Behind Environmental Injustice: Disparate Siting and Post-Siting Migration of Fossil Fuel Power Plants*

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November 13, 2025

Abstract

Environmental injustice can be explained by two mechanisms: the disproportionate siting of polluting industries in low-income and minority communities, and demographic changes following the establishment of toxic sites. This paper investigates the siting decision of fossil fuel power plants and the subsequent demographic changes due to the siting in the context of environmental injustice. Using data at census tract level in the United States from 2000 and 2019, we find that fossil fuel power plants are more likely to be located in areas with higher minority populations, which leads to an average increase in the local minority ratio by 1.2%.

Key words: Environmental Justice, Fossil Fuel Power Plant, Siting, Migration
JEL codes: Q53, Q56, Q58, R23

* This work was supported by the National Science Foundation [Grant Number 2200648]. All remaining errors and omissions are our own.

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1 Introduction

Socioeconomic disparities in exposure to environmental pollution remain a persistent and significant problem in the United States. Decades of research have documented that minority and low-income communities are disproportionately exposed to pollution sources, including industrial plants, highways, and fossil fuel facilities (Bullard, 1983, Banzhaf et al., 2019b, Colmer et al., 2020). This pattern of environmental injustice has endured since the 1980s despite growing public awareness, regulatory interventions, and government efforts to address racial and spatial inequality in environmental outcomes (Bullard, 1993). These disparities are not only morally and ethically troubling but also associated with serious health and economic consequences for the affected populations.

Understanding the mechanisms behind this persistent inequality is critical for designing effective and equitable policy interventions. As discussed by Banzhaf et al. (2019b,a), two channels contribute to environmental injustice: disparate siting and post-siting migration. Disparate siting refers to the tendency for polluting facilities to be located in minority and disadvantaged communities, often due to lower land values, proximity to infrastructure, weaker political resistance, or historical patterns of segregation. Post-siting migration captures the idea that pollution exposure is also shaped by household mobility decision - when White and higher-income households move away after a plant is sited, and minorities or lower-income households remain or move in, demographic sorting amplifies initial disparities over time.

While these mechanisms are conceptually well-established, there is relatively little empirical work that quantifies both channels in a unified framework. Existing studies have largely focused on either siting or sorting alone, often using historical or coarse geographic data. In this paper, we provide new tract-level evidence on both mechanisms by examining the siting of fossil fuel power plants in the United States from 2010 to 2019. This period is especially relevant, as it follows major environmental justice initiatives and coincides with continued debates over energy transition and the unequal distribution of its burdens.

Our empirical analysis yields several key findings. First, we find that new fossil fuel power plants are significantly more likely to be sited in census tracts with higher minority population shares, even after controlling for a wide range of socioeconomic, geographic, and infrastructure characteristics. This confirms that disparate siting remains a contemporary issue, not merely a historical artifact. Second, we use event-study and difference-in-differences methods to estimate the causal effects of power plant siting on local demographics. On average, the local minority share increases by 1.2 percentage points after a plant is sited, driven by a 10.4% increase in minority population and a 6.3% decline in White population. These patterns suggest that demographic sorting plays a significant role in amplifying racial disparities in pollution exposure.

To the best of our knowledge, this is the first study to provide causal evidence of both siting and post-siting migration mechanisms in the U.S. energy sector using recent data and census tract level geographic resolution. By quantifying how firms' location decisions and individuals'

migration responses jointly shape environmental inequality, our findings have direct implications for environmental justice policy.

The remainder of the paper is structured as follows. Section 2 provides a conceptual framework and reviews related literature. Section 3 describes the data sources and presents summary statistics. Section 4 details the empirical strategies and presents the main results. Section 5 concludes and discusses policy implications.

2 Conceptual Prospective and Literature

2.1 Polluting Plants Sites Selection

The selection of polluting industrial plant sites is primarily determined by the operating costs, which include production costs, transportation costs, and abatement costs (Wolverton, 2009). These costs vary across different locations. Specifically, production cost depends on factors such as land rents, labor costs, and the cost of raw or intermediate materials. Transportation costs are associated with the distance required to deliver products to targeted markets, and abatement costs depends on local government regulation stringency as well as public pressure (Lyon and Maxwell, 1999, Bi and Khanna, 2012, Zhang and Khanna, 2024).

Moreover, these costs are strongly correlated with the socioeconomic characteristics of local communities. Disadvantaged communities are more likely to be areas with lower costs of land, labor, and materials (Been, 1994, Hamilton, 1995, Banzhaf et al., 2019b). In addition, disadvantaged communities tend to have less public pressure to reduce pollution because local residents have a lower willingness to pay for environmental amenities (Depro et al., 2015); inadequate information about pollution damage, and limited capacity for collective action and Coasian bargaining against polluting industries (Hamilton, 1995; Shapiro, 2005; Banzhaf et al., 2019a). As a consequence, polluting plants are more likely to site in disadvantaged communities, leading to higher pollution exposure for local underrepresented residents.

There is a large literature examining the disparities in the siting of polluting facilities, consistently documenting that such facilities tend to be located in communities with higher shares of minority or low-income residents. Early work by Bullard (1983) highlighted that solid waste sites in Houston were disproportionately sited in African American neighborhoods, laying the foundation for the concept of environmental racism. Subsequent studies extended this insight across regions and facility types. For example, Saha and Mohai (2005) analyzed hazardous waste facilities in Michigan and found persistent racial and socioeconomic disparities in siting decisions between 1950 and 1990. Income has also been shown to play a significant role, as Wolverton (2009) demonstrated in her study of polluting facility locations. More recently, McCoy (2017) provided evidence that coal-fired power plants were more likely to be sited in minority communities, reaffirming the continuation of these patterns into the modern energy sector.

2.2 Post-siting Migration (Sorting)

The siting of polluting facilities can degrade local environmental quality, which in turn influences residential mobility and community demographics. Households' decisions to stay or relocate are shaped not only by environmental preferences but also by constraints such as income, job opportunities, and housing costs. In some cases, disadvantaged households may lack the resources to move away from pollution sources, a phenomenon sometimes described as being "stuck with the nuisance". In other cases, they may even "move toward the nuisance" due to lower housing costs or employment opportunities associated with polluting industries.

A growing body of literature models these dynamics through residential sorting frameworks. For example, Bayer et al. (2009) and Klaiber and Phaneuf (2010) show that environmental quality is a key factor in household location decisions, and that individuals sort themselves into neighborhoods based on both preferences and constraints. Depro et al. (2015) find a racial gap in the willingness to pay (WTP) for clean air, with White households more likely to relocate away from polluted areas, contributing to increasing racial disparities in environmental exposure. Relatedly, Melstrom and Mohammadi (2022) show that minority residents are more likely to leave areas where environmental quality improves, potentially due to resulting increases in housing prices or neighborhood gentrification.

Despite strong theoretical support for post-siting demographic changes, empirical evidence remains mixed. Some studies, such as Pastor et al. (2001) and Hunter et al. (2001), do not find significant changes in local minority share following the siting of polluting facilities. However, other research has documented racial differences in mobility patterns around hazardous or industrial sites. For instance, Stretesky and Hogan (1998) and Crowder and Downey (2010) provide evidence that White households are more likely to move away from areas near polluting facilities, whereas minority households are less mobile or more likely to remain.

These mixed findings suggest that the demographic effects of pollution siting may be context-dependent and vary across time periods, facility types, and geographic scales. Our study contributes to this literature by providing recent, census tract-level causal evidence on post-siting migration patterns in the context of fossil fuel power plant sitings across the U.S. from 2010 to 2019.

2.3 Comprehensive Analysis on Both Siting and Sorting

There is limited empirical work that jointly analyzes both disparate siting and post-siting demographic changes as mechanisms driving environmental injustice. Mohai et al. (2009) and Banzhaf et al. (2019b) provide theoretical frameworks and qualitative reviews of these two channels, emphasizing their interplay in producing unequal pollution exposure. However, few studies quantify both mechanisms in a unified empirical framework. The most notable exception is Pastor et al. (2001), which investigated siting and migration around toxic storage facilities in Los Angeles County. While their analysis raised important questions, it found no significant post-siting demographic shifts and

did not establish causal identification.

