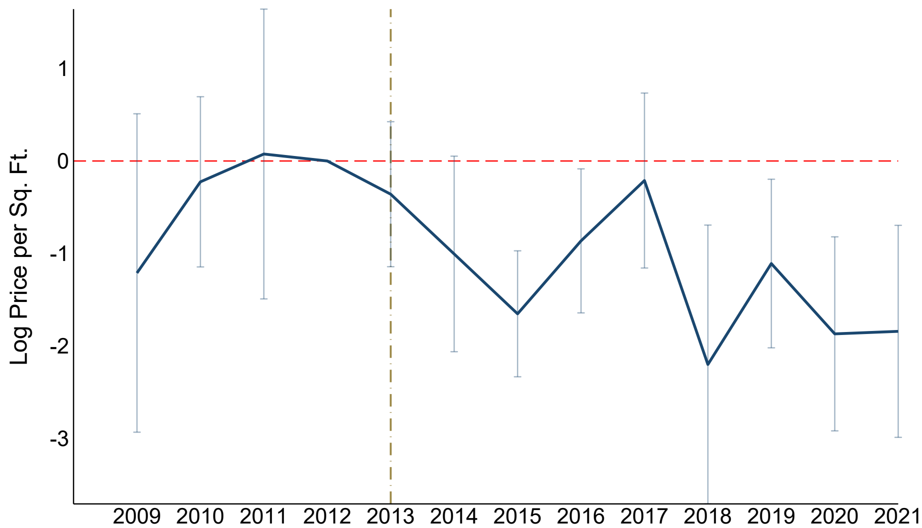
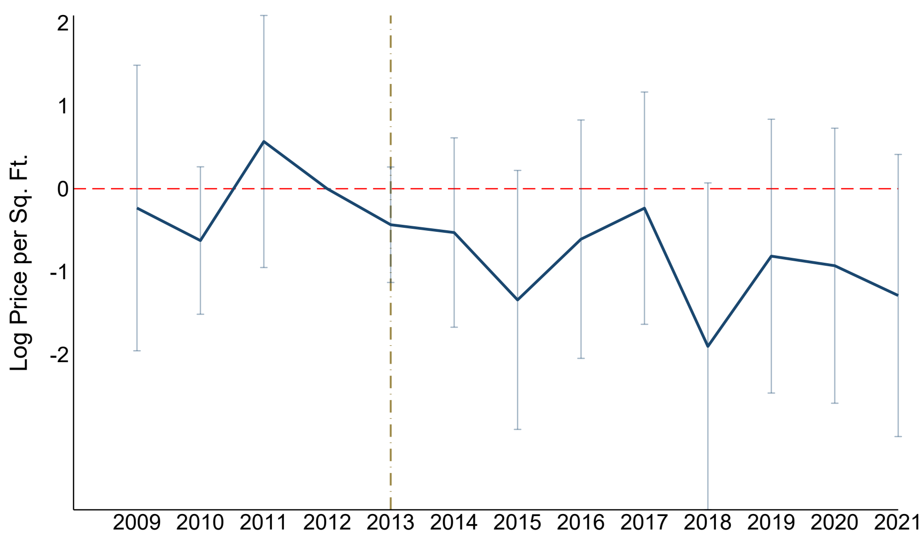


Figure 5. Difference-in-Differences Purchases by Foreign Buyers

This figure plots annual coefficients and 95% confidence intervals from regression (11) of log of USD foreign acquisition volume using the full BERDO sample relative to the Control Group I. The dependent variable aggregates the total dollar value of property purchases made by foreign investors within each city–submarket–year cell, computed according to the aggregation rule in equation (9). All control variables for investor characteristics are constructed using the corresponding averages defined in equation (10). The regression includes city and year fixed effects and controls for building class and property type. Coefficients above 1 indicate that foreign purchase volume in Boston was nearly three times higher than the level implied by the evolution of the control cities in that year.



