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ENVIRONMENTAL AND ENERGY ECONOMICS AROUND THE WORLD[‡]

Where Is Pollution Moving? Environmental Markets and Environmental Justice[†]

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In the half century since the 1970 US Clean Air Act, air quality has improved dramatically, and concentrations of some pollutants have fallen by 90 percent. At the same time, recognition has grown that low-income and minority communities bear a disproportionate burden from air pollution—a concern that motivates the "environmental justice" movement.

Environmental justice concerns have prompted regulators to seek policies to address these disparities. Market-based environmental policy instruments, such as cap and trade or pollution taxes, have been one of economists' most important contributions to policy. They have also led to important equity concerns. Since environmental markets do not guarantee emissions reductions in all communities, it is possible that emissions would increase in some facilities or reductions would be unequally distributed.

This paper investigates how one of the oldest and most prominent forms of market-based environmental policy in the United States has affected pollution disparities between communities. Since the 1970s, the Clean Air Act has allowed the trading of permanent pollution emissions rights between firms within a metropolitan area, technically known as emissions offsets. Offset markets differ in many ways from cap-and-trade markets (Shapiro and Walker 2020). We investigate the equity implications of these offset markets, asking whether pollution trades between facilities reallocate emissions toward low-income or minority communities. We also explore what we can learn from these transactions more broadly about how market-based policies may affect the distribution of pollution going forward.

Our first approach uses publicly available data from 5 cities and 12 city × pollutant combinations (that is, 12 markets) in California and Texas. These data provide information on the locations of facilities that sold permanent rights to emit a specific amount of pollution (that is, where emissions declined) and the locations of facilities that purchased these rights (that is, where emissions increased). This lets us compare the characteristics of communities where facilities permanently reduced their emissions to the characteristics of communities where facilities bought these emissions rights for new or expanding facilities.

The equity implications of market-based environmental policies depend on where facilities with different marginal abatement costs are located. For example, if policymakers replaced a command-and-control standard with an emissions fee, pollution emissions should fall the most in facilities with the lowest-cost pollution abatement opportunities and the least in facilities where pollution abatement is most expensive.

The Texas data clarify the spatial distribution of facility marginal abatement costs across different communities. Shapiro and Walker (2020) show how the bilateral transaction *price* between these facilities can be used to understand marginal abatement costs. Thus, our second approach compares facility-level offset prices to community characteristics, asking whether strong correlations exist between

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offset prices and community characteristics in Texas.

We find little evidence that the tradability feature of the offset program has disproportionately moved pollution to lower-income communities or communities of color over the past 30 years. We find that neighborhoods where offsets are sold and purchased have similar demographics. Similarly, we find little association of facility-level offset prices with community characteristics. The similarity of offset prices across communities suggests that expanding the scope of market-based environmental policy instruments for air pollution in the settings we study may not disproportionately reallocate emissions to low-income or minority communities.

This paper builds on a burgeoning literature that studies how environmental markets affect equity. Papers have provided retrospective evaluations of whether prominent US cap-and-trade programs have disproportionately reallocated emissions toward low-income or minority communities (for example, Fowlie, Holland, and Mansur 2012; Hernandez-Cortes and Meng 2020). We believe no research has studied the distributional consequences of the Clean Air Act's offset program, which is the oldest and, by some measures, largest market-based environmental program in the United States. More broadly, we are not aware of any research that has directly attempted to use or construct measures of the spatial distribution of facility-level marginal abatement costs to learn about the distributional consequences of market-based environmental policy.

We view this paper as demonstrating an approach to studying how market-based environmental policies affect environmental justice. That said, several important caveats are warranted. Data restrictions let us study only 12 markets; each of these markets is large and important, but together they are still a small sample. Our comparison of the communities where offsets are sold and purchased provides a simple test of where emissions are moving, but it does not tell us what the distribution of emissions would look like in the absence of the offset program. Variation in offset prices within a market can reflect variation in fundamentals like supply and demand for offsets in addition to search frictions, marginal abatement costs, and other market forces; while we use regression analysis to control for some of these fundamentals, we cannot completely rule out whether some of the price variation we observe reflects differences in more than simply marginal abatement costs of different facilities.

While this paper finds little evidence that market-based features of the Clean Air Act exacerbate existing pollution disparities, important gaps in pollution exposure between communities remain. Understanding and addressing these disparities is important for future research and policy design.

I. Data and Institutions

The Clean Air Act created a set of National Ambient Air Quality Standards that regulators enforce separately for each pollutant and location. Areas where ambient air quality exceeds these standards are in "nonattainment" for the offending pollutant. The Environmental Protection Agency then implements a range of regulations to help the region meet the standards.

Title I of the Clean Air Act effectively bans the entry or expansion of large polluting facilities in nonattainment areas unless the new facility offsets its emissions by paying a facility in the same area to permanently reduce its emissions of the same pollutant. We call these transactions "offsets," though legally they are called emission reduction credits. Offset markets seek to prevent net increases in industrial emissions from polluted cities while still allowing polluting firms to enter or expand. Regulators carefully evaluate offset transactions, and detailed engineering and environmental data must accompany transactions to show that changes in pollution emissions are permanent, quantifiable, enforceable, and surplus (Shapiro and Walker 2020).