To the best of our knowledge, this current study is the first to provide a comprehensive empirical analysis of both disparate siting and post-siting migration in the context of the fossil fuel power generation industry. We offer causal estimates of how each channel contributes to racial disparities in environmental exposure and demonstrate that these dynamics reinforce socioeconomic segregation at the community (census tract) level.

Our findings complement and differ from the recent work by Clay et al. (2025), who study the long-run impacts of fossil fuel power plant siting using county-level data from 1900 to 2020. While they focus on historical siting patterns and observe demographic shifts over several decades, they find little evidence of disparate siting by race on average. In contrast, our analysis targets a more recent period (2010–2019) and uses finer spatial resolution (census tracts), allowing us to identify both statistically significant racial disparities in siting decisions and immediate demographic changes following plant openings.

It is important to note that demographic changes observed in long-horizon historical studies, such as Clay et al. (2025), may partially reflect broader macroeconomic and social transformations, such as the Great Migration or the industrialization of northern cities rather than direct responses to localized environmental changes. For example, observed increases in the Black population following plant siting in some counties may have been driven by regional employment opportunities or large-scale internal migration trends during the early and mid-20th century. These historical dynamics, while important in their own right, introduce potential confounding factors that complicate causal interpretation.

By focusing on the post-2010 period, our study is less affected by such large-scale migration events and is able to better isolate the effects of local environmental conditions on demographic shifts. Our results therefore provide cleaner evidence of the causal role that siting plays in shaping local racial composition through post-siting migration behavior. Taken together, our study and Clay et al. (2025) highlight the importance of examining both long-run historical processes and contemporary dynamics to fully understand the persistence of environmental injustice.

3 Empirical Framework

3.1 DID and Event Study

The primary goal of this study is to identify the causal impact of new fossil fuel power plants on local racial composition. Our analysis relies on the quasi-experimental variation of the establishment of new fossil fuel-fired power plants. The construction of our treatment indicator is straightforward: a census tract is considered to be treated if at least one new fossil fuel power plant was established during our study period (2010-2019). We use difference-in-differences event-study method to estimate the impact of new power plants on local racial composition in treated relative

to yet-to-be-treated and never treated census tracts.

To estimate the average treatment effect, we start with a baseline two-way fixed effects model:

$$q_{it} = \delta D_{it} + \gamma X_{it} + Group_i + Year_t + \varepsilon_{it} \tag{1}$$

where q_{it} is the demographic characteristics of census tract i in year t. Here we use three different outcome variables: minority population, White population, and minority ratio. D_{it} is the treatment dummy. X_{it} includes a set of covariates. $Group_i$ and $Year_t$ are the group and time fixed effects, respectively.[1] ε_{it} represents unobserved characteristics of the census tract.

To test if there is pre-trend, we conduct a difference-in-differences event-study analysis using the following model specification:

$$q_{it} = \sum_{\tau=-9}^{-2} \eta_t \mathbf{I}[t - t_i^s = \tau] + \sum_{\tau=0}^{9} \eta_t \mathbf{I}[t - t_i^s = \tau] + \gamma X_{it} + Group_i + Year_t + \varepsilon_{it} \tag{2}$$

where t_i^s is the year in which a new plant is sited in census tract i. For census tracts that do not have a plant during the sample period, we set $t_i^s = \infty$. τ is the difference in years between year t and the siting year t_i^s. $\mathbf{I}[t - t_i^s = \tau]$ is the indicator function, which equals 1 if the condition in the bracket is satisfied and 0 otherwise. η_τ captures the annual gap between the treated census tracts and others, conditional on the set of covariates X_{it}.

The parameter of interest in the model (1) is δ that captures the before-after siting differences in the demographic characteristics between treated and control groups. There is a reliability concern of TWFE estimator – it is considered to be consistent only under assumptions that the treatment effects are homogeneous across treated units and time (Goodman-Bacon, 2021, Sun and Abraham, 2021). To address this concern, we estimate our model using the robust estimator in a staggered DID setting proposed by Sun and Abraham (2021).

3.2 Matched Samples

The census tracts in the treated and control groups may differ in ways that are related to their trends of demographic characteristics over time. To address this concern, we use the methods of propensity score matching to construct a comparable control group (Rosenbaum and Rubin, 1983). Specifically, we estimate the following logistic regression model, which is used to predict the propensity score for the likelihood of a new fossil fuel power plant being sited in each census tract:

$$Logit(y_{it}) = \alpha + \beta M_{it} + \gamma X_{it} + \varepsilon_{it}, \tag{3}$$

[1] We use group fixed effect (i.e., treated/control group) instead of census tract fixed effects to avoid overfitting. Census tracts fixed effects capture most of the variation in the data. Specifically, for the model with census tract fixed effects, the overall R-square is 96.9%, while the within R-square is only 1.3%.

where $y_{it} = 1$ if a new fossil fuel-fired power plant is sited in census tract i in year t and $y_{it} = 0$ otherwise. M_{it} is the minority ratio, X_{it} is a vector of control variables, and ε_{it} is error term.

According to the environmental justice literature, places were chose to site a new fossil fuel power plants mainly based on local socioeconomic characteristics, including population density, income per capita, education level; median housing values, and weather, in addition to newly retired electricity capacity and current electricity capacity. The matched control group is constructed as follows: for each treated census tract, we select the ten census tracts from all available control census tracts in the year of siting whose propensity scores are most similar to that of the treated census tract.

As an alternative matching strategy, we construct a different sub-sample that focuses on census tracts within the same areas. Specifically, we keep the original treated group, but redefine the control group to include census tracts located in the same county as the control census tracts. This is a reasonable matched sample because census tracts within the same county are likely to share similar demographic, economic, and social characteristics, which are key determinants of local racial composition. This approach could reduce confounding and improves the comparability of the treated and control groups with respect to the outcome variable.

4 Data

We construct a census tract level dataset covering all fossil fuel power plants in the contiguous U.S. from 2010 to 2019. Compiled from multiple data sources, the dataset includes annual information on census tract socioeconomic characteristics, weather, and the total capacity of new, existing, and retired fossil fuel power plants.

4.1 Data Sources

We obtain fossil fuel power plant data from the Electric Generator Inventory by the U.S. Energy Information Administration (EIA). The data is collected from EIA-860 form, a survey form including generator-level information for new, existing, and retired generators with 1 megawatt or greater of combined nameplate capacity. The dataset includes power plant locations, energy sources, electricity generation capacities, operation start years, and retirement years. We aggregate the generator-level data to the plant level and select fossil fuel power plants based on whether their energy sources are coal, petroleum, or natural gas. According to the data, a total of 3,898 fossil fuel power plants ever operated in the contiguous U.S., among which 1,479 plants were retired by 2019, and 818 are newly established between 2010 and 2019. Figure 1 plots the locations of these newly established fossil fuel power plants, which are mostly located around major metropolitan areas in California, Texas, and the Northeastern region. We also present the trends in fossil fuel power plants by fuel type and operation status in Figure A1.

We obtain the annual socioeconomic data from American Community Survey at the census tract

level, including per capita income, high school graduate rate, population, and racial composition. We also use census tract geographical data from the U.S. Census Bureau to calculate population density. The socioeconomic data covers 71,958 census tracts across 3,108 counties in the contiguous U.S. (lower 48 states and Washington D.C.).

Since weather is closely related to energy consumption and may affect power plant siting, we collect annual temperature data from Parameter–elevation Regressions on Independent Slopes Model (PRISM), a spatial climate database (http://prism.oregonstate.edu). PRISM data are available at a 4 km^2 spatial resolution, which can be aggregated to various geographical units. Following Zhang et al. (2023), we aggregate the grid-level temperature data to the census tract level using a weighted average, where the weight is determined by the overlapping area between census tracts and grids.