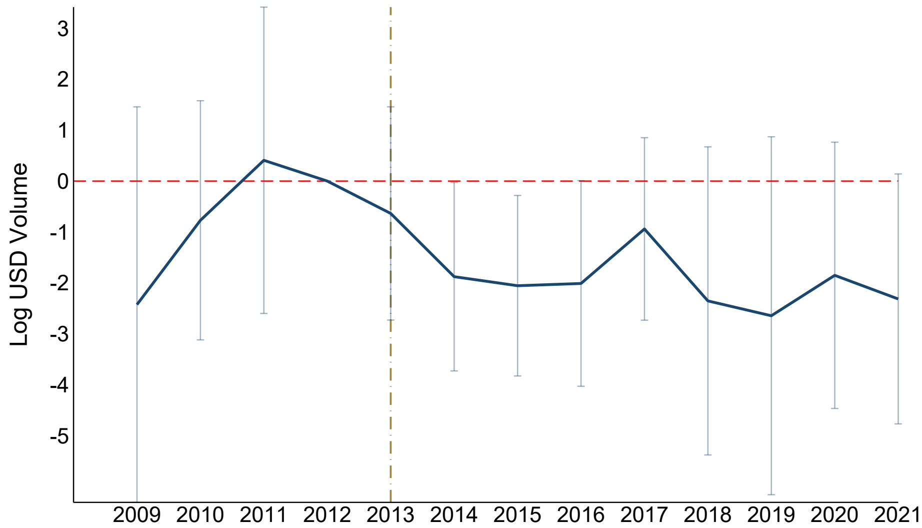
(a) Boston vs Control Group II



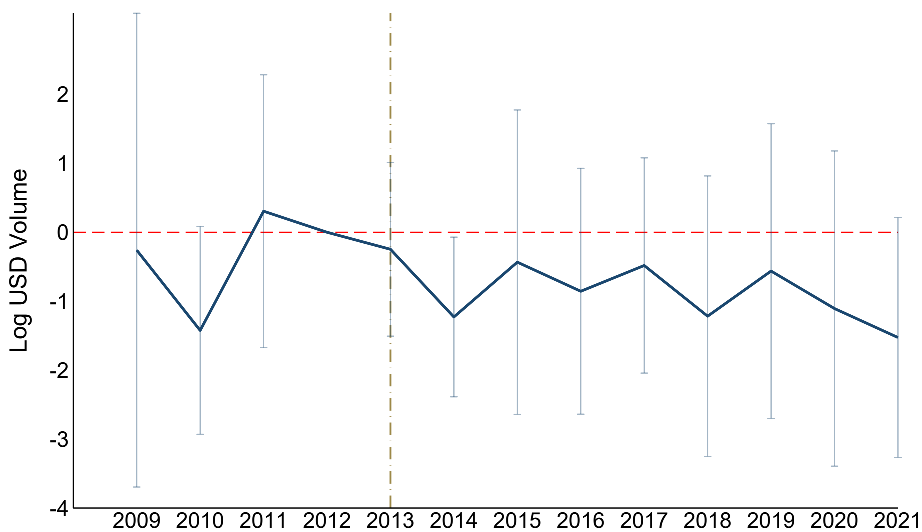
(b) Boston vs Control Group III

Figure 6. Robustness: Difference-in-Differences in Prices

This figure replicates the analysis of Figure 1 but replaces Control Group I with the additional control groups defined in Figure 4. Panel (a) compares Boston to Control Group II, and Panel (b) to Control Group III. Each specification estimates regression (1) using log price per square foot for lower-decile properties and includes city and year fixed effects, along with property-level controls for building age, class, size, and type. The vertical line at 2013 marks the BERDO approval. Across both alternative control groups, Boston's post-policy price trajectory continues to decline relative to comparable markets.



