The social lifecycle impacts of power plant siting in the historical United States

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Equity and environmental justice considerations have risen to the forefront of policy discussions over the location of long-lived infrastructure. These discussions have centered on ensuring equitable siting of planned infrastructure, but rarely account for its long-run general equilibrium consequences such as residential sorting and discriminatory steering (Christensen and Timmins, 2022). Relatively little work has focused on estimating the "social lifecycle" impacts of long-lived infrastructure precisely because these effects can take many decades to manifest.

We overcome this challenge by combining newly-digitized data on power plant siting and operations from 1940-2000 (Clay et al., 2021) with spatially-resolved demographic data from the US Census. This extended time horizon allows us to assess how disparities in air pollution exposure evolve over the decades after power plants are built. Measuring the evolution of air pollution disparities from power plants is especially important since power generation remains one of the largest contributors to local air pollution and its current impacts are felt disproportionately by minority and low-income individuals (Tessum et al., 2021; Hernandez-Cortes, Meng and Weber, 2023).

We first document that, on average, fossil-fuel power plants are not disproportionately sited in areas with higher shares of African-Americans. Namely, we estimate whether power plants built after 1955 are disproportionately sited in predominantly Black counties as compared to power plants built before the Air Pollution Control Act of 1955 when air pollution plausibly became a salient concern. Table 1 shows that, after controlling for state fixed effects and population, we do not find statistically significant differences in the proportion of the population that is Black in counties where power plants are sited relative to this control group.[1] This cross-sectional comparison suggests that current disparities in exposure to power plant impacts do not stem from inequities in initial siting decisions.[2]

We next estimate the impacts of the first power plant being built in a county on subsequent shares of population by demographic group. Since the timing of treatment is staggered and the effects are likely to be heterogeneous across plant vintages, we estimate

[1] In work-in-progress, we also document that power plants are not disproportionately sited relative to counties never home to a fossil-fuel power plant during our sample period.

[2] Morehouse and Rubin (2021) documents the restrictive geographic, political, and regulatory constraints facing electric utilities deciding where to build coal-fired power plants.

these effects using the methodology from Callaway and Sant'Anna (2021).[3] As presented in Figure 1 below, our event study estimates indicate that, on average: (1) initial power plant siting decisions were not a function of pre-existing trends in demographics, and (2) the share of the county-level population that's African-American declines slightly in the first decades after the plant is built, but grows by 1-3 percentage points *30-50 years* after the first plant in the county was built. This suggests that long-run sorting in response to the building of power plants contribute to current disparities in exposure to power plant impacts.[4]

This long-run effect is not driven by plant retirements. Figure 2 shows that annual total county-level capacity does not decline even 50 years after the first plant was built. Exploratory analysis suggests this is due to new plants being built in the same county, and potential delays in the retirements of older plants not subject to the stricter New Source Performance Standards under the Clean Air Act.

Our preliminary findings highlight that the equity implications of long-lived infrastructure can differ dramatically depending on the time span considered. Accounting for the full social lifecycle implications of directing investment to disadvantaged communities is essential for understanding the equity implications of clean energy policy. This message is especially relevant in light of the Biden Administration's recent Justice40 Initiative. The goal of this initiative is to ensure that 40% of the overall benefits from federal investments in areas such as climate change and clean energy go to disadvantaged communities. Measuring these benefits over the full lifespan of investments in clean infrastructure such as wind farms or solar plants—inclusive of general equilibrium impacts tied to long-run changes in economic activity and sorting—will be essential to ensure an equitable clean energy transition.

This paper contributes to the literature on the current disparities in pollution exposure faced by minority and low income individuals in the United States (Banzhaf, Ma and Timmins, 2019; Tessum et al., 2021; Cain et al., 2023). Disparities in pollution from power plants is no exception (Hernandez-Cortes, Meng and Weber, 2023). A key factor driving current disparities in pollution exposure is residential sorting and discriminatory

[3]We utilize both not-yet-treated and never-treated counties as controls. Standard errors are clustered by county.

[4]In work-in-progress, we utilize our data on power plant operations to study the evolving levels of pollution exposure faced by different communities living near power plants.

steering (Christensen and Timmins, 2022; Christensen, Sarmiento-Barbieri and Timmins, 2022). Our paper contributes to this literature by estimating the evolving impacts on demographics and pollution exposure over the decades after the siting of fossil-fuel power plants, bridging the gap between these two sets of literature documenting current pollution disparities and the long-run sorting that shapes these current disparities.

