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Where is Pollution Moving? Environmental Markets and Environmental Justice

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Where is Pollution Moving? Environmental Markets and Environmental Justice*

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Abstract

Do US air pollution offset markets disproportionately relocate pollution to or from low-income or minority communities? Concerns about an equal distribution of environmental quality across communities – environmental justice – have growing policy influence. We relate prices and quantities of offset transactions to demographics of the communities surrounding polluting plants. We find little association of offset prices or offset-induced movements in pollution with the share of a community that is Black, Hispanic, or with mean household income. This analysis of twelve prominent offset markets suggests that they do not substantially increase or decrease the equity of environmental outcomes.

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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, there has been increased recognition that low-income and minority communities bear a disproportionate burden from the environmental harms associated with air pollution—a concern that motivates the modern-day "environmental justice" movement.

Environmental justice concerns have prompted regulators at the local, state, and federal levels to look for policy solutions to address existing disparities. Market-based environmental policy instruments, like 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, for example, 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 1970's, the Clean Air Act has allowed for trading of permanent pollution emissions rights between firms within a metropolitan area, technically known as emissions offsets. Offset markets represent a distinct market design and 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 towards 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 five cities and twelve city×pollutant combinations (i.e., twelve markets) in California and Texas. These data provide information on the locations of facilities that sold their permanent rights to emit a specified amount of pollution (i.e., where emissions were reduced) as well as the locations of facilities that purchased these rights (i.e., where emissions increased). This allows us to 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 most in facilities that have the lowest cost pollution abatement opportunities, and they should fall the least in facilities where pollution abatement is most expensive.

The data from Texas help us understand 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 offset prices and community characteristics in Texas.

We find little evidence in the twelve offset markets we study to suggest 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 towards low-income or minority communities (e.g., 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 the largest market-based environmental program in the US. 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 concerns. 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 that 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 to suggest 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.

1 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 Emissions Reductions 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 twelve 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 twelve markets. We match this to demographic data of the surrounding community from the 2006-2010 American Community Survey 5-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 1-mile radius of the facility.

2 Results: Where Do Offset Transactions Move Pollution?

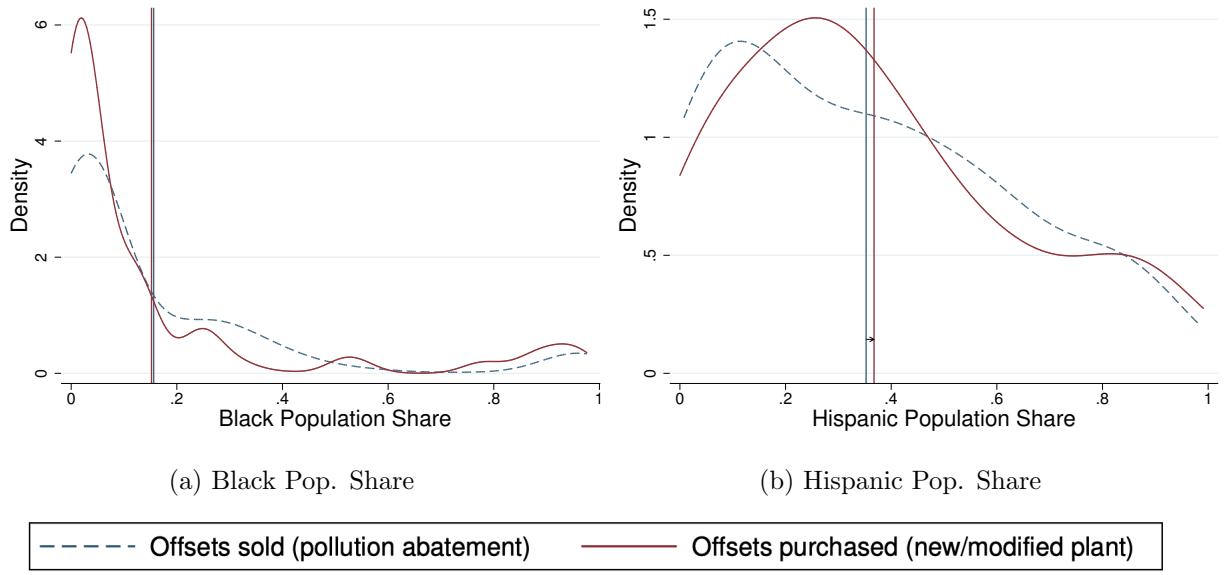
We first compare the characteristics of communities where offsets are sold versus where offsets are purchased. This lets us follow emissions from one community to the next and ask whether these offset markets move pollution in ways that exacerbate existing disparities.