(a) Boston vs Control Group II



(b) Boston vs Control Group III

Figure 7. Difference-in-Differences in Transaction Volume: Boston vs Other Control Groups

This figure replicates the analysis of Figure 2 per regression (5) but replaces the primary comparison group with the additional control groups defined in Figure 4. Panel (a) compares Boston to Control Group II, and Panel (b) to Control Group III. All specifications include city and year fixed effects, along with property-level controls for building age, class, size, and type. The vertical line at 2013 marks the BERDO approval.

Table 1. Summary Statistics for Boston

Variable	Obs.	Mean	SD	Min	Max
Panel A. Property-Level Transactions					
Price per Square Foot (USD)	1,103	430.2	311.6	1.2	2,953.6
Sale Price (USD Millions)	1,103	90.38	139.68	0.12	915.46
Building Square Footage (000s)	1,103	200.2	245.0	14.0	1,764.8
Building Age (Years)	1,066	72.4	43.2	0.0	200.0
Building Class (A=1, B=2, C=3)	1,099	1.88	0.67	1.0	3.0
Panel B. Submarkets Aggregates					
Total Transaction Volume (USD Millions)	254	392.5	835.4	0.12	6,544.1
Number of Transactions	254	21.24	4.95	6.0	29.0
Average Building SF (000s)	254	167.5	156.5	14.0	1,191.9
Average Age (Years)	241	64.9	39.5	0.0	184.0
Average Building Class (A=1, B=2, C=3)	252	2.00	0.66	1.0	3.0

Note: All panels restrict the sample to properties located in Boston over the 2009–2021 period. Panel A reports property-level statistics across all individual transactions. Panel B reports annual aggregates constructed at the city–year–submarket–property-type level using the aggregation procedure defined in Equations 3–4. For each cell, transaction values are summed to obtain total annual market activity, and building characteristics (age, size, class, and property attributes) are averaged across all properties transacted within that city–year–submarket–type group. All quantities, therefore, represent annual measures of market composition and activity. Sale prices are expressed in millions of USD, and building class is encoded as A=1, B=2, and C=3.

Table 2. Difference-in-Differences: Price Effects Boston vs Control Group I

	Lower 10%	**Lower 25%**	**Lower Half**	**Full**
Boston × Post-2013	-1.01***	-0.65***	-0.12*	-0.02
	(0.18)	(0.13)	(0.07)	(0.06)
Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.40	0.39	0.43	0.51
Observations	2,147	3,273	4,020	4,686

Note: Each column reports estimates from regression (2) of log price per square foot for progressively broader market tiers. Column (1) restricts the sample to properties below Boston's lower decile cutoff; Columns (2) and (3) expand to the 25th percentile and median cutoffs; Column (4) includes the full sample. The treatment group is Boston, and the control group is Control Group I (Austin, Nashville, and San Antonio). The estimation sample includes pre-policy years 2009–2012 and post-policy years 2013–2021, with 2013 marking the BERDO approval. All regressions include city and year fixed effects and property-level controls for building age, class, size, and type. Robust standard errors are in parentheses. The interaction estimates correspond to post-policy price discounts of approximately 64% (Column 1), 48% (Column 2), 11% (Column 3), and no detectable effect in the full sample (Column 4). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 3. Difference-in-Differences: Volume Effects Boston vs Control Group I

	Lower 10%	**Lower 25%**	**Lower Half**	**Full**
Boston × Post-2013	-1.181***	-0.767***	-0.235	-0.316
	(0.415)	(0.294)	(0.233)	(0.221)
Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.45	0.46	0.46	0.50
Observations	1,074	1,570	1,753	1,876

Note: This table reports estimates from regression (6) of the logarithm of total transaction volume in USD. The treatment group is Boston, and the control group is Control Group I. The estimation window includes pre-policy years 2009–2012 and post-policy years 2013–2021. Columns (1)–(4) correspond to progressively broader market tiers defined using Boston's price-per-square-foot thresholds. All regressions include city and year fixed effects and controls for building age, class, size, and property type. The interaction term measures the post-policy change in Boston's transaction volume relative to the control cities. Robust standard errors are in parentheses. The estimates imply a reduction of roughly 70% for the lowest tier (Column 1), about 53% for the lower quartile, and modest additional declines for broader samples, consistent with concentrated liquidity contractions in the low-value tier after BERDO. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 4. Difference-in-Differences: Foreign Buyer Purchases Boston vs Control Group I