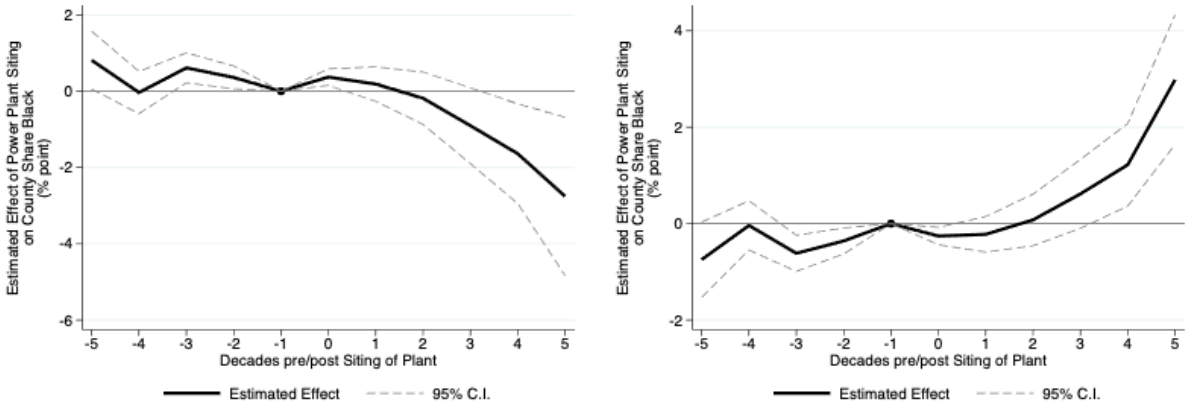
Figures and tables

Table 1: Plant siting and demographic shares by plant vintage

	(1)	(2)	(3)	(4)	(5)	(6)
Control group = plants built before 1955						
1[Built Between 1955-1962]	0.0389	0.0152	0.00821	-0.0473	-0.0412	-0.0232*
	(0.0299)	(0.0235)	(0.0200)	(0.0281)	(0.0224)	(0.0102)
1[Built Between 1963-1971]	0.0263	0.0257	0.0556	-0.0270	-0.0106	0.00290
	(0.0346)	(0.0303)	(0.0280)	(0.0334)	(0.0316)	(0.0200)
1[Built Between 1972-1994]	0.00562	0.0271	0.0364	-0.0138	-0.0218	-0.00143
	(0.0340)	(0.0280)	(0.0199)	(0.0356)	(0.0255)	(0.0139)
Mean of dep. var.	0.574	0.301	0.120	0.425	0.187	0.059
Number of obs.	9,450	9,450	9,450	9,450	9,450	9,450
R^2	0.052	0.064	0.091	0.052	0.034	0.026
State FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regressions exploring whether power plants built in 1955-1962, 1963-1971, and 1972-1994 are disproportionately sited in predominantly White or Black neighborhoods compared to plants built before 1955. The dependent variable in each specification is an indicator variable that equals one if the share of Black (columns 1-3) or White (columns 4-6) population in the county at the time of siting is higher than the median, 75th percentile or 90th percentile across all of the counties in the same state. We control for county population at the time of siting and state fixed effects in all specifications. Standard errors are clustered by state.