4.2 Descriptive Statistics

Unmatched Sample Table 1 summarizes key variables for all census tracts, as well as for those with and without new siting of fossil fuel power plants between 2010 and 2019. It shows that new fossil fuel power plants are more likely to be located in census tracts with relatively higher minority populations, lower population density, lower education attainment, lower housing values, and lower temperatures. Additionally, new fossil fuel power plants tend to be sited in areas that already have large fossil fuel power plants. However, new fossil fuel power plants are also more likely to be sited in census tracts with relatively higher income per capita, which is probably because of the positive association between local energy consumption (which influences new plant siting probability) and economic development (which is associated with higher income).

Figure 2a plots the annual trend in racial composition. In general, there is an increase in the minority ratio across all census tracts. However, as shown in Figure 2b, the minority ratio is relatively higher in census tracts with new siting of fossil fuel power plants, and their increase in minority ratio is also relatively faster.

Matched Sample To examine the determinants of siting decisions, we estimate logistic regressions using a variety of model specifications, as reported in Table A1. Across all models, the coefficient on the minority population share is consistently positive and statistically significant. This suggests that census tracts with a higher proportion of minority residents are more likely to be chosen for siting a new fossil fuel-fired power plant, indicating the persistence of racial disparities in environmental exposure.

In addition to race, we find that new plants are more likely to be sited in tracts with existing or recently retired power generation capacity, supporting the idea of infrastructure clustering. We also observe that plants are disproportionately located in areas with lower population density and cooler climates. While the associations between siting probability and other socioeconomic

Table 1: Summary Statistics before Matching

Variable	Full Sample	New Siting Census Tracts	Other Census Tracts
Minority Rate	0.2675	0.2759	0.2674
	(0.2525)	(0.2305)	(0.2526)
Current Elec. Cap. (MW)	12.3333	224.1702	11.2470
	(134.4152)	(535.6579)	(128.2881)
Newly Retired Elec. Cap. (MW)	0.1367	2.5661	0.1243
	(11.4675)	(51.8936)	(10.8785)
Population Density (1,000 per KM^2)	2.0416	1.2635	2.0456
	(4.5591)	(3.1010)	(4.5650)
Income per Capita ($1,000)	29.4086	30.4661	29.4032
	(0.1132)	(0.1104)	(0.1132)
High School Grad. Rate	0.8579	0.8557	0.8579
	(0.1132)	(0.1104)	(0.1132)
Median Housing Value ($10,000)	23.6149	23.5990	26.7850
	(20.0420)	(20.0300)	(22.0774)
Min. Temperature (°C)	8.7882	8.3762	8.7903
	(4.6670)	(4.6681)	(4.4194)
Max. Temperature (°C)	19.9026	19.4814	19.9048
	(4.8878)	(4.5309)	(4.8895)
Number of Census Tracts	72,040	367	71,673
Number of Observations	719,349	3,670	715,679

Note: Column "New Siting Census Tracts" reports the statistics of all census tracts with newly established fossil fuel power plants between 2010 and 2019, regardless of participating year. Column "Other Census Tracts" reports the statistics of all census tracts that do not have newly established fossil fuel power plants between 2010 and 2019. Current and newly Retired Capacities are only fossil fuel power plants. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

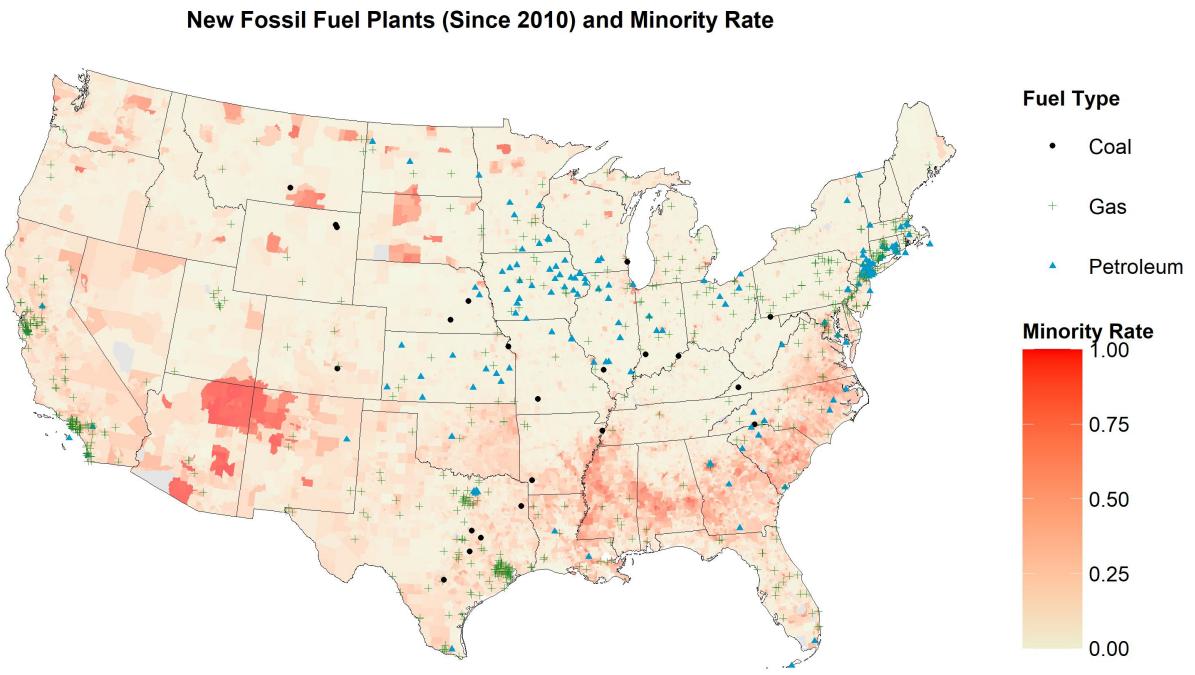
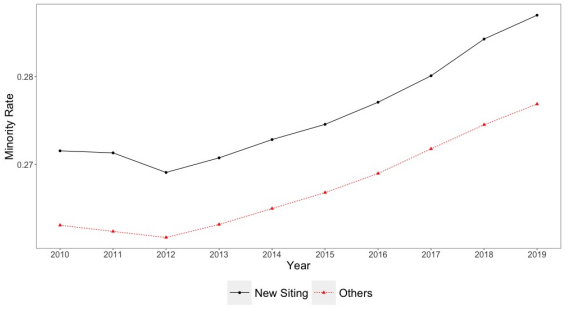
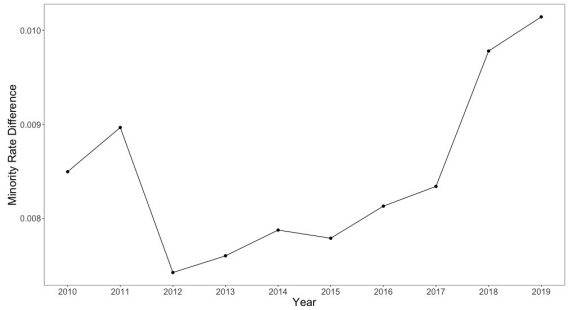


Figure 1: Fossil Fuel Power Plant Siting Locations, 2010–2019

Note: This map shows the locations of new fossil fuel power plants (coal, gas, and petroleum) built from 2010 to 2019, overlaid on census tracts shaded by minority population share from 2010. Coal plants are shown as black dots, gas plants as green crosses, and petroleum plants as blue triangles. Darker red areas indicate higher minority share.



(a) Separate Trends of Census Tract Minority Ratios with/without New Siting, Respectively



(b) Difference between Census Tracts with/without New Siting

Figure 2: Minority Ratio in Census Tracts with/without New Fossil Fuel Power Plants, 2010 – 2019

characteristics (e.g., income and education) are generally aligned with expectations, they are less precisely estimated. Interestingly, median housing value is positively associated with siting probability, which may reflect the underlying correlation between housing values and other factors such as local income, economic activity, or infrastructure.

To improve the comparability of treated and untreated tracts, we use two matching strategies: propensity score matching and within-county matching. Table 2 summarizes the characteristics of the matched samples used in the analysis. After matching, treated and control census tracts exhibit similar socioeconomic profiles across both the propensity score and within-county matching strategies, indicating improved comparability between groups. Differences in minority population share remain small, consistent with evidence of racial disparities in siting even after accounting for observable covariates. These balanced samples provide a stronger basis for the subsequent regression analyses examining siting determinants.

