Environmental Justice: The Economics of Race, Place, and Pollution

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1. Introduction

The shock at the recent water crisis in Flint, Michigan is but the latest chapter in a long line of stories highlighting the interrelationship between local pollution and the presence of poor or minority households. In response, some 30 years ago the "environmental justice" (EJ) movement began to call attention to and protest such discriminatory patterns. Identifying the nature of the injustice inherent in these patterns as well as understanding the effects of proposed policy remedies requires an understanding of the economic processes that underlie them. In this paper, we review the environmental justice literature with a focus on its important intersections with economics, arguing that economics is well-situated both to analyze questions in environmental justice and to suggest policy responses.

What is environmental injustice? In the simplest terms, it is the disproportionate exposure of disadvantaged groups to environmental nuisances. "Disadvantage" is typically defined in terms of race or class, the latter of which is usually expressed in terms of income, wealth, or other determinants of material well-being. Disadvantage need not, however, be limited to these categories.

Practically, the definition of environmental justice has been shaped by stakeholders. The EPA's definition requires "that no population…is forced to bear a disproportionate share of negative human health or environmental impacts of pollution" (i.e., distributive justice) and "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development of environmental laws" (i.e., procedural justice). Benjamin Chavis, who as Executive Director of the United Church of Christ's Commission on Racial Justice played a key role in the earliest environmental justice protests has focused on intent, referencing "racial discrimination…deliberate targeting of communities of color…official sanctioning of life threatening presence of poisons and pollutants…history of excluding people of color from leadership of the ecology movements." While the intent referenced in Chavis' definition is not a prerequisite for injustice, it does play an important role in establishing the basis for legal remedies. A final definition that provides a useful jumping-off point for our economic discussion comes from the 2001 Declaration of Principles of the Brazilian Network for Environmental Justice, which speaks of "social and economic mechanisms" that "channel the lion's share of the environmental damage caused by development towards…vulnerable populations." These sorts of mechanisms are at the core of an economic analysis of EJ.

The second and third definitions presented above focus on "why" an environmental injustice exists. The question of why is crucially important, as we cannot hope to address injustices if we do not understand their origins. Failure to understand the processes that lead to inequities may lead us to the wrong tools in an effort to fix them. As is so often the case in economics, this can lead to unanticipated consequences and can even make the situation worse.

The field of economics is well-equipped to answer the question of why we see inequities in exposure to pollution.[1] Economics is about decision-making under constraints. Applied to producers, it has the tools to ask why a firm chooses to locate a noxious facility in a particular neighborhood. Is the siting decision motivated by simple cost-minimization concerns? Do those cost-minimization concerns incorporate the perceived costs of dealing with local community groups who might object to the facility's siting? Looking at the other side of the market, what motivates a household to choose to reside in a particular neighborhood? How does the household trade-off pollution exposure with the opportunity to consume other necessities of life? How do constraints (e.g., income, employment, information) affect those decisions?

More generally, environmental justice fits neatly with growing interest in the economics of inequality (e.g. Chetty et al. 2014; Piketty 2014). The distribution of environmental amenities is part of the overall landscape of inequality. In particular, quality of the place in which one works and plays, as much as his natural endowments, may affect both where a person begins on the income ladder as well as his chances for upward mobility. Beyond ethical considerations, these distributional effects are an important part of welfare and policy analysis as inequality today may deprive society of valuable opportunities for innovation and growth in the future.

[1] Although we approach EJ questions from the perspective of economics, the field of environmental justice is interdisciplinary, and is based on the insights and analyses of researchers from sociology, medicine, law, political science, women's studies, comparative cultures, and other fields.