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 1a 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 1b 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

Figure 1: Densities of Community Characteristics: Offset Origins Versus Destinations



(a) Black Pop. Share

(b) Hispanic Pop. Share

Note: 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.

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.

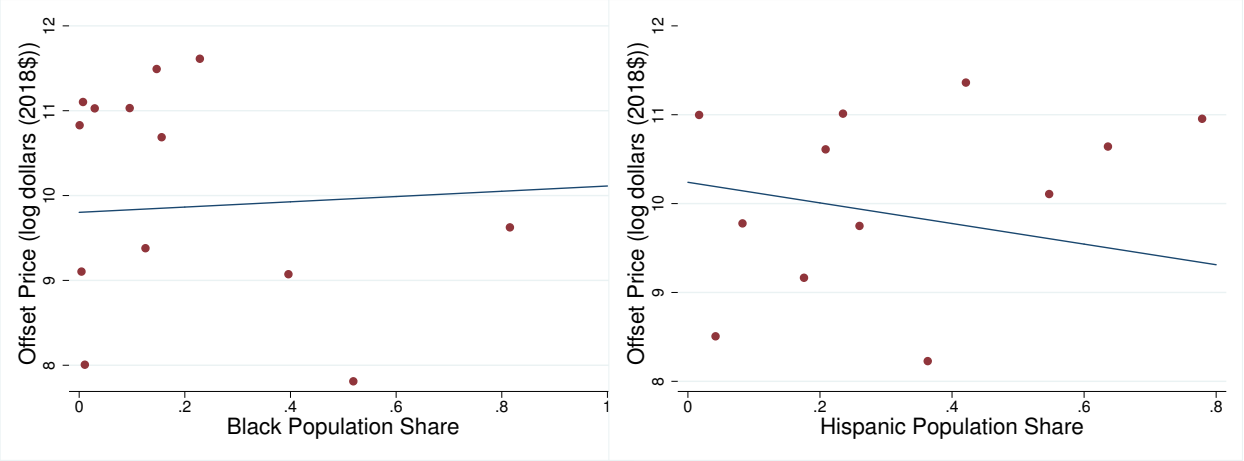
Finally, Appendix Figure A1 plots the density of median household income in the communities where offsets are sold and purchased. The two densities largely overlap. The graphs show modest evidence that offset transactions move pollution towards communities with higher median household income, since the solid line (offset purchases) has higher density in higher-income communities.

Appendix Table A1 presents statistical tests for the difference in characteristics between communities where offsets are sold (emissions permanently reduced) compared to where offsets are purchased (emissions expansions). For example, Panel A, column (1), shows that in communities where offset 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.

Appendix Table A1 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 towards 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

Figure 2: Offset Prices Versus Community Characteristics



(a) Black Pop. Share

(b) Hispanic Pop. Share

Note: 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.

community characteristics, and in particular little evidence that they disproportionately relocate pollution towards 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.

3 Results: Offset Prices and Community Characteristics

Economists tend to support market-based environmental policies like emissions taxes or cap-and-trade markets because they are cost-effective and so reduce emissions at minimum cost (or, equivalently, maximize the emissions 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 2a and the income graph in 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.