The resulting samples are displayed in Appendix Figures A2 and A3, respectively. Figure A2 shows the spatial distribution of the propensity score matched sample, where treated tracts are matched to observationally similar controls across the U.S. based on observable covariates. Treated tracts (in teal) appear somewhat clustered in the Southwest, Midwest, and along the East Coast. Control tracts (in red) are dispersed more widely, as expected under cross-county matching. Figure A3, by contrast, shows the within-county matched sample, in which treated tracts are matched to control tracts within the same county. This strategy improves geographic comparability and absorbs unobserved county-level factors (e.g., energy policy, zoning laws, or political environment). As the figure shows, the within-county matches tend to be more spatially concentrated, reflecting that controls are drawn from nearby tracts. Together, these two matched samples allow us to test the robustness of our findings to different identification strategies. In both settings, the evidence of disparate siting by race remains strong, reinforcing concerns about environmental justice in contemporary power plant siting. To assess the two matched sample, we test the bias between the two groups before and after the matching, shown in Figure A4.

Table 2: Summary Statistics

	Propensity Score Matched Sample		County Matched Sample	
	Treated	**Control**	**Treated**	**Control**
Minority Population	1451.386	1250.236	1415.106	1552.805
	(1898.779)	(1267.190)	(1864.353)	(1424.530)
White Population	3597.174	3137.432	3449.329	2864.081
	(1959.218)	(1901.373)	(2015.982)	(1888.231)
Minority Rate	0.269	0.288	0.276	0.362
	(0.229)	(0.256)	(0.231)	(0.273)
Income Per Capita	30.550	31.588	30.449	32.145
	(15.733)	(16.385)	(17.351)	(19.032)
High School Grad. Rate	0.856	0.860	0.855	0.841
	(0.107)	(0.114)	(0.112)	(0.134)
Median Housing Value ($10,000)	26.782	30.268	26.784	34.836
	(22.015)	(25.855)	(22.074)	(26.560)
Current Elec. Cap. (MW)	232.526	118.867	236.588	6.587
	(545.491)	(484.198)	(564.961)	(94.189)
Newly Retired Elec. Cap. (MW)	2.669	1.043	2.703	0.082
	(53.055)	(39.683)	(52.601)	(7.864)
Population Density (1,000 per KM^2)	1.210	1.482	1.240	4.277
	(3.122)	(2.844)	(3.077)	(7.384)
Max. Temperature (°C)	19.482	19.508	19.515	19.852
	(4.584)	(4.489)	(4.513)	(4.400)
Min. Temperature (°C)	8.309	8.401	8.451	9.241
	(4.471)	(4.233)	(4.421)	(3.756)
Number of Census Tracts	3,338		22,235	
Number of Observations	33,375		222,860	

Notes: Standard deviations are reported in parentheses.

5 Results

Our analysis confirms that new fossil fuel power plants in 2010–2019 were disproportionately sited in minority communities. Descriptive statistics show that census tracts which experienced a new plant siting had a higher average minority population share than tracts without new plants. These tracts also tended to be more socioeconomically disadvantaged – for instance, they had lower population density, lower education levels, lower housing values, and were more likely to already host other (or recently retired) power generation facilities. Such patterns are consistent with environmental injustice concerns that polluting facilities are located in communities with fewer resources and less political resistance.

Formal regression results reinforce this disparate siting pattern (see Table A1). In a logistic regression of new power plant siting on local characteristics, the coefficient on the tract's minority share is positive and statistically significant across all model specifications. This implies that even after controlling for factors like income, education, and existing power infrastructure, tracts with higher minority ratios were more likely to be chosen for new fossil fuel power plants. In other words, holding other factors constant, new fossil fuel power plants were more likely to be sited in communities with higher minority shares, suggesting that minority and other underrepresented populations continue to bear a disproportionate burden of exposure to new pollution sources. Besides race, other factors emerge as significant predictors of siting: new plants are more likely to locate in areas with an existing cluster of power generation (i.e. greater current capacity or recently retired capacity) and in lower-density, cooler climate areas. The relationships with income and education are less precisely estimated, but generally align with expectations that firms prefer sites with lower land costs and potentially less community pushback (which often correlate with lower-income, lower-education areas). Overall, these findings underscore the role of firm siting decisions in creating environmental injustice: polluting facilities continue to be preferentially sited in minority and less affluent neighborhoods.

5.1 The Effects of Siting on Minority Population

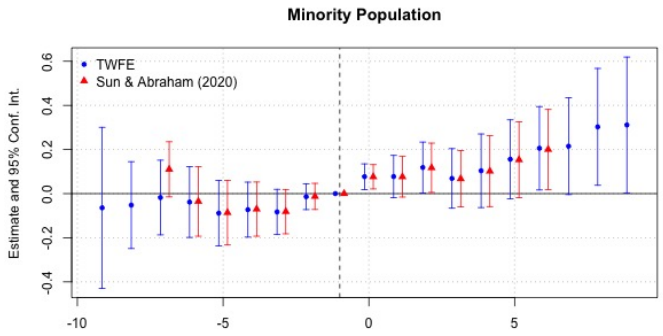
Beyond disparate siting, our study finds that power plant openings trigger significant demographic shifts in the surrounding community. We examine the within-tract changes in population by race after a new plant is established, using a difference-in-differences framework with matched samples for rigor. Figure 3 presents an event-study analysis comparing tracts that received a new plant (treated) with similar tracts that did not (controls). Notably, the trends in demographic outcomes for the two groups are parallel in the years leading up to the plant's opening, showing no signif-

icant pre-siting differences.[2] This provides credibility that any divergence after the event can be attributed to the plant siting.

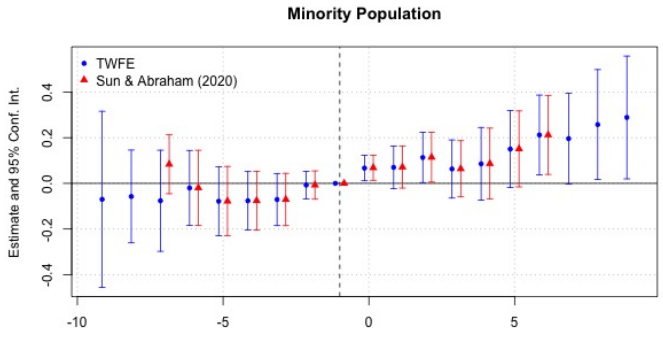
Indeed, we observe a clear increase in the minority population living in the tract following the siting of a new fossil fuel plant. Both the traditional two-way fixed effects estimator and the more flexible staggered adoption estimator (Sun and Abraham, 2021) yield positive and significant treatment effects on the minority population count. In practical terms, the introduction of a power plant is associated with roughly a 10–17% (see Table 3) rise in the number of minority residents in the host tract in the years afterward (relative to the counterfactual of no plant). This result is consistent across our two matching approaches, though the exact magnitude varies slightly by specification. The event-study plot (Figure 3) shows a jump in minority population after year 0 (the establishment year) with no significant pre-trend, reinforcing a causal interpretation. Quantitatively, our preferred estimates indicate that a new plant leads to approximately a 10% (Table 3, column 2) increase in the local minority population in the short to medium run. This sizable growth in minority residents suggests that post-siting in-migration of minority populations is an important mechanism contributing to the changing demographics. Minority households may be moving into these areas after the plant opens – potentially attracted by new jobs or lower housing costs – even as environmental quality deteriorates.

Comparing the results across matching strategies also reveals meaningful differences. In general, the treatment effect estimates from the propensity score matched (PSM) sample are larger than those from the within-county matched sample. This likely reflects the fact that the within-county approach absorbs intra-county spillover effects, especially when households relocate within the same county but to a nearby census tract. Such movement may attenuate the estimated treatment effects, since within-county controls may not fully capture the counterfactual for the treated tracts due to exposure contamination. In contrast, PSM samples draw controls from other counties, reducing the likelihood of local spillovers and providing a cleaner contrast. For this reason, we argue that the staggered specification with the PSM sample (Table 3, column 2) provides the most credible estimate of the causal effect, and we adopt this as our preferred specification for interpreting the effect of siting on minority population dynamics.

