Does Free Allocation Slow Decarbonization?

Installation-Level Evidence from the EU ETS, Phases III and IV

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Abstract

Installations at high risk of carbon leakage receive free allowances from the European Union Emissions Trading System. Free allowances are allocated to prevent energy-intensive factories from relocating outside the EU. However, whether free allocation slows decarbonization remains an open question. In this paper, I test this question directly.

The panel was built at the installation-level. The data were obtained from the European Union Transaction Log (EUTL). In total, 112,787 installation-years from 2013 to 2023 were observed. To avoid the mechanical bias in derived variables such as surplus (total free allocations-verified emissions) and generosity ratio (total free allocations/verified emissions), free allocation was scaled by fixed base-year (2013) emissions and then lagged by one year. Log verified emissions was then regressed on the scaled variable and Two-Way Fixed Effects (TWFE) estimator with installation and year fixed effects was used.

The estimated effect is very small, close to zero. The coefficient is 0.0006 with a p-value of 0.78. A unit increase in scaled allocation changes emissions by 0.06%, and this is statistically insignificant. This indicates that large free allocations did not slow installation-level decarbonization in Phases III and IV.

The result remains true even without winsorization and when an emissions floor is added. It also holds when removing the 2020 pandemic year. Changing the outcome to emissions intensity using a Eurostat production index does not change the findings either. A difference-in-differences (DiD) test around the 2021 allocation cut gives a large negative coefficient. However, that estimate is invalidated by pre-trends. The Callaway & Sant'Anna, 2021 estimator finds no effect when installations losing most of their free allocation are compared with those losing almost none. Splitting that comparison by sector suggests the cut is associated with lower emissions only in the energy-intensive (carbon-leakage) manufacturing sectors. There are no detectable effect elsewhere. This localized pattern is suggestive rather than confirmed.

Keywords: EU ETS; free allocation; carbon leakage; installation-level data; difference-in-differences; staggered treatment.

1. Introduction

An EU Allowance (EUA) is a permit to emit 1 tonne of CO_2, issued under the European Union Emissions Trading System (EU ETS). The EU ETS is the world's first and one of the largest carbon markets, launched in 2005. Between 2005 and 2024, emissions from stationary installations fell by roughly 51% (European Environment Agency, 2025). The EU ETS is based on "cap" and "trade" principles, and the caps are expressed in allowances. Companies either receive allowances for free or buy them at auction. Free allowances are issued to installations to avoid carbon leakage (Marcantonini et al., 2017). But this support is distributed unevenly across sectors. For instance, since 2013, power generators have bought almost all allowances at auction, but sectors like cement and steel still receive most of their allowances for free (Stenqvist & Åhman, 2016).

The carbon leakage list decides which installations receive free allocation and how much. If the installation's emissions intensity multiplied by trade intensity is above 0.2, it is considered at risk of carbon leakage (*Carbon Leakage - Climate Action - European Commission*) . The goal is to support emission-intensive sectors that might leave the EU to avoid pollution laws. Listed sectors receive a high share of their benchmark-based allocation for free. In contrast, non-listed sectors face a declining free share over time. The list therefore concentrates free allocation in energy-intensive manufacturing sectors such as cement, steel, and chemicals. These sectors are listed because they are both trade-exposed and emissions-intensive, which is also why most over-allocation ends up there.

A series of reforms changed the rules through phases (Verde et al., 2019). In the early phases (Phase I and Phase II), allowances exceeded the emissions, creating a surplus. Low carbon prices did little to absorb it (Bayer & Aklin, 2020). From 2013, allocations were centralized under an EU-wide cap. Reforms such as dynamic allocation measures (Duscha, 2018) and the introduction of the Market Stability Reserve (MSR) (Borghesi et al., 2023) changed incentive structures and compliance conditions (Martin et al., 2016), causing varying decarbonization outcomes (Dechezleprêtre et al., 2023). Allowances do not expire and can be held by companies unless surrendered. Surpluses can persist for years. This raises the question of whether installations holding more free allowances than they emit face less pressure to reduce their emissions? A

2025 study of Phase IV (Willemaers, 2025) suggests that cutting free allocation lowers emissions. But the author also finds that reductions still occur even when companies still held excess allowances from before 2020. In this paper I focus on Phase III and Phase IV together (2013–2023) to examine how installations holding large amounts of free allowances manage their emissions.