The Birth of the EJ movement: Warren County, NC

While systematic evidence has supported the claims of the environmental justice movement, its energy has come from particular stories. Many attribute the birth of the EJ movement to the Warren County, North Carolina protests in 1982. In 1978, 31,000 gallons of polychlorinated biphenyl (PCB) were illegally dumped on behalf of the Ward Transformer Company of Raleigh along 210 miles of roads in fourteen counties in North Carolina. PCB exposure can lead to skin conditions, liver damage, lowered immune system response, and cognitive failure in children. The state developed a plan to collect the PCB-contaminated soil for landfilling. Requirements for a landfill were that the site be (i) bound by counties where spill occurred, (ii) surrounded by at least 16 acres of land, and (iii) isolated from highly populated areas. Two alternative sites were identified: a publicly-owned landfill in Chatham County, and a recently foreclosed property in Warren County. In 1980, Warren County was 59.5% black and had 24.9% of families below the poverty-line, whereas the corresponding figures for Chatham County were only 26.9% and 6.4%. On scientific grounds, the Warren County site was deemed not suitable, with a shallow water table and nearby residents reliant on private wells. The fact that the Chatham County site was publicly-owned, however, meant that local residents were invited to participate in siting decision whereas the citizens of Warren County (where the proposed site was private property) were not. The landfill was ultimately placed on the foreclosed property in Warren County near the town of Shocco, which had an even higher percentage of African American residents than did Warren County overall. Moreover, Shocco was not incorporated and had no mayor or city council – factors that likely also contributed to residents' inability to express their true willingness to pay to avoid the landfill.

Residents began protesting the siting of the PCB landfill in 1982. These protests drew widespread support from civil rights groups and gained national media attention. While this was not the first documented case of disproportionate exposure of minorities to pollution (see Bullard 2005), it was among the first to raise awareness about the particular environmental concerns of minorities. However, it was not until 1993, when evidence was discovered that it was leaking, that the landfill was removed: 81,500 tons of contaminated soil were later excavated and burned (on-site) at a cost of $18 million.

Plus ça change: Water Contamination in Flint, Michigan

It appears sometimes history does repeat itself. In April of 2014, the city of Flint, driven by efforts to reduce costs, switched its water source from Lake Huron to the river that shares its name. The Flint River had not been used as a source of supply since 1967, after a report by the Department of Interior documented poor water quality attributable to various municipal and industrial sources (US DOI 1966). Despite this, the Michigan Department of Environmental Quality (MDEQ) did not test the impact of the new source on Flint's aging distribution system when it decided to switch its water source, nor did it implement any controls for pipe corrosion (which is required for water systems that serve over 50,000 people).

By September of 2015, two studies, one conducted by researchers at Virginia Tech and another by researchers at the Hurly Medical Center, found elevated lead levels in water samples, exceeding the 15 ppb standard considered safe for drinking water, in 252 out of 300 residences. They also found elevated blood lead levels in children age 5 and under, even though the Flint water system had just achieved compliance with EPA standards a month earlier. While officials at both MDEQ and the State Department of Health and Human Services insisted the public disregard these studies, the findings (and other complaints) ultimately prompted the city to revert to its original water source in October of that year. In January 2016, Governer Rick Snyder (R-MI) declared a state of emergency in Genessee county, followed by President Obama's declaration on January 16, 2016. Lawsuits ensued and officials began devising strategies (e.g. pipe replacements) to address the crisis. Astonishingly, the regulatory action to reinstate the original water source occurred 17 months after the initial decision to switch sources, even though residents began complaining about odors and water discoloration after just one month.

The city of Flint is predominantly low income and African American. In 2016, the city was 54.3 percent African-American (reporting one-race) and had a median income of $25,865 between 2012 and 2016 (2016$). Compared to the 14.2 percent of African Americans and a $50,803 median income reported at the state level (US Census), this was an area where residents' willingness to pay to avoid water pollution was low to begin with. To make matters worse, the city of Flint had gone into bankruptcy and was under the control of a city manager whose responsibility was to the state treasury, not to local residents. Given these circumstances, the outcome may not be all that surprising. Still, one might ask, if Flint was less poor and more white, could it have more effectively persuaded regulators to act or to initially take more precaution?