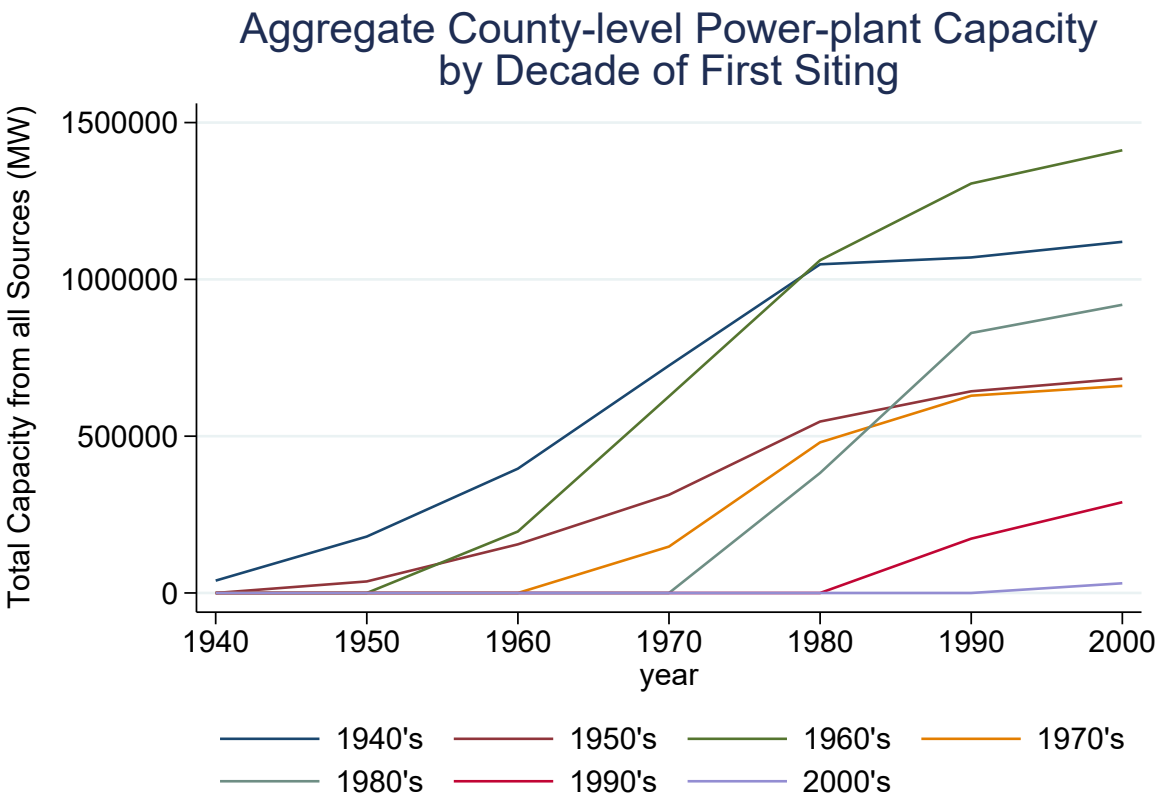
Figure 1: Event study estimated effects of power plant siting on demographics



(a) White population share (b) African-American population share

Notes: This figure plots event study estimates and 95% confidence intervals of the impacts of the first plant being built in a county on the county's demographics. The left panel (right panel) considers the share of the population that's White (African-American). We estimate these event studies utilizing the methodology from Callaway and Sant'Anna (2021); we utilize both never-treated and not-yet-treated counties as controls. For both panels, all reported effects are relative to the decade prior to first plant (i.e., the decade prior to first plant serves as the reference decade). Standard errors are clustered by county.

Figure 2: Annual total fossil-fuel generating capacity by cohort



Notes: This figure documents total fossil-fuel generating capacity for each decade across counties where the first plant was built in the 1940s, the 1950s, the 1960s, etc.

References

Banzhaf, H. Spencer, Lala Ma, and Christopher Timmins. 2019. "Environmental justice: The economics of race, place, and pollution." *Journal of Economic Perspectives*, 33(1): 185–208.

Cain, Lucas, Danae Hernandez-Cortes, Christopher Timmins, and Paige Weber. 2023. "Recent Findings and Methodologies in Economics Research in Environmental Justice." CESifo Working Paper.

Callaway, Brantly, and Pedro HC Sant'Anna. 2021. "Difference-in-differences with multiple time periods." *Journal of econometrics*, 225(2): 200–230.

Christensen, Peter, and Christopher Timmins. 2022. "Sorting or steering: The effects of housing discrimination on neighborhood choice." *Journal of Political Economy*, 130(8): 2110–2163.

Christensen, Peter, Ignacio Sarmiento-Barbieri, and Christopher Timmins. 2022. "Housing discrimination and the toxics exposure gap in the United States: Evidence from the rental market." *Review of Economics and Statistics*, 104(4): 807–818.

Clay, Karen, Akshaya Jha, Joshua A Lewis, and Edson R Severnini. 2021. "Impacts of the Clean Air Act on the power sector from 1938-1994: Anticipation and adaptation." National Bureau of Economic Research.

Hernandez-Cortes, Danae, Kyle C Meng, and Paige Weber. 2023. "Decomposing trends in US air pollution disparities from electricity." *Environmental and Energy Policy and the Economy*, 4(1): 91–124.

Morehouse, John, and Edward Rubin. 2021. "Downwind and out: The strategic dispersion of power plants and their pollution." *Available at SSRN 3915247*.

Tessum, Christopher W, David A Paolella, Sarah E Chambliss, Joshua S Apte, Jason D Hill, and Julian D Marshall. 2021. "PM2. 5 polluters disproportionately and systemically affect people of color in the United States." *Science advances*, 7(18): eabf4491.