The starting point is a simple idea about cap-and-trade markets, called the independence property (Montgomery, 1972). A firm can always sell free allowances. So keeping the allowances has a cost: the money the firm gives up by not selling them. The cost remains the same whether the allowances are allocated freely or bought at auction. Because of that, a firm trying to keep costs low has the same reason to cut emissions either way. Theoretically, the way allowances are given should not change how much firms emit. The paper tests whether this is also true in practice in Phase III and Phase IV. The other hypothesis is that firms holding a surplus of free allowances treat them as cheap assets and therefore cut emissions less. So, the null hypothesis: free allocation has no effect on emissions. The alternative hypothesis: allocating free allowances slows down decarbonization.

2. Data and Measurement

The installation panel data was built from the European Union Transaction Log (EUTL). The data were obtained from the (*EUETS.INFO* project, October 2024 release). Three source files were combined: compliance.csv, installation.csv, and activity_type.csv. Python (pandas) was used on Google Colab.

Only installation_id, year, reportedInSystem_id, allocatedFree, allocatedNewEntrance, allocated10c, and verified columns were retained in compliance.csv. Similarly, in installation.csv only “id", "country_id", "activity_id", "nace_id", "isAircraftOperator", and "isMaritimeOperator" columns were kept. The sample was restricted to installations reported under the EU ETS. The records from the Swiss registry (CHETS) and the Effort Sharing Decision (ESD) were excluded. Aircraft and maritime operators were removed so that the analysis is confined to stationary installations. Verified emissions are reported only through 2023. Therefore the panel was restricted to the 2013–2023 period.

Non-operating factories were removed. These were installations that lack both free allocations and verified emissions (60,118 installation-years). Reporting gaps - free allocations without verified emissions (8,408 installation-years) were removed as well. On the other hand, installations reporting verified emissions without any free allocation (12,922 installation-years) were interpreted as zero allocations. This is consistent with the withdrawal of free allowances from the power sector from 2013 onward.

EUTL codes from Phase I and Phase II (1–9) were matched with their current equivalents. For example, cement 6:29 and steel 5:24, to make sure that each sector has one unique code. Codes of non-stationary factories were dropped. These included: aircraft (10), CO_2 transport and storage (46, 47), maritime (50), and EU Effort Sharing (1000).

Three variables were derived:

1. $Total\ Free\ Allocation = AllocatedFree + AllocatedNewEntrance + Allocated10c$

2. $Surplus = Total\ Free\ Allocations - Verified\ Emissions$

3. $Generosity\ ratio = \frac{Total\ Free\ Allocations}{Verified\ Emissions}$

A Generosity ratio above one indicates over-allocation, a ratio below one indicates under-allocation. To prevent division by zero, the ratio was set to missing for installation-years that report zero verified emissions.

The panel comprises 112,787 installation-year observations. They are distributed across 27 sectors. The period covered is 2013-2023. The complete code is provided in the supplementary notebook (01_build_panel.ipynb).

Later, the panel was cross-checked with eu-ets-2013-2025.csv file. The data was obtained from (*EU Emissions Trading System (ETS) Data Viewer*, 2025) on 16 June 2025. For this study, only "allowances and emissions" were selected. Emission unit was selected as "t CO_2 -eq". For ETS information: 1.1 Freely allocated allowances, 1.3 Allowances auctioned or sold(EUAs and EUAAs), and 2. Verified emissions were selected. The two aggregate categories, "20-45 & 99 All stationary installations" and "21-45 & 99 All industrial installations (excl. combustion)", were excluded and the individual activities selected, to avoid double-counting. All countries were selected, except the aggregates and special funds ("All countries", EU27, EU27+ UK, Innovation Fund, Modernization Fund, NER 300 Auctions, Recovery and Resilience Facility).