Overview

The following discussion begins with the "stylized fact" of a spatial correlation between pollution and poor/minority households, but quickly moves to an evaluation of its root causes. Understanding the mechanisms that lead to the correlation is necessary for two reasons. First, it helps identify the locus of injustice. Is it in discriminatory acts? Is it in the siting decisions by firms and, if so, what are the drivers of those decisions? Is it in the location decisions of households, and to what extent are those decisions driven by underlying inequalities in income, wealth, or other resources? To what extent are patterns the consequence of past injustices that re-surface in the form of long-run schooling or health outcomes? To what extent are they driven by failures of the legal system to provide an avenue of recourse? To what extent do they arise from the failures of representative government or bureaucratic infrastructure to convey the preferences of disadvantaged groups or simply implement policies? Second, these various mechanisms naturally offer policy remedies. Accordingly, we briefly overview some policy options before concluding. These include the role for institutions (legal and administrative) to ensure full participation and choice of pollution exposure, place- and people-based remedies targeting inequitable exposure or inequality more generally, and the way EJ is incorporated into decisions by policymakers, particularly at US EPA, as it is embedded in US cost-benefit analyses.

We note that our discussion is focused almost exclusively on US topics within environmental justice. EJ questions have arisen in many parts of the world, including land use, REDD+ and forest preservation, international disposal and management of toxic (e.g. electronic) waste, and the disproportionate impacts of climate change. While there may be additional considerations with respect to the global or international nature in these cases, much of our discussion in the US context applies.

2. Poor and Minority Households are Disproportionately Exposed to Pollution.

The grassroots movement that placed environmental justice issues on the national stage initiated a research effort to document the correlation of pollution with race and/or poverty. Over the past 35 years, this work has established inequitable exposure to nuisances as a "stylized fact" of social science.[2] Figure 1 illustrates such correlations, plotting 2010 emissions from large polluters (those in the Toxic Release Inventory [TRI]) in North Carolina, against a heat map of the percentage of the population that is white, at the census tract level. The correlation between minority density and emissions intensities at TRI facilities is striking. Figures 2 and 3 similarly plot TRI emissions against income. While the correlation is less striking at the county level (Fig. 2), zooming in reveals that while TRI facilities are often located in the state's higher income counties, they are disproportionately located in the lower-income tracts within the county (Fig. 3).

Such correlations were first documented in a study by the US Government Accountability Office (US GAO 1983). This study tested for the existence of disproportionate exposure around four hazardous waste landfills in the southeastern US. It found that three of the four communities examined were over 50 percent African American in 1980, compared to only 22-30 percent at the state level. Following the GAO report, the United Church of Christ commissioned a nationwide analysis of the correlation between commercial hazardous waste facilities and race (UCC 1987). It reached similar conclusions, finding the share of minorities in communities with commercial hazardous waste facilities was double, and even triple, that for areas containing no facilities.

Following the GAO and UCC reports, as well as early academic work by Bullard (1983), came a growing body of academic work in law, sociology, public policy, and economics aimed at further documenting such correlations under a variety of measures of exposure, spatial scales, and statistical controls. Importantly, early debates in this literature directed researchers to be more cognizant of the various modeling decisions that could influence estimated outcomes. We discuss these issues in the following sub-sections.

[2] In the spirit of the venue, we do not try to provide a thorough list of relevant citations. Good overviews can be found in Bullard (1994), Banzhaf (2012), Bowen (2002), Cole and Foster (2001), Noonan (2008), and Ringquist (2003, 2005).

Measures of Exposure

Early empirical work in EJ focused primarily on undesirable land uses such as hazardous waste sites and landfills.[3] Other papers have considered the proximity of large air polluters, such as those listed in the US Toxic Release Inventory (TRI).[4] However, proximity to nuisances may not capture actual risk exposure. Not every toxic waste facility handles an equal amount of waste, nor does every TRI site emit an equal amount of pollution. Moreover, chemical toxicity varies with the pollutant. For example, beryllium as an air toxin is over 3 million times more hazardous than the same amount of dichlorotetraflouro-ethane. With this in mind, some papers have considered emission levels at the intensive margin rather than simply proximity to a site at the extensive margin.[5] Others have gone further by incorporating air-dispersion and chemical-transport models to better capture the actual health hazards that populations face.[6]

Overall, while recent work has developed more nuanced and more defensible measures of exposure, the environmental justice correlations have not been sensitive to these alternative measures.