	(1)	**(2)**
Boston $\times$ Post-2013	0.843*	0.528**
	(0.492)	(0.244)
Controls	No	Yes
Year Fixed Effects	Yes	Yes
City Fixed Effects	Yes	Yes
R-squared	0.34	0.68
Observations	259	258

Note: This table reports estimates from regression (12) of the effect of BERDO's 2013 announcement on foreign buyer purchases in Boston relative to Control Group I. The dependent variable is log USD purchased by foreign investors. Column (2) includes controls for building size, age, and class, as well as year and city fixed effects, where standard errors are heteroskedasticity-robust. The estimation sample is limited to foreign buyers and covers pre-policy years 2009–2012 and post-policy years 2013–2021. The coefficient on $Boston \times Post2013$ remains positive and statistically significant, indicating a 60–70% increase in foreign investment volume relative to the pre-policy baseline.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 5. Robustness in Prices: Boston vs Other Control Groups (Lower Decile)

Panel A. Boston vs Control Group II	
Boston × Post-2013	-1.019***
	(0.310)
Controls	Yes
Year Fixed Effects	Yes
City Fixed Effects	Yes
R-squared	0.35
Observations	268

Panel B. Boston vs Control Group III	
Regulated × Post-2013	-0.877***
	(0.284)
Controls	Yes
Year Fixed Effects	Yes
R-squared	0.49
Observations	211

Note: This table reports estimates from regression (2) of log price per square foot for properties below the Boston cutoff price for the bottom decile. Panel A uses Control Group II and Panel B uses Control Group III, as defined in Figure 4. The estimation window includes pre-policy years 2009–2012 and post-policy years 2013–2021. All specifications include year fixed effects and property-level controls for building age, class, size, and property type and the analysis for Control Group II also includes city fixed effects in line with the baseline specification. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 6. Robustness in Volume: Boston vs Other Control Groups (Lower Decile)

Panel A. Boston vs Control Group II	
Boston × Post-2013	-1.391**
	(0.543)
Controls	Yes
Year Fixed Effects	Yes
City Fixed Effects	Yes
R-squared	0.23
Observations	151

Panel B. Boston vs Control Group III	
Regulated × Post-2013	-0.971*
	(0.531)
Controls	Yes
Year Fixed Effects	Yes
R-squared	0.52
Observations	132

Note: This table reports robustness estimates from regression (6) of log transaction volume for properties below Boston's lower-decile cutoff. Panel A uses Control Group II and Panel B uses Control Group III, as defined in Figure 4. The estimation window includes pre-policy years 2009–2012 and post-policy years 2013–2021. All specifications include year fixed effects and controls for aggregated building age, total floor area, and average building class for each submarket–year–property-type cell. Panel A also includes city fixed effects in line with the baseline specification Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 7. Robustness in Price: Weighted Difference-in-Differences Boston vs Control Group I

	Lower 10%	**Lower 25%**	**Lower Half**	**Full Sample**
Boston × Post-2013	-2.154***	-1.048***	-0.402***	-0.408***
	(0.300)	(0.260)	(0.107)	(0.098)
Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.581	0.286	0.377	0.506
Observations	2,147	3,273	4,020	4,686

Note: This table replicates Table 2 using inverse-propensity-score weights to estimate the treatment effect. Weights are constructed using the logistic assignment model in Equation 13 and applied following the inverse-probability weighting formula in Equation 14. Columns expand the sample from the bottom decile (Col. 1) to the full distribution (Col. 4). The estimation window includes pre-policy years 2009–2012 and post-policy years 2013–2021 All regressions include controls for building age, size, class, property type, and city and year fixed effects. Robust standard errors in parentheses. Weighted difference-in-differences estimates show larger declines across all tiers relative to the baseline results, including a statistically significant decline in the full sample.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 8. Robustness in Volume: Weighted Difference-in-Differences Boston vs. Control Group I