Column names were changed to country, year, metric, sector, and value. In the metric column, unique values such as '1.1 Freely allocated allowances', '1.3 Allowances auctioned or sold (EUAs and EUAAs)', and '2. Verified emissions' were pivoted (using pivot_table function) into separate columns. 1.1 and 2 renamed to free_alloc and verified_emissions. The metric '1.3 was dropped because the focus is on the free allocation of allowances.

The final data check shows that the country-level data matches the trends in our installation-level data. Later, descriptive statistics, surplus and generosity ratio, and a figure were generated (02_analysis.ipynb).

3. Empirical Strategy

Both the surplus and the generosity ratio are calculated from verified emissions. Verified emissions are the dependent variable. Regressing emissions on these variables (surplus, and generosity ratio) causes the problem. It puts the outcome on both sides of the equation. This creates a mechanical bias/endogeneity. To fix this, the treatment variable was derived from using allocation alone.

The treatment is each installation's total free allocation scaled by a fixed base-year emissions(2013) level: alloc_scaled = free_total / base_emissions. 2013 is the first year of Phase III, and it was fixed across all years. The denominator is a fixed number for each installation. Because of this, it does not change over time within the same installation. Therefore, the variation inside each installation comes from the numerator and the numerator is the free allocation set by policy. The variation does not come from the installation's current emissions. The base year is fixed at 2013. This year comes before the post-2013 emission changes used in the lagged regressions. Because it is fixed in the past, it cannot react to later emissions. This feature separates our measure from the generosity ratio. It avoids the mechanical bias described above. Scaling by fixed base-year (2013) emissions and applying winsorization also keeps the cause variable statistically stable. A few very large installations dominate raw free allocation levels. Furthermore, allocations can change when an installation changes its activity. This means part of the year-to-year movement reflects output changes. An unscaled version would be driven by sheer size and by allocation responding to output. It would fail to provide a clean test of the policy.

Only the installations that were operating in 2013 were included in the modelling sample. Installations that entered after 2013 were removed. This was done to have the same starting point for all units in the sample. The modelling panel then contains 11,563 installations and 106,569 installation-years. After the one-year lag and the logarithmic transformation, the sample is 89,262 installation-years from 10,433 installations. This is smaller than the full descriptive panel which has 112,787 installation-years. Because the sample contains only incumbents, the estimates describe installations that have operated since 2013 and do not describe new entrants.

The treatment enters the model with one-year lag. In this way, the previous year's allocation predicts the emissions of the current year. This reduces the risk of reverse causality. The dependent variable is the natural logarithm of verified emissions and defined only for installation-years with positive emissions. Some base-year denominators are very small and produce extreme values of the treatment. To limit their influence, the scaled treatment is winsorized at the 1st and 99th percentiles. The model is then estimated with installation and year fixed effects. The standard errors are clustered by installation.

The fixed-effects estimate is supported by a difference-in-differences test. This test uses the one-time reduction in free allocation at the transition from Phase III to Phase IV in 2021. For this test, a treatment intensity (the dose) is defined for each installation.

$$Dose = 1 - FA2021/FA2020.$$

FA2021/FA2020 stands for the ratio of 2021 free allocation to the 2020 free allocation. Its value is bounded to the interval between zero and one and the dose is fixed within each installation and does not change over time. For this reason, the identification comes from the change in emissions after 2021. It compares installations that lost more of their free allocation with installations that lost less. The test is estimated in three ways. First, as a continuous difference-in-differences with installation and year fixed effects. Second, as an event study. Third, it is checked with the Callaway & Sant'Anna, 2021 estimator. The continuous dose was made binary for this estimator. Installations that lose more than 30 percent of their free allocations are treated, and those losing less than 5 percent form the untreated control group. Intermediate group is dropped. All treated installations share a single 2021 group. Because of this, the setup is a two-group, one-period design. It is not a staggered design. The model calculates the effect for installations with high losses relative to installations with near-zero losses. It does not calculate an average effect across the entire panel. Finally, to find where the effect appears, the level model and the difference-in-differences are also estimated separately in two groups. The first group is the carbon-leakage manufacturing area (the energy-intensive factories that receive the most free allocation) and the second group is the remaining installations.