Spatial Relationships

The earlier studies typically assume that the population "exposed" to a nuisance coincides with those people living in the same geographic unit as the nuisance, such as a census tract or zip code. This approach is known as unit-hazard coincidence (McMaster, Leitner, and Sheppard 1997, Mohai and Saha 2006). While possessing the virtue of simplicity, unit-hazard coincidence is problematic for at least three reasons. First, it implicitly assumes that exposure to hazards is distributed equally within the geographic unit. Moreover, geographic units like census tracts are drawn to be homogeneous with respect to population *levels* but heterogeneous with respect to

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[3] Subsequent work along these lines includes Anderton et al. (1994), Baden and Coursey (2002); Been (1997); Boer et al. (1997); Cameron, Crawford, and McConnaha (2012); Depro, O'Neil, and Timmins (2017); Gamper-Rabindran and Timmins (2011); Goldman and Fitton (1994); and UCC (2007).

[4] Examples include Banzhaf, Sidon, and Walsh (2012), Ringquist (1997), Sadd et al. (1999) and Wolverton (2009).

[5] See Arora and Cason (1999), Bowen et al. (1995), Brooks and Sethi (1997), Kriesel et al. (1996), and Ringquist (1997).

[6] Examples include Ash and Fetter (2004), Depro and Timmins (2012), Morello-Frosch and Jesdale (2004), and Morello-Frosch, Pastor, and Sadd (2001).

geographic size, with smaller and denser units in more urban areas. Unit-hazard coincidence therefore assigns a smaller exposure area around facilities in more urban areas. Second, when nuisances are located near geographical boundaries, it ignores exposures in adjacent areas that may be quite close by, while assigning exposure to parts of the coincident geographic unit that may be far from the nuisance. This introduces measurement error, which is likely to attenuate estimates of environmental justice correlations. Third, when geographic units like tracts are created to be fairly homogenous, the unit-hazard approach will mechanically extend local correlations to wider areas. For example, perhaps only a very local area near a nuisance is made up of one demographic group, but through the creation of homogeneous geographic units, that local area will be systematically combined with similar areas even if they are randomly distributed. This would tend to exaggerate any such effects (Banzhaf and Walsh 2008).

An alternative approach to measuring exposure looks at the population within some distance of a site (or, alternatively, the number of nuisances or level of emissions within some distance of a population). Using an application to hazardous waste facilities, Mohai and Saha (2006) find that the conclusions regarding disproportionate exposure are sensitive to such changes in definitions of exposure. In particular, they find no evidence that race is significantly correlated with hazardous waste facilities using unit-hazard coincidence, but do find significant evidence of higher African American and Hispanic population shares in tracts within 1 and 3 miles of such facilities. Additionally, they show that employing the unit-coincidence definition results in both larger tracts in the treatment group as well as tracts whose centroids are farther from facilities, compared to a distance-based measure. As these patterns increase the likelihood of misclassifying exposure, they conclude that distance-based measures are superior to unit-coincidence.

Table 1 highlights the differences between using unit-coincidence or a distance-based measure to define exposure. Each column represents a separate regression, regressing logged 2000 TRI emissions on local demographics for all of the continental US. The first three columns use the unit-coincidence approach, using the state, county, or census tract as three respective geographic units. The next three columns use a distance based approach for the same respective units. In the case of unit-coincidence, a tract, for example, is exposed if any TRI facility is located within the boundaries of that tract. In contrast, a distance-based measure would designate a tract as being exposed if any facilities are located within 3 km of the tract's centroid. Whereas the corresponding estimates using unit-coincidence are either negative or not statistically different from zero, the distance-based measure finds a positive correlation between emissions and percent black and Hispanic and the local level.