	Lower 10%	**Lower 25%**	**Lower Half**	**Full Sample**
Boston × Post-2013	-2.462***	-1.342***	-0.828***	-0.518**
	(0.643)	(0.386)	(0.277)	(0.251)
Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
City Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.628	0.453	0.521	0.622
Observations	1,074	1,570	1,753	1,876

Note: This table replicates Table 3 using inverse-propensity-score weights to estimate the treatment effect. Weights are constructed from the logistic assignment model in Equation 13 and applied using the inverse-probability formula in Equation 14. Columns expand the sample from the bottom decile (Col. 1) to the full distribution (Col. 4). The estimation window includes pre-policy years 2009–2012 and post-policy years 2013–2021. All regressions include city and year fixed effects and full building-level controls. Robust standard errors in parentheses. Weighted difference-in-differences estimates show larger declines across all tiers relative to the baseline results, including a statistically significant decline in the full sample. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Online Appendix:

A.1 Database and Variable Summary

A.1.1 BERDO Data

A.1.1.1 Data Overview

The BERDO disclosure dataset contains annual energy and emissions reports for all properties subject to BERDO. Reporting begins in 2015 and continues through 2025 (with the 2025 release covering reporting year 2024). The regulated universe expands over time, reflecting both new construction and the lowering of the reporting threshold beginning with the 2021 cycle. As of the 2025 reporting cycle, the BERDO registry includes more than 5,800 properties, compared with roughly 2,500 in the initial 2015 cohort. Across all reporting years, the dataset comprises more than 20,000 building-year observations. Each record contains the core attributes used in the compliance, energy-use-intensity, and market-share analyses. These data are not used to estimate the core price and volume regressions but provide the regulatory exposure measures underlying the compliance, energy-intensity, and market-share analyses.

A.1.1.2 Variable Summary

- GHGEmissionsIntensityKgCO2eSf: annual reported or imputed emissions intensity.
- ReportedGrossFloorAreaSqFt: total building floor area used to weight citywide aggregates.
- cap_kgCO2e_sf: applicable BERDO emissions cap by use type and compliance year.
- noncompliant: indicator equal to 1 if reported intensity exceeds the cap.
- PV_penalty: present-value estimate of cumulative compliance costs over 2025–2050.
- AdjustedBERDOSF_t: adjusted total regulated square footage by year, incorporating new construction.

A.1.1.3 Handling of Missing or Imputed Energy Data

Approximately 30 percent of buildings in the BERDO disclosure file report incomplete or missing metered data. For these buildings, the City imputes a default emissions intensity of

$1.093\,\mathrm{kg\,CO_2e/ft^2}$, corresponding to the average carbon intensity of commercial properties in 2019. We retain these records using the imputed value to avoid selection bias in emissions-intensity estimation.

A.1.1.4 Adjustment for New Construction

For market-share calculations, especially when constructing series that extend to periods prior to 2015 and on a per square foot basis, we compute an adjusted coverage measure, $\mathrm{AdjustedBERDOSF}_t$, defined as the total square footage of BERDO-eligible buildings in year t. New construction is incorporated using CoStar completion dates and floor areas.

A.1.2 CoStar Transaction Data

A.1.2.1 Data Coverage and Structure

The CoStar transaction database provides the primary source for all price, volume, and ownership analyses in the paper. The dataset covers commercial property transactions in the Greater Boston area and in several comparison cities from 1995 through 2024. After restricting to arms-length, non-portfolio transactions, the raw dataset contains more than 100,000 transactions. Each transaction record includes:

- sale price and sale date,
- building size (gross floor area),
- property type (office, retail, industrial, multifamily, specialty, etc.),
- building class (A/B/C),
- construction year,
- CoStar star rating (1–5),
- CoStar-defined submarket identifiers,
- buyer and seller names.