The total emissions alone cannot show the difference between two cases. In the first case, installation emits less because it became cleaner and in the second case, it emits less because it produced less – production went down. To separate these two cases, the analysis is repeated with emissions intensity as the outcome. Emissions intensity is calculated by dividing verified emissions by the production index. The production index comes from Eurostat and is measured for each country and the sector. It matches to each installation by country, NACE division and year. This adjusts for output trends at the sector level. However, it cannot adjust for the output of each individual installation. This information is not available in the public registry data.

4. Descriptive Results

There are 112,787 installation-years from 12,899 unique installations in 27 sectors in 32 countries between 2013 and 2023. The overall surplus distribution shows that the median (50%) is -1,933. This suggests that most installation-years are slightly net-short (negative). The mean is

-80,899, much more negative than the median, because of outliers on the low end. The standard deviation is 713,523, showing wide variation across factories. Range (min to max): The minimum (-35,028,250) is a large deficit, and the maximum (8,739,566) is a large surplus. The data also show that 29.34% of all installation-year rows had a carbon-credit surplus.

There are 106,610 usable installation-year observations for the generosity ratio. The median value is approximately 0.71. This indicates that a typical factory received free allowances covering 71 percent of its emissions. But the mean value is 42.62. That shows there is right-tail skewness in the distribution. The maximum outlier value is 693,307. To avoid division by zero errors, 6,177 zero-emission installation-years were set to ‘missing’.

The data also show that the share of over-allocated factories fell from 39.8 percent in 2013 to 25.3 percent in 2023.

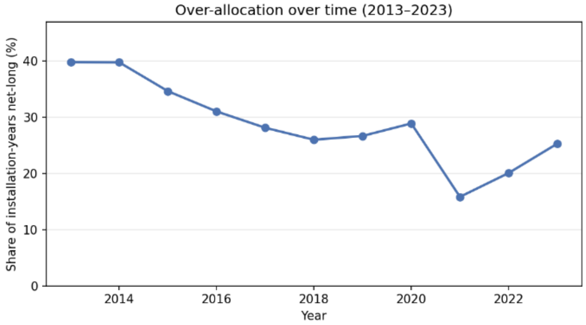

Figure 1. Share of net-long (over-allocated) installations, 2013-2023

Sector	**Median surplus (tCO2e)**	**Mean surplus (tCO2e)**	**Installation -years**	**Share net-long (%)**
Production of adipic acid	183975	271916	33	100.00
Production of soda ash and sodium bicarbonate	94404	87458	150	74.00
Production of coke	13161	-61172	181	69.60
Production of nitric acid	12961	14702	347	65.40
Production of bulk chemicals	2677	13310	3339	57.60
Production of cement clinker	0	16510	2630	48.70
Production of pulp	-528	7054	1693	45.90
Production of pig iron or steel	-244	154790	2260	45.90
Manufacture of ceramics	-106	-1022	9193	45.30
Metal ore roasting or sintering	-1976	-36609	109	44.00
Production of carbon black	-3848	-11757	190	40.00