[2] Sun and Abraham (2021)'s method separates treated groups into subgroups by treatment years and constructs a large number of dummy variables (in our scenario, there will be 100 dummy variables constructed to capture the different annual trends for 10 subgroups). This, together with the limited number of observations for large lag and lead periods (with respect to treatment year), will cause huge standard errors or even multicollinearity problems. For example, lag period "-9" only includes one year (2010) observations for the subgroup with treatment time in 2019. To overcome such difficulty, we combine far lags and leads in the regression, so that lag -9 to -7 share a unique dummy variable, and leads 6 to 9 also share a unique dummy variable.



(a) Propensity Score Matched Sample



(b) Within-County Matched Sample

Note: Control variables are current electricity capacity, newly retired electricity capacity, population density, income per capita, high school graduation rate, maximum and minimum temperature, new siting (treated) group dummy, and year fixed effect. Standard errors are clustered at the county level.

Figure 3: The Effects of Siting on Minority Population (SE clustered at County Level)

Table 3: The Impact of New Fossil Fuel Power Plant Siting on Minority (SE Clustered at County Level)

	Minority Population			
	Propensity Score Matched Sample		Within-County Matched Sample	
Model:	(1) TWFE	(2) Staggered	(3) TWFE	(4) Staggered
New Site	0.1663*	0.1039*	0.1580*	0.0994*
	(0.0883)	(0.0534)	(0.0853)	(0.0509)
Income per Capita ($1,000)	-0.0244***	-0.0244***	-0.0189***	-0.0189***
	(0.0030)	(0.0031)	(0.0028)	(0.0028)
High School Grad. Rate	-0.9326***	-0.9310***	-0.7726**	-0.7720**
	(0.3459)	(0.3507)	(0.3654)	(0.3656)
Median Housing Value ($10,000)	0.0156***	0.0156***	0.0084***	0.0084***
	(0.0026)	(0.0026)	(0.0024)	(0.0024)
Current Elec. Cap. (MW)	-0.0002***	-0.0002***	-0.0002**	-0.0002***
	(4.37×10^{-5})	(4.37×10^{-5})	(6.75×10^{-5})	(6.67×10^{-5})
Newly Retired Elec. Cap. (MW)	-0.0002	-0.0002	-0.0001	-0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Population Density (1,000 per Squared KM)	0.0788***	0.0783***	0.0348***	0.0348***
	(0.0215)	(0.0216)	(0.0046)	(0.0046)
Max. Temperature (C)	0.0498***	0.0499***	0.0392***	0.0393***
	(0.0154)	(0.0154)	(0.0143)	(0.0143)
Min. Temperature (C)	0.0496***	0.0496***	0.0344**	0.0343**
	(0.0154)	(0.0154)	(0.0156)	(0.0156)
Group FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	33,266	33,265	216,069	216,069
R^2	0.2871	0.2886	0.2578	0.2582
Adjusted R^2	0.2867	0.2864	0.2577	0.2578

Clustered (County_FIPS) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

5.2 The Effects of Siting on White Population

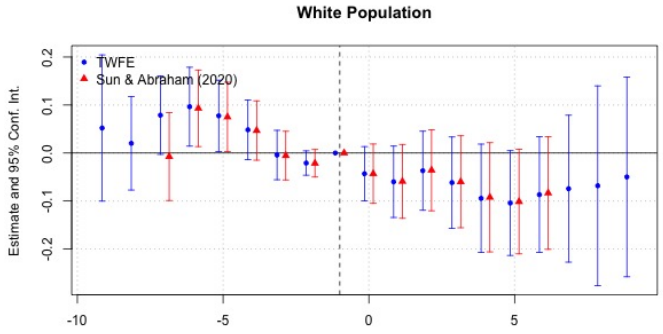
Complementing the rise in minority residents, we observe a significant decline in White population in tracts that receive new fossil fuel power plants. The event-study results (Figure 4) show divergence beginning before the formal opening of plants, suggesting that White households respond to early signals, such as permitting, public announcements, or visible construction, leading to anticipatory relocation.

This is consistent with evidence that large energy infrastructure projects in the U.S. typically require multiple years for permitting and construction. For example, the Brookings "Eight facts about permitting and the clean energy transition" report finds that many energy generation projects historically took several years from first permitting milestone to completion (Bauer et al., 2024). Media and policy sources also estimate that a new gas power plant may take up to 4-5 years from proposal to full operation under current regulatory, supply chain, and construction conditions (Project, 2025). Furthermore, studies of environmental hazards (e.g., around Superfund sites) show that socio-demographic changes often begin well before full operation or remediation, hinting that households anticipate environmental disamenities (Cameron and McConnaha, 2005).

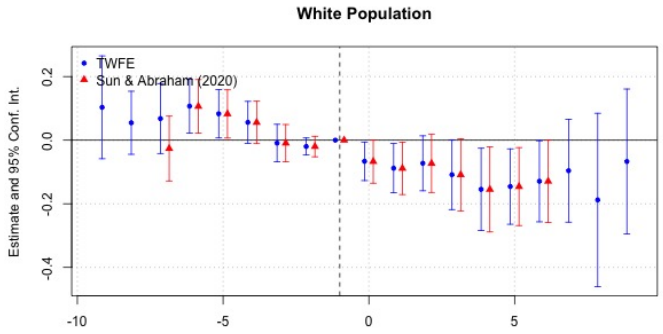
When we re-baseline our event studies at period -4 (four years prior to plant production rather than the usual -1), pre-treatment differences in White population largely disappear, and the post-plant declines become cleaner and more robust (Figure 5). This suggests that much of what looks like a pre-trend at standard baseline may actually reflect anticipatory movement rather than systematic differences in baseline trends.

By a few years after the plant's opening, the treated tracts have significantly fewer White residents than they would have without the plant. Depending on the matching method and estimator, we estimate roughly a 6% to 14% decrease in the White population of the host tract attributable to the power plant siting. For example, in the within-county matched analysis, a new plant led to an estimated 10–14% drop in White population (Table 4, columns 3-4). The propensity-score matched sample yields a slightly smaller decline that is marginally significant. These results together confirm that White out-migration (or avoidance) is a significant response to the introduction of a polluting facility. In practical terms, many White residents appear to move away from the area once a fossil fuel power plant is sited, contributing directly to the rising minority share we discuss later. This selective out-migration by race is consistent with differences in willingness-to-pay for environmental quality and in the ability to relocate: White (often higher-income) households are more likely to move to avoid living near a pollution source, whereas minority and lower-income households may have fewer outside options or might even move into the area if housing becomes more affordable (Depro et al., 2015). It contributes to an increase in segregation and environmental injustice over time, as the community around the polluting site becomes disproportionately minority after the plant's arrival. Additionally, in Table 5, we re-estimate the models using shifted treatment baselines (from one to four years prior to plant siting) to account for the possibility that White residents

may adjust their residential decisions in anticipation of new power plant construction. The results remain consistent across these alternative specifications, reinforcing the robustness of our findings.