CoStar markets and submarkets are commercial real-estate delineations defined by CoStar to reflect economically coherent property clusters. These geographic definitions form the basis of the hedonic controls and the volume aggregations used in the empirical analysis.

A.1.2.2 Treatment Assignment and Regulatory Status

Properties are classified as BERDO-regulated if they meet the square-footage or residential-unit thresholds specified by the ordinance:

- BERDO 1 (2014–2021): buildings $\geq$ 35,000 ft^2 or $\geq$ 35 residential units.
- BERDO 2 (2022 onward): buildings $\geq$ 20,000 ft^2 or $\geq$ 15 residential units.

Cross-city control groups are drawn from Austin, Nashville, and San Antonio (Control Group I) as well as nearby Greater Boston cities (Revere, Quincy, Malden, Attleboro, Taunton) Control Group II. Below-threshold Boston properties serve as within-Boston controls in robustness exercises, which serve as Control Group III. The Regulated indicator equals 1 for Boston properties above BERDO size/unit thresholds; this corresponds to the treatment indicator in within-Boston specifications.

A.1.2.3 Sample Definition and Cleaning

We restrict the sample to arms-length, non-portfolio transactions between 2004 and 2024 with positive prices and valid building-size data. Transactions are excluded if:

1. sale price is non-positive or missing, or
2. the transaction is flagged as not completed.

Building-level controls include property type, building class, building square footage, and building age (computed as SaleYear minus YearBuilt).

A.1.2.4 Submarkets and Geographic Matching

CoStar submarkets form the geographic unit for all location fixed effects. Boston's 67 submarkets are used directly. For comparison cities, we use CoStar-defined submarket structures to ensure comparable geographic units. This harmonized geography supports the difference-in-differences and event-time analyses.

A.1.2.5 Buyer Identification and Standardization

Buyer names in CoStar appear as free-text strings. We implement the following steps:

1. String standardization: removal of punctuation, entity suffixes ("LLC", "Inc", "Ltd"), and real-estate descriptors ("Properties", "Realty", "Partners").

2. Parent–subsidiary consolidation: identification of ultimate parent firms using Orbis (when available), SEC filings (10-K/10-Q), and publicly available corporate disclosures.

3. Multi-investor transactions: CoStar's company1–company5 fields are separated into distinct buyer entries, each representing a participating firm or joint-venture partner.

This process produces a consistent buyer identifier for all transactions between 1995 and 2024, enabling measurement of entry, exit, cumulative flows, and foreign ownership shares.

A.1.2.6 Foreign Status

Foreign status is assigned using CoStar's buyer-country fields and then verified using external sources when necessary. A buyer is classified as foreign if any entity in its ownership chain has a global headquarters outside the United States (including minority joint-venture partners). A transaction is classified as a foreign purchase if any participating buyer is foreign. This approach ensures consistent identification of foreign capital across subsidiaries, joint ventures, and multi-layered ownership structures.

A.1.3 Investor Data

To analyze ownership reallocation and differences in investor response to BERDO, we supplement the CoStar transaction data with a manually constructed investor database. This dataset, which is used to provide descriptive evidence rather than to estimate our main empirical specifications, begins with the standardized buyer identifiers from CoStar and adds information on foreign status and firm-level characteristics.

A.1.3.1 Firm Scale: Revenues and Employees

To characterize investor size and capacity, we begin with the buyer information available directly in CoStar and then supplement it with firm-level financial data from multiple publicly available sources. The two primary measures are:

- consolidated revenues, and
- total employees.

These values are assembled from a combination of:

- Orbis company profiles,
- SEC filings and annual reports,

- parent-company websites,
- LinkedIn firm pages.

Because reporting practices differ across real estate investors, particularly private firms and individual buyers, financial data are missing for a non-trivial share of entities. When available, information from external sources is manually verified, cross-referenced, converted to U.S. dollars when reported in foreign currency, and standardized across years when necessary.