Production or processing of non-ferrous metals	-2026	2713	887	39.70
Production of paper or cardboard	-1330	4254	5783	39.10
Production or processing of ferrous metals	-1948	-1522	2523	38.50
Production or processing of gypsum or plasterboard	-3002	-5860	417	36.50
Production of lime or calcination of dolomite/magnesite	-3637	-10907	2571	36.10
Production of hydrogen and synthesis gas	-14785	-17658	429	34.50
Production of ammonia	-80833	-90393	278	32.70
Production of primary aluminium	-25851	-25854	337	28.50
Combustion of fuels	-2804	-129440	71094	23.30
Refining of mineral oil	-80607	-207490	1343	22.00
Other activity opted-in pursuant to Article 24 of Directive 2003/87/EC	0	-1095	2500	21.00
Manufacture of glass	-6043	-9613	3653	20.10
Production of secondary aluminium	-3851	-6152	323	17.30
Manufacture of mineral wool	-7340	-9599	499	17.00
Capture of greenhouse gases under Directive 2009/31/EC	-190	-2786	17	0,00
Production of glyoxal and glyoxylic acid	-2808	-2691	8	0,00

Table 1. Sector level over-allocation

Table 1. reports the median and mean surplus in tonnes of CO_2-equivalent, the installation-years, and the share of net-long positions in 27 sectors. The table is ranked by the share of net-long (%). Over-allocation is mostly in a few energy-intensive industries. Production of adipic acid is the most over-allocated (100.0% of installation-years net-long, and the median surplus of 183,975 tCO_2e). This is followed by soda ash and sodium bicarbonate (74.0% net-long; median 94,404 tCO_2e), coke (69.6%), and nitric acid (65.4%).

Production of cement clinker has a median surplus of zero and a positive mean of 16,510 tCO_2e. This shows that the typical cement plant was roughly balanced. But a small minority held large surpluses.

Pig iron and steel show a bigger gap, with a negative median of -244 tCO_2e but a positive mean of 154,790 tCO_2e. This suggests that a few large plants hold huge surpluses.

These highly subsidized fields match the carbon-leakage industries. They are protected from government auctions. This indicates that free-allowance generosity went where carbon-leakage rules directed it.

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5. Empirical results

The fixed-effects results show no strong association between lagged free allocation and emissions. In the model, the coefficient on the scaled, one-year-lagged allocation is 0.0006. Its standard error is 0.0020, and the p-value is 0.78. The model is estimated over 89,262 installation-years from 10,433 installations. So the estimate is very close to zero, and it is also estimated quite precisely. One-standard-deviation increase in lagged allocation is associated with a change of only about 0.6 percent in emissions. The 95 percent confidence interval on the coefficient is [-0.003, 0.004]. In the same per-standard-deviation terms, the effect lies between -3.2 and +4.3 percent. This means that larger effects can be ruled out at standard levels. The result is therefore a precise null.

The null result is robust. It was checked in several ways, and it holds. When the treatment is not winsorized, the coefficient is 0.00001 ($p = 0.75$). When the 2020 pandemic year is excluded, it is -0.0002 ($p = 0.93$). Both are very close to zero and not significant. One specification adds a minimum-emissions threshold. Here the coefficient is small and positive (0.005), but it is still not significant ($p = 0.06$). This is the only specification that comes close to significance. Its sign is positive, and this is the direction we would expect if allocation slowed abatement a little among the larger emitters. However, this effect does not hold at standard levels, and it does not appear in the other specifications.

Taken together, these results give no evidence that larger free allocations slowed decarbonization at the installation level in Phases III and IV. This is consistent with (Willemaers, 2025). That study also finds no weaker emissions response among installations that held surpluses before 2020. Generosity ratio as a treatment was not used. The reason is that the ratio contains verified emissions inside it. This would give the negative association.

These estimates control for installation and year fixed effects. But they do not control for output. For this reason, they cannot yet separate real decarbonization from a simple fall in production. This was addressed in two ways: First, I re-estimate the model with emissions intensity, using a merged measure of production. Second, I add a difference-in-differences estimator to support the fixed-effects design. Both are reported in the discussion part.

6. Conclusion and Discussion

Difference-in-differences and reconciliation with recent evidence

The fixed-effects analysis shows no association between how many free allowances an installation gets and its future emissions. The estimate is very precise. Because of this precision, we can rule out anything except a tiny effect. This zero result is important because free allocation is the main policy tool we care about. Across both Phase III and Phase IV, existing factories with bigger shares of free allowances did not cut their emissions any less on average.