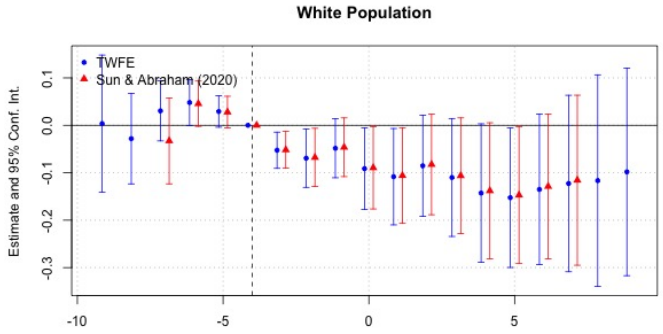
(a) Propensity Score Matched Sample



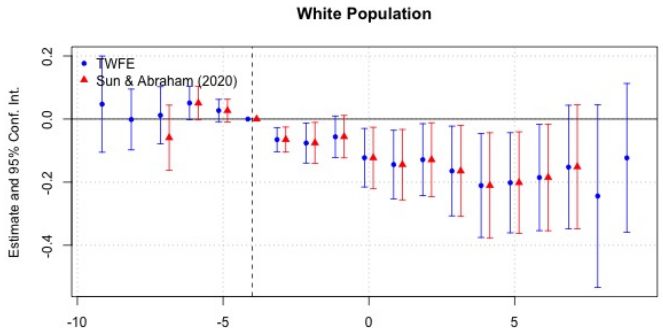
(b) Within-County Matched Sample

Note: Control variables are current electricity capacity, newly retired electricity capacity, population density, income per capita, high school graduation rate, maximum and minimum temperature, new siting (treated) group dummy, and year fixed effect. Standard errors are clustered at the county level.

Figure 4: The Effects of Siting on White Population (SE clustered at County Level)



(a) Propensity Score Matched Sample



(b) Within-County Matched Sample

Note: Control variables are current electricity capacity, newly retired electricity capacity, population density, income per capita, high school graduation rate, maximum and minimum temperature, new siting (treated) group dummy, and year fixed effect. Standard errors are clustered at the county level.

Figure 5: The Effects of Siting on White Population (SE clustered at County Level)

Table 4: The Effects of Siting on White Population (SE Clustered at County Level)

	White Population			
	Propensity Score Matched Sample		Within-County Matched Sample	
Model:	(1) TWFE	(2) Staggered	(3) TWFE	(4) Staggered
New Site	-0.0919*	-0.0627	-0.1366**	-0.1019**
	(0.0547)	(0.0427)	(0.0603)	(0.0476)
Income per Capita ($1,000)	0.0111***	0.0112***	0.0163***	0.0163***
	(0.0022)	(0.0022)	(0.0023)	(0.0023)
High School Grad. Rate	1.441***	1.432***	0.5303	0.5285
	(0.3264)	(0.3263)	(0.3291)	(0.3289)
Median Housing Value ($10,000)	-0.0036**	-0.0036**	-0.0024	-0.0024
	(0.0016)	(0.0016)	(0.0019)	(0.0019)
Current Elec. Cap. (MW)	8.95×10^{-5}***	9.02×10^{-5}***	0.0002***	0.0002***
	(2.93×10^{-5})	(2.95×10^{-5})	(5.5×10^{-5})	(5.55×10^{-5})
Newly Retired Elec. Cap. (MW)	-0.0002	-0.0002	1.85×10^{-5}	4.44×10^{-5}
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Population Density (1,000 per Squared KM)	-0.0236**	-0.0235**	-0.0061	-0.0061
	(0.0115)	(0.0116)	(0.0071)	(0.0071)
Max. Temperature (C)	0.0748***	0.0754***	0.1258***	0.1259***
	(0.0161)	(0.0161)	(0.0272)	(0.0272)
Min. Temperature (C)	-0.0679***	-0.0685***	-0.1185***	-0.1186***
	(0.0162)	(0.0162)	(0.0261)	(0.0261)
Group FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	33,266	33,265	216,069	216,068
R^2	0.1215	0.1230	0.1436	0.1439
Adjusted R^2	0.1210	0.1203	0.1436	0.1434

Clustered (County_FIPS) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 5: The Effects of Siting on White - Treatment Shifted to 3 Years Prior (SE Clustered at County Level)

	White Population			
	Propensity Score Matched Sample		Within-County Matched Sample	
Model:	(1) TWFE	(2) Staggered	(3) TWFE	(4) Staggered
New Site	-0.1130**	-0.0824*	-0.1517***	-0.1159**
	(0.0502)	(0.0428)	(0.0545)	(0.0481)
Income per Capita ($1,000)	0.0111***	0.0112***	0.0163***	0.0163***
	(0.0022)	(0.0022)	(0.0023)	(0.0023)
High School Grad. Rate	1.440***	1.431***	0.5302	0.5282
	(0.3266)	(0.3263)	(0.3291)	(0.3289)
Median Housing Value ($10,000)	-0.0036**	-0.0036**	-0.0024	-0.0024
	(0.0016)	(0.0016)	(0.0019)	(0.0019)
Current Elec. Cap. (MW)	8.87×10^{-5}***	9.04×10^{-5}***	0.0002***	0.0002***
	(2.92×10^{-5})	(2.96×10^{-5})	(5.46×10^{-5})	(5.55×10^{-5})
Newly Retired Elec. Cap. (MW)	-0.0002	-0.0002	8.71×10^{-6}	6.1×10^{-5}
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Population Density (1,000 per Squared KM)	-0.0237**	-0.0235**	-0.0061	-0.0061
	(0.0115)	(0.0116)	(0.0071)	(0.0071)
Max. Temperature (C)	0.0748***	0.0755***	0.1258***	0.1259***
	(0.0161)	(0.0161)	(0.0272)	(0.0272)
Min. Temperature (C)	-0.0679***	-0.0685***	-0.1185***	-0.1186***
	(0.0162)	(0.0162)	(0.0261)	(0.0261)
Group FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	33,266	33,265	216,069	216,068
R^2	0.1215	0.1231	0.1436	0.1439
Adjusted R^2	0.1210	0.1204	0.1435	0.1435

Clustered (County_FIPS) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

5.3 The Effects of Siting on Minority Ratio

Because the minority population increases after a siting while the White population simultaneously declines, the racial composition of the tract shifts in favor of minority groups. We find that the minority share of the population (the fraction of residents who are non-White) in a community rises following the establishment of a power plant. Our difference-in-differences estimates imply an average increase of about 1.2%-2.7% percentage points in the minority proportion of local residents attributable to a new plant. This effect is statistically significant in the within-county matched sample, while the propensity-score matched sample shows a similar positive point estimate, albeit with slightly larger standard errors (see Table A2). In sum, there is evidence of a modest but definite increase in the minority percentage of the local population post-siting. The demographic shift in racial composition aligns with the notion of "White flight" and minority influx toward environmentally burdened areas. Although the magnitude might seem moderate, it occurred over only a few years. This highlights that even in the short run, post-siting migration contributes to heightened racial disparities in pollution exposure, compounding the initial siting inequity. Figure A5 provides the event study evidence on the effects of new fossil fuel power plant sitings on the share of minority residents in census tracts. The plots reveal no significant pre-trends, suggesting that treated tracts and controls were on parallel trajectories prior to siting. Following the siting, we observe a clear upward shift in the minority share, particularly within the first few years. In the propensity score matched sample (Panel a), the minority share begins rising immediately after siting and continues to increase, peaking around 3–5 years after the treatment. A similar trend is observed in the within-county matched sample (Panel b), although the magnitude of change appears slightly lower. The event study estimates support the TWFE and staggered DiD findings from Table A2: minority shares increase significantly post-siting.

To further contextualize our findings, we compare the estimates obtained from the traditional two-way fixed effects (TWFE) and the staggered difference-in-differences (DID) estimators following (Sun and Abraham, 2021). Across Tables 3, 4, and A2, we generally observe that the TWFE estimates are larger in magnitude than their staggered counterparts. This pattern is consistent with concerns raised in recent econometric literature regarding potential bias in TWFE models when treatment effects are heterogeneous over time or vary across cohorts (Goodman-Bacon, 2021; Sun and Abraham, 2021). Specifically, TWFE may overweight later-treated units as controls for earlier-treated ones, inflating or attenuating the estimated average treatment effect depending on timing and dynamics.

6 Conclusion and Discussion

Understanding the mechanisms behind environmental injustice is essential for designing effective and equitable environmental policies. In this paper, we disentangle the sources of racial dispar-

ities in exposure to fossil fuel power plants into two distinct but interacting channels: (1) the disparate siting of polluting facilities by firms, and (2) post-siting migration patterns by individuals. Using high-resolution data that combines fossil fuel plant locations, census tract demographics, and weather conditions, we provide the first tract-level causal analysis of both mechanisms in the context of the U.S. power generation sector during 2010–2019.