We use transaction data from 12 large US offset markets that provide facility-level information on the seller and buyer of offset transactions. These markets differ by pollutant and location. The pollutants in our data include nitrogen oxides (NO_x), particulate matter, sulfur oxides, and volatile organic compounds (VOCs). The locations in our data consist of the San Joaquin (Central) Valley of California; and Beaumont, Dallas, Houston, and San Antonio, Texas. The most common offset transactions involve NO_x and VOCs. These pollutants contribute to both ground-level ozone and particulate matter smaller than 2.5 micrometers

($PM_{2.5}$), which have large negative effects on morbidity and mortality.

Our data report the latitude and longitude of each facility in these 12 markets. We match this to demographic data of the surrounding community from the 2006–2010 American Community Survey Five-Year Estimate files. The American Community Survey data provide block-group information on racial composition and median household income. We compute the mean community characteristics of a facility by taking the area-weighted average of all block groups within a one-mile radius of the facility.

We use measures of facility emissions. One important caveat is that pollution emitted in one neighborhood affects ambient air quality in other neighborhoods. Atmospheric chemistry models incorporating information on wind, weather, stack conditions, and other variables can translate emissions into ambient concentrations; we leave incorporation of such atmospheric chemistry models to future work.

II. Results: Where Do Offset Transactions Move Pollution?

We first compare the characteristics of communities where offsets are sold versus where offsets are purchased. This lets us follow emissions from one community to the next and ask whether these offset markets move pollution in ways that exacerbate existing disparities.

The kernel densities in Figure 1 show the characteristics of communities where facilities sell (dotted line) and buy (solid line) offsets. The two vertical lines show the mean characteristics of the communities where offsets are sold and purchased. The arrows between the vertical lines show the difference in mean characteristics. Figure 1 pools over all pollutants and locations. All values are weighted by the tons of pollution bought or sold.

Figure 1, panel A, suggests that communities where offsets are sold and purchased have fairly similar shares of the population that is African-American or Black. The graph does show suggestive evidence that offset transactions relocate pollution from communities where 30–40 percent are Black to communities where a smaller share are Black. Correspondingly, the mean Black share in communities where offsets are sold is (barely) higher than the share in communities where offsets are purchased.

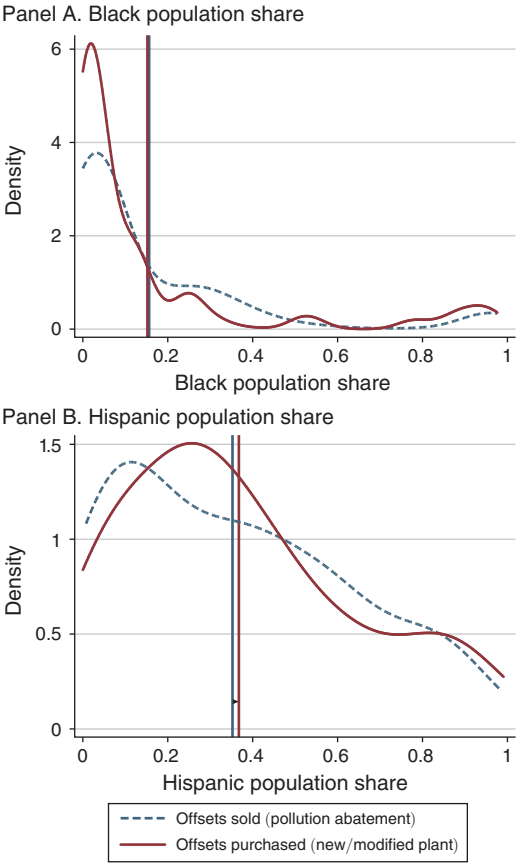

Figure 1. Densities of Community Characteristics: Offset Origins versus Destinations

Notes: This figure plots kernel densities of community characteristics where offsets are sold (by plants decreasing emissions) and purchased (by plants opening or expanding). An observation is an offset that is either created or used. See text for details.

Figure 1, panel B, plots the density of Hispanic population shares for communities where offsets are sold and purchased. This graph suggests similar conclusions. The Hispanic share in communities where offset transactions are sold is broadly similar to the Hispanic share in communities where offsets are purchased. The difference in means suggests that communities where offsets are bought have a slightly lower Hispanic population share than communities where offsets are sold.

Finally, online Appendix Figure A1 plots the density of median household income in the communities where offsets are sold and purchased.

The two densities largely overlap. The graphs show modest evidence that offset transactions move pollution toward communities with higher median household income, since the solid line (offset purchases) has higher density in higher-income communities.