Next, difference-in-differences approach was used. This method looks at the one-time cut in free allowances when the EU ETS moved from Phase III to Phase IV in 2021. For each installation, the treatment intensity(the dose) was calculated. This dose is calculated as one minus the ratio of the 2021 free allocation to the 2020 free allocation. Large negative coefficient (-0.50) was returned when the standard model with both installation and year fixed effects was run. This suggested that factories losing more free allowances cut their emissions much faster. Yet, the event study graph tells a different story. There is a clear pre-trend in the data. The installations that ended up facing the biggest policy cuts in 2021 were already cutting their emissions much faster from 2013 to 2020. This means the vital parallel-trends assumption fails for the whole sample. To address this, the model was re-estimated with the Callaway & Sant'Anna, 2021 estimator, which compares installations that lost most of their free allocation against a clean control group that lost almost none. This does not repair the pre-trend in the full-panel design and it estimates a different, better-identified contrast between high-loss and near-zero-loss installations. In that comparison the average treatment effect after 2021 is -0.003, statistically indistinguishable from zero. So in this high-loss-versus-low-loss comparison the 2021 allocation cut shows no detectable effect on emissions.

To test this directly, instead of guessing, the data was split into two separate groups. The first group is an energy-intensive manufacturing proxy for the carbon-leakage core. It is defined as five NACE divisions: paper, coke and refined petroleum, chemicals, non-metallic minerals, and basic metals. This is a broad proxy and not the official Phase IV carbon-leakage list. These industries drive most of the over-allocation shown in Table 1. They also make up about 40 percent of all our observations. The second group contains all the remaining installations. I then ran the exact same models for each group separately. The level-based result stays near zero in both groups, so the level of free allocation is unrelated to emissions in both the manufacturing core and the rest, not only on average. Next, the standard difference-in-differences model shows large, negative results for both groups. The coefficient is approximately -0.63 in the manufacturing core and -0.39 in the remaining sectors. However, this drop comes entirely from the same pre-trend problem shown earlier. So this is not a real causal effect in either group. The main comparison is again the Callaway & Sant'Anna, 2021 estimator. It runs separately within each group. In the manufacturing-core proxy, it gives a negative and significant effect of about -0.09. That is a drop of roughly nine percent (95 percent confidence interval: -14 to -3 percent). For the remaining installations, the effect is basically zero (+0.03, with a confidence interval spanning zero). So the high-loss-versus-low-loss comparison is negative and significant inside the manufacturing core, but not outside it. Because each subgroup is estimated on its own redefined treated and control groups, these contrasts are not a weighted decomposition of the near-zero aggregate effect. In this comparison, cutting free allocation is linked to lower emissions in the manufacturing core and to no clear change elsewhere. This pattern looks localized. But the subgroup pre-trends have not been checked yet. So this is only suggestive, not confirmed. To confirm it, subgroup event studies would be needed.

This split within data matches the findings of Willemaers, 2025. That paper finds a strong negative dose-response of about -0.359 for the same 2021 policy change. The main difference is, however, Willemaers looks only at existing factories in the carbon-leakage manufacturing sectors. His sample focuses on specific industry groups with clean data and stable trends before the policy. By contrast, our data covers all stationary installations. It includes every single sector and country in the system. Because of this, the data split shows that the drop in emissions is concentrated on the manufacturing-core proxy and it is not a pattern across the whole system. This matches the direction of Willemaers' result. Still, the two samples and research designs are different and full-panel difference-in-differences model here is also confounded by pre-trends.