We find clear evidence of disparate siting: fossil fuel power plants are significantly more likely to be located in census tracts with higher shares of minority residents, even after controlling for socioeconomic and geographic characteristics. This siting pattern reinforces concerns that marginalized communities continue to bear a disproportionate share of environmental burdens.

Moreover, our event-study and difference-in-differences analyses reveal strong post-siting demographic shifts. Within a few years after a new plant is sited, the minority population increases by 10.4%, while the White population decreases by 6.3%, resulting in an average 1.2 percentage point increase in the minority share of the local population. These findings indicate that racial disparities in environmental exposure are not only the result of where polluting facilities are located, but also of who chooses (or is able) to live near them afterward. Such demographic sorting may stem from differences in income, housing market responses, occupational opportunities, or preferences for environmental quality.

Importantly, our analysis shows that environmental injustice is both a siting and a sorting problem. While siting reflects firm strategies that can be regulated through environmental justice review processes, migration reflects individual behavior that is more difficult to directly regulate. Policies targeting only firm siting decisions may thus be insufficient to mitigate long-term racial disparities in pollution exposure.

To reduce these disparities, policy solutions should take a dual approach. First, strengthen environmental siting regulations that explicitly consider demographic impacts. Second, address housing affordability, school access, and employment opportunities in pollution-adjacent communities to prevent segregation from worsening post-siting. Integrating environmental justice goals into zoning, housing, and public health policies may be essential to disrupt the reinforcing cycle of pollution and inequality.

Finally, this paper opens the door for future research to explore the heterogeneity in post-siting migration mechanisms - for example, examining how the magnitude of sorting varies by plant type, local housing market conditions, or baseline community characteristics. Longitudinal household-level data could further uncover whether sorting is driven by changes in household decisions or by cohort replacement. Understanding these dynamics will be crucial for designing policies that ensure that environmental benefits and burdens are equitably shared, both now and in the decades to come.

A Online Appendix

A.1 Logistic Regression: Siting

Table A1: New Fossil Fuel Power Plant Siting

	Dependent variable:				
	New Fossil Fuel Power Plant Siting Dummy				
	(1)	(2)	(3)	(4)	(5)
Minority Ratio	0.3507*	0.6968***	0.8463***	0.8961***	0.8864***
	(0.1946)	(0.2049)	(0.2364)	(0.2679)	(0.2691)
Current Elec. Cap. (MW)	0.0014***	0.0014***	0.0015***	0.0016***	0.0016***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Newly Retired Elec. Cap. (MW)	0.0021***	0.0021***	0.0021***	0.0021***	0.0020***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Population Density (per KM^2)		−0.0001***	−0.0002***	−0.0003***	−0.0002***
		(0.00003)	(0.00003)	(0.00004)	(0.00004)
Income per Capita ($1,000)			−0.0117**	−0.0079	−0.0082
			(0.0059)	(0.0069)	(0.0070)
High School Grad. Rate			−0.6724	0.1933	0.2331
			(0.6453)	(0.6522)	(0.6559)
Median Housing Value ($10,000)			0.0219***	0.0052	0.0046
			(0.0031)	(0.0045)	(0.0045)
Max. Temperature (°C)			−0.0386	−0.1336***	−0.1359***
			(0.0279)	(0.0367)	(0.0372)
Min. Temperature (°C)			−0.0091	0.0932**	0.0813**
			(0.0295)	(0.0382)	(0.0385)
Constant	−7.7259***	−7.6668***	−6.4299***		
	(0.0774)	(0.0786)	(0.6751)		
State FE	N	N	N	Y	Y
Year FE	N	N	N	N	Y
Observations	719,349	719,297	708,082	708,082	708,082
Log Likelihood	−3,198.8008	−3,188.2782	−3,020.9643	−2,873.7231	−2,862.3509
Akaike Inf. Crit.	6,405.6016	6,386.5563	6,061.9287	5,863.4462	5,858.7017

Note: Current electricity capacity and newly retired electricity capacity are only for fossil fuel power plants. Newly retired electricity capacity is for all fossil fuel power plants that retired within the year. *p<0.1; **p<0.05; ***p<0.01

A.2 Additional Maps

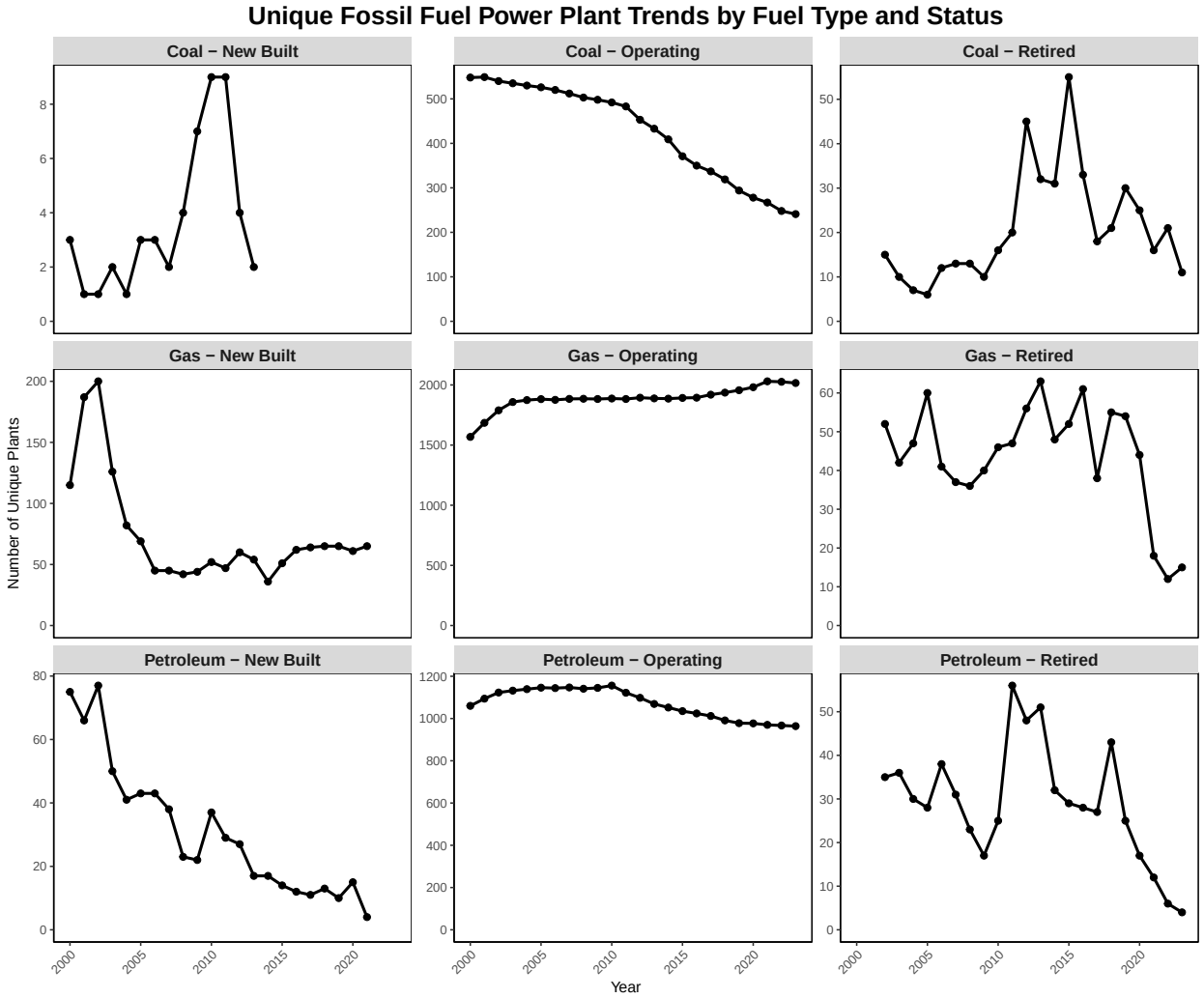


Figure A1: Trends in Fossil Fuel Power Plants by Fuel Type and Operational Status, 2000–2024

Note: This figure shows annual counts of unique fossil fuel power plants (coal, gas, and petroleum) in the United States from 2000 to 2024, categorized by operational status — newly built, operating, and retired. The panels illustrate how coal plant retirements accelerated after 2010, while new natural gas facilities increased sharply through the 2010s and early 2020s. Petroleum plants remain relatively few in number and exhibit limited new construction activity. Data are aggregated from the U.S. Energy Information Administration's Form 860 plant-level records.