Online Appendix Table 1 presents statistical tests for the difference in characteristics between communities where offsets are sold (emissions permanently reduced) and purchased (emissions expansions). For example, panel A, column 1, shows that in communities where offsets are sold, 15.6 percent of the population is Black. Conversely, in communities where offsets are purchased, 15.2 percent of the population is Black. Statistically, we fail to reject the hypothesis that these shares are equal.

Online Appendix Table 1 also separates these comparisons for the two pollutants where we observe the most transactions, VOCs and NO_x. The pollutants have some differences. For example, NO_x trades tend to move pollution toward more Hispanic communities, and VOC trades move pollution away from Hispanic communities. Neither change is statistically distinct from zero at conventional levels, however.

Overall, these patterns suggest little systematic evidence that trades are closely correlated with community characteristics and, in particular, little evidence that they disproportionately relocate pollution toward low-income or minority communities. However, averages can obscure the experiences of individual communities. For example, in our Texas data, 5 percent of offset trades represent a greater than 40 percentage point increase in the share of Hispanic residents living nearby, and many trades also represent a large decrease in the share of Hispanic residents living nearby.

III. Results: Offset Prices and Community Characteristics

Economists tend to support market-based environmental policies such as emission taxes or cap-and-trade markets because they are cost effective and reduce emissions at minimum cost (or, equivalently, maximize the emission reduction for a given cost). Market-based policies may have other efficiency benefits, such as generating revenue that can reduce other distortionary taxes.

Efficiency is not the only criterion for policy, however, and equity concerns have been prominent in recent market-based environmental policy discussions. With market-based environmental regulations, emissions disproportionately decrease in facilities where pollution abatement is cheapest. Thus, the equity implications of market-based policies depend on how facility-level marginal abatement costs are associated with community-level characteristics.

Shapiro and Walker (2020) show how market-level transaction prices for Clean Air Act offsets can represent market-level marginal abatement costs. If offset prices cost less than a firm's potential abatement technologies, the firm should choose to buy offsets rather than invest in additional abatement. Conversely, if offset prices exceed the cost of abatement technology, the firm should abate until abatement costs equal the offset price.

Figure 2 shows correlations between offset prices and community characteristics. The red dots represent the mean offset price within 15 quantiles of the community characteristic. The line represents the fitted value from a regression of log offset prices on each community characteristic. The regression controls for year, market, and pollutant fixed effects.

The demographic graphs in Figure 2 and the income graph in online Appendix Figure A2 show weak relationships between community characteristics and offset prices. If anything, the graphs suggest that communities where a larger share of the population is Hispanic have lower offset prices, and thus markets would tend to move pollution away from Hispanic communities. Overall, these graphs do not strongly suggest that market-based policies systematically change the distribution of pollution.

IV. Conclusion

While market-based environmental policies are important tools for achieving emissions reductions at the lowest cost, there remain important equity concerns over their use. This paper attempts to shed light on the equity implications of one of the oldest and most prominent sets of environmental markets in the United States, the Clean Air Act's offset program. We find little evidence that the tradability of emissions rights has historically reallocated emissions to or from low-income or minority communities.

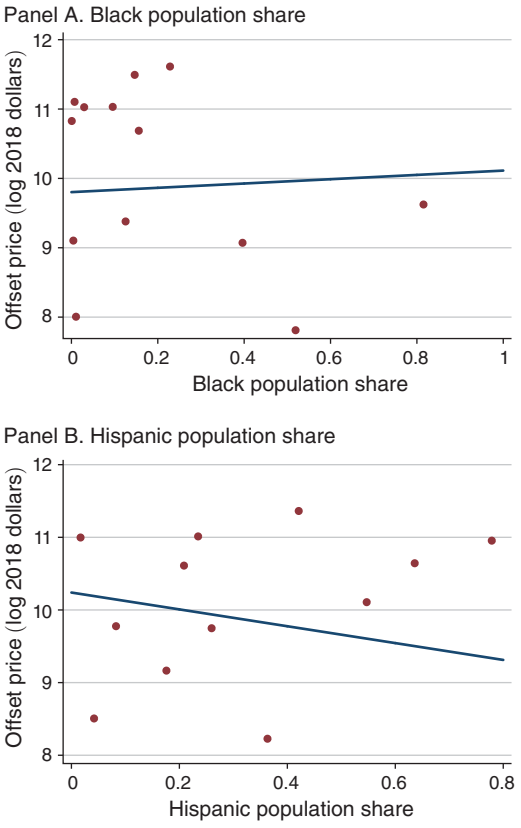

FIGURE 2. OFFSET PRICES VERSUS COMMUNITY CHARACTERISTICS

Notes: This figure plots the relationship between offset transaction prices and community characteristics. The solid line represents a linear fit from a regression of offset prices on the respective community characteristic after controlling for year, market, and pollutant fixed effects. The points represent the conditional mean offset price for the various quantiles of the community characteristic. See text for details.

Although this is a limited sample and setting, it echoes related findings that market-based environmental policies have not exacerbated environmental inequality in the United States. At the same time, important gaps in pollution exposure remain, and regulators may have reason to consider new tools to address these inequities going forward (Carlson 2018).

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