Two more papers further support these results. First, Alder et al., 2025 look at 2018 carbon leakage list reform and installation-level data linked to firm accounts. They find that installations losing their free allowances cut emissions by more than 14 percent compared to those that kept them. This result is very close in size and direction to the findings in (Willemaers, 2025) It is also estimated using the same limited manufacturing core. Two independent designs find a similar effect on the carbon-leakage core. My panel analysis finds a null once all sectors and countries are included. Together, this points to an effect that is concentrated and it is not happening across the whole system. Bordignon & Gamannossi degl'Innocenti, 2023 points the same way from a different subgroup. The Article 10c derogation kept free allocation for power generators in lower-income member states, and this was linked to higher emissions. Again, the allocation effect sits inside a specific subgroup, not across the system. At the sector level, Aydin & Acar, 2025 find no significant relationship between free allowances and emissions, which repeats the same zero result that was found in this paper, even though they look at larger industry groups instead of individual factories. Another explanation looks at how emissions are cut. Guerriero & Pacelli, (2023) studied Italian installations. They found that taking away free allowances does not change how existing plants cut emissions. Instead, it encourages new, cleaner factories to enter the market. This study focuses only on installations that have operated since 2013. Because of this setup, it only captures the incumbent margin and cannot detect changes in the market caused by new factories entering or old ones leaving. Therefore, zero result that we found for existing plants matches their findings.

The null was also tested against the objections like: "what if the flat emissions mean factories are producing less and not actually cutting pollution?" To check this, main variable was changed to emissions intensity. I built this by dividing verified emissions by a Eurostat sector-by-country production index. This index matched 92 percent of the data, including the power generation sector.

The level-based zero result holds up even with this output control. The amount of free allocation does not predict emissions ($p = 0.78$) or emissions intensity ($p = 0.59$). This is consistent with the flat result reflecting true carbon efficiency rather than reduced production.

However, two problems remain. First, the production index is measured for whole sectors within a country, not for each individual installation. This means the output changes at specific plants cannot be captured fully. Second, the standard difference-in-differences models on the full panel are contaminated by the pre-trends shown earlier. This bias persists even when using emissions intensity. Given these pre-trends, data split already gives the direct comparison. It shows a real abatement response inside the carbon-leakage manufacturing core but a zero effect everywhere else. Analyzing subgroup pre-trends is a necessary next step to confirm this localized effect.

These findings carry a direct implication for the policy transition. From 2026 the Carbon Border Adjustment Mechanism (CBAM) begins to replace free allocation for several of the carbon-leakage manufacturing sectors. The logic is that the border charge can stop carbon leakage and at the same time remove the free allowances (Pan & Liu, 2024; Wettestad, 2023). The evidence speaks to the emissions side of that trade-off. Across the system as a whole, the level of free allocation had no association with installation emissions, and taking away these free allowances might not speed up emission cuts on average. But the response to cutting allocation is concentrated exactly in the trade-exposed manufacturing core. Since the new mechanism targets this exact group, this is where the phase-out will actually matter for emissions. The policy shift is based partly on the idea that free allocation was needed to stop leakage. Yet, the actual data show that carbon leakage has played only a tiny role in global emissions so far (Nordström, 2023).

Taking everything together, these results suggest that the emissions cost of removing free allocation is likely to be small, and limited to a few specific sectors. This finding strengthens the environmental argument for the phase-out. It means that the arguments about competitiveness, legal issues, and distribution that dominate the Carbon Border Adjustment Mechanism debate (Alfvegren, 2025; Corvino, 2025) must be settled on other grounds.

Conclusion

Overall, the evidence answers the original question. Across Phase III and Phase IV, installations with larger free allocations did not decarbonize more slowly. The association is a null. This result holds up even when controlling for output through emissions intensity.

The apparent effect of the 2021 allocation cut on the full panel reflects pre-existing trends. It is not a real causal response. The credible negative effect found in recent papers is confined strictly to the carbon-leakage manufacturing core.

For policy, these results suggest something important. Free allocation, as implemented, has not broadly weakened the incentive to cut pollution created by the carbon price. This fits the independence property. Under this property, freely allocated allowances still carry an opportunity cost. Free allocation may affect emissions on one specific margin, but in this study that pattern is suggestive rather than confirmed. This margin is the trade-exposed manufacturing sectors that get the most generous allocations.

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