A.3 Two Matched Samples

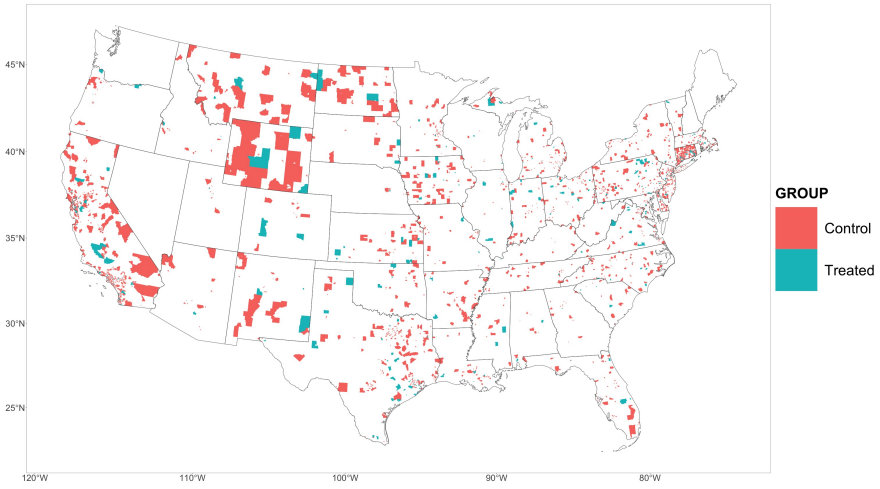


Figure A2: Propensity Score Matched Sample

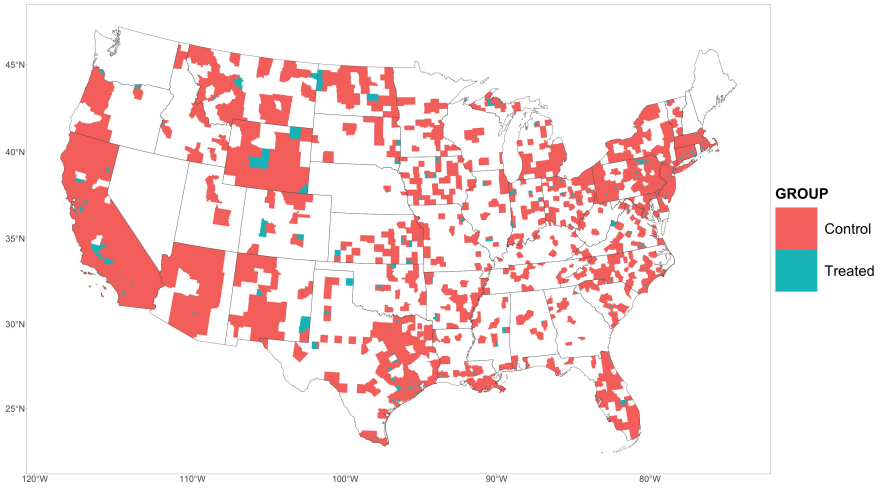


Figure A3: Within-County Matched Sample

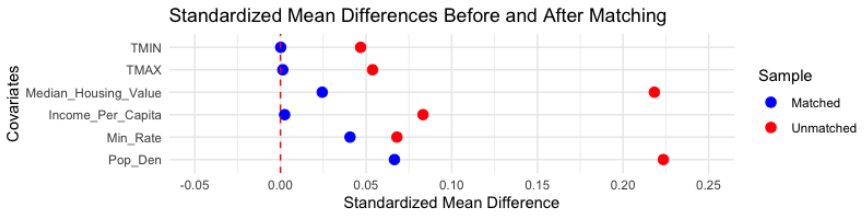
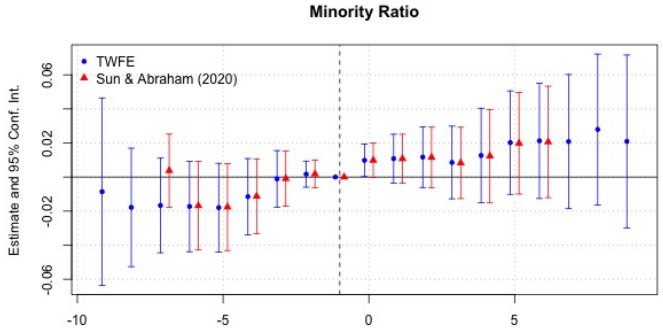
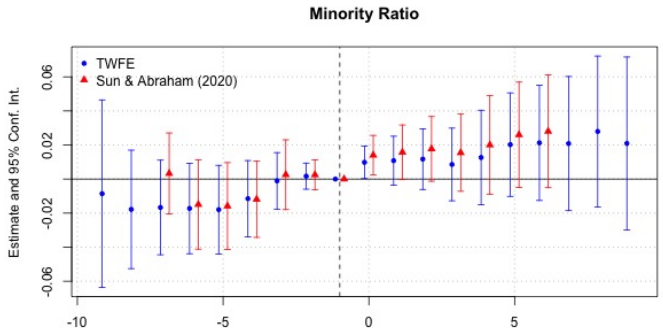


Figure A4: Standard Mean Differences

A.4 Minority Ratio



(a) Propensity Score Matched Sample



(b) Within-County Matched Sample

Note: Control variables are current electricity capacity, newly retired electricity capacity, population density, income per capita, high school graduation rate, maximum and minimum temperature, new siting (treated) group dummy, and year fixed effect. Standard errors are clustered at the county level.

Figure A5: The Effects of Siting on Minority Ratio (SE clustered at County Level)

Table A2: The Effects of Siting on Minority Ratio (SE Clustered at County Level)

	Minority Ratio			
	Propensity Score Matched Sample		Within-County Matched Sample	
Model:	(1) TWFE	(2) Staggered	(3) TWFE	(4) Staggered
New Site	0.0211	0.0124	0.0265*	0.0183*
	(0.0155)	(0.0090)	(0.0158)	(0.0096)
Income per Capita ($1,000)	-0.0059***	-0.0059***	-0.0061***	-0.0061***
	(0.0007)	(0.0007)	(0.0006)	(0.0006)
High School Grad. Rate	-0.4217***	-0.4209***	-0.2486**	-0.2484**
	(0.0942)	(0.0949)	(0.0980)	(0.0981)
Median Housing Value ($10,000)	0.0030***	0.0030***	0.0020***	0.0020***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Current Elec. Cap. (MW)	-4.05×10^{-5}***	-4.09×10^{-5}***	-5.96×10^{-5}***	-6.09×10^{-5}***
	(7.63×10^{-6})	(7.64×10^{-6})	(1.37×10^{-5})	(1.35×10^{-5})
Newly Retired Elec. Cap. (MW)	-1.32×10^{-5}	-1.39×10^{-5}	-4.5×10^{-5}	-4.82×10^{-5}
	(3.9×10^{-5})	(3.9×10^{-5})	(5.65×10^{-5})	(5.59×10^{-5})
Population Density (1,000 per Squared KM)	0.0149***	0.0148***	0.0066***	0.0066***
	(0.0047)	(0.0047)	(0.0017)	(0.0017)
Max. Temperature (C)	-0.0087**	-0.0088**	-0.0163***	-0.0163***
	(0.0038)	(0.0038)	(0.0051)	(0.0051)
Min. Temperature (C)	0.0189***	0.0190***	0.0246***	0.0246***
	(0.0041)	(0.0041)	(0.0051)	(0.0051)
Group FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Fit statistics				
Observations	33,266	33,265	216,069	216,068
R^2	0.2967	0.2973	0.2901	0.2903
Adjusted R^2	0.2963	0.2951	0.2901	0.2899

Clustered (County_FIPS) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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