4 Conclusion

While market-based environmental policies are important tools for achieving emissions reductions at 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 set of environmental markets in the US, the Clean Air Act's offset program. We find little evidence to suggest that the tradability of emissions rights has historically reallocated emissions to or from low income or minority communities. Although this is a limited sample and setting, it echoes related findings that market-based environmental policies have not exacerbated environmental inequality in the US. 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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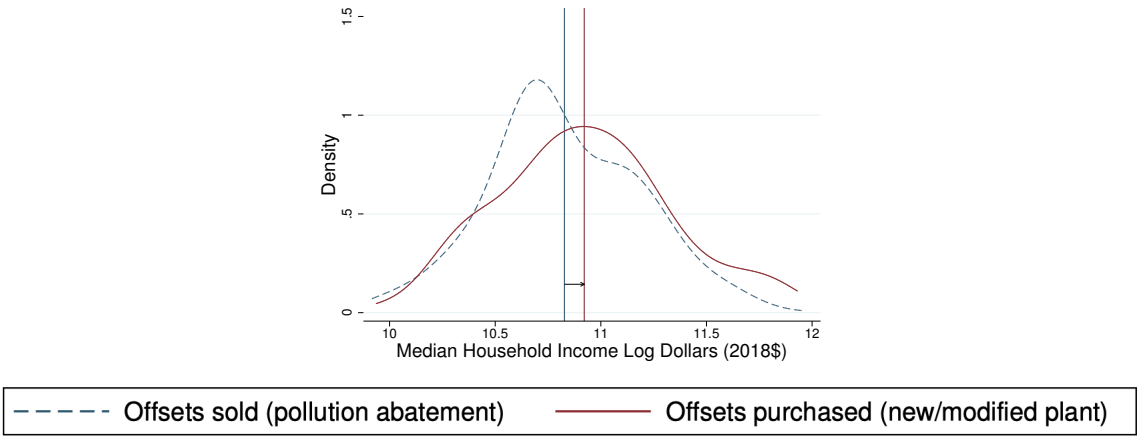
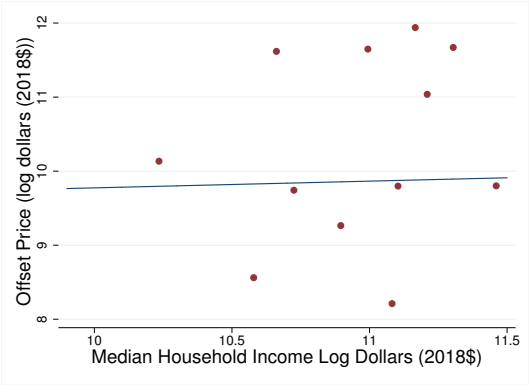
Appendix A Figures and Tables

Figure A1: Densities of Median Household Income: Offset Origins Versus Destinations



Note: This figure plots kernel density of community median household income where offsets are sold (due to pollution abatement) and purchased (for a new or expanding source). The vertical lines represent the respective means of each distribution, and the arrow points in the direction household income has moved due to trading of offsets. An observation is an offset that is either sold or purchased. Median household income represents an population-weighted average of census block group income in all block groups within 1 mile of the corresponding pollution source using demographic characteristics from the 2006-2010 American Community Survey 5 Year Estimates.

Figure A2: Offset Prices Versus Community Characteristics



Note: This figure plots the relationship between offset transaction prices and median household income of the communities within 1 mile of a facility. The solid line represents a linear fit from a regression of offset prices on median household income, after controlling for year, market, and pollutant fixed effects. The points represent the conditional mean offset price for the various quantiles of community median household income. Median household income represents an population-weighted mean of census block group characteristics in all block groups within 1 mile of the corresponding pollution source using demographic characteristics from the 2006-2010 American Community Survey 5 Year Estimates.

Table A1: Neighborhood Demographics in Communities where Offsets Increase and Decrease Pollution

Dependent Variable	Black or African American Population %	Hispanic Population %	Median Household Income
	(1)	(2)	(4)
All Counties	13.6%	34.1%	$10.28
Panel A. All pollutants			
Origin of pollution decrease	15.6%	35.2%	$10.83
Destination of pollution increase	15.2%	36.7%	$10.92
Difference	-0.4%	1.5%	$0.09
p-val	[0.91]	[0.66]	[0.07]
N		1,448	
Panel B. Nitrogen oxides (NO_x)			
Origin of pollution decrease	16.7%	29.2%	$10.83
Destination of pollution increase	18.5%	35.9%	$10.93
Difference	1.8%	6.7%	$0.10
p-val	[0.73]	[0.15]	[0.19]
N		548	
Panel C. Volatile organic compounds (VOCs)			
Origin of pollution decrease	14.3%	44.3%	$10.82
Destination of pollution increase	9.8%	37.8%	$10.91
Difference	-4.5%	-6.5%	$0.08
p-val	[0.12]	[0.09]	[0.09]
N		794	

Note: This table compares mean neighborhood characteristics of locations where offsets sold and purchased. An observation is a single offset generation or offset use. Offset data comes from years 1993 to 2020 for the nonattainment areas in Beaumont, Dallas, Houston, and San Antonio, Texas and San Joaquin Valley, California. "All pollutants" include nitrogen oxides (NO_x), volatile organic compounds (VOCs), particulate matter of diameter 10 micrometers or less (PM_{10}), and sulfur oxides (SO_x). Mean of demographics and income are weighted by amount of offset generated or used. Neighborhood are defined as census blockgroups that intersect within the 1-mile radius of plants. In the case that the 1-mile radius around plant intersected multiple census block groups, the characteristics are taken as the average of characteristics of all intersected block groups, weighted by the population of intersection between the block group and the 1-mile-radius circle around the facility. Block group level neighborhood characteristics comes from the American Community Survey 2006-2010.