Spatial Scale: The Ecological Fallacy

When measuring the correlation between pollution and demographics, the literature also has highlighted the "ecological fallacy." A kind of aggregation bias, the ecological fallacy stems from inferring relationships between individual units (e.g. households) from larger, more aggregated units (e.g. counties) that contain those units. Some authors have raised concerns that the observed correlations between race and pollution found at the larger community level may potentially be subject to the ecological fallacy (e.g. Anderton et al. 1994).

Figure 4 illustrates this concept. In (a), pollution sources, denoted by smaller, yellow squares, are perfectly correlated with minority neighborhoods, represented by larger, blue squares, leading one to conclude that pollution is perfectly correlated with race. Suppose, however, that this relationship is estimated based on larger units of geography that aggregate neighborhoods according to the bold, dark lines in (b). Viewed at an aggregate level, minority and non-minority neighborhoods are equally exposed to pollution sources, and one would conclude that there is no correlation between race and pollution.

The relationship estimated from aggregated data is only equal to the relationship at the micro level if there are no group-level effects correlated with pollution. This is an extreme assumption that is not likely to hold. For example, if individuals have any peer preferences, creating segregation between larger geographic units, or if geographic units' boundaries are systematically gerrymandered to create the illusion of homophily (as discussed above), we would expect exaggerated findings of correlations between pollution and demographics at a higher geographic level. If, on the other hand, communities follow a chessboard-like configuration due to clustering (as illustrated), then aggregation can mask inequitable exposure.

In one review, Baden, Noonan, and Turaga (2007) surveyed 110 EJ studies to assess the impact of the unit of analysis on their findings. While there are exceptions, they find that most studies failing to find a correlation work with larger spatial scales. They also conducted their own analysis to examine exposure to hazardous waste sites. Overall, they find that evidence of racial, ethnic and income inequities becomes more significant when using smaller units of analysis (like tract and block group).

Returning to our own analysis of 2000 TRI releases, we find similar results when we vary the unit of analysis. Table 1 shows that, using our preferred distance-based measure, positive correlations between pollution and either percent Black or percent Hispanic are most likely to appear and be statistically significant at local spatial scales. The same is true for negative correlations with income using either the distance-based measure or unit coincidence. A comparison of Figures 2 and 3 illustrate these differences.

Statistical Controls: The Locus of Injustice

The most basic environmental justice pattern in the data is the simple correlation between pollution and poor and/or minority populations, a robust finding especially at smaller spatial scales and when distance-based measures are used. But, in the context of linear regression, the question arises as to the importance of additional statistical controls. For example, Anderton et al. (1994) found no evidence that race is significantly correlated with the location of waste facilities after including socio-economic controls; rather, the most salient feature was the intensity of manufacturing employment. This would suggest instead that access to labor pools, and not race itself, was the driver of environmental justice correlations.

In the subsequent literature, broader conceptual issues have pervaded the discussion of statistical controls. In particular, which demographic variables are of most interest? Are EJ claims based on race, or class? Does race matter after controlling for economic status and vice-versa? If it does, does it matter, and why? Our view is that it *does* matter when it comes to determining the social *causes* of environmental justice correlations. For example, Mohai and Bryant (1992) and Hamilton (1995) posit a number reasons why racial groups may be directly correlated with exposure, even after controlling for income and wealth, including taste-based discrimination in pollution, discrimination in the housing market, and political clout and access to legal resources. A finding that race is not correlated with pollution after controlling for socio-economic status might lead one to reject some of these hypotheses.

On the other hand, it is not clear that it is important to distinguish race from class when establishing the *existence* of an environmental inequity, if they are tangled together in a web of causal relationships. One could still argue that there is an injustice—even an injustice at the level of racial groups—when there are inequities in the simple correlations, even if these correlations are the result of socio-economic processes. Simply because the inequity is mediated through some mechanism does not mean it isn't there.

In the following section, we consider these matters in greater detail.

3. Potential Mechanisms

Studies documenting contemporaneous correlations among race, income, and pollution are unable to distinguish between alternative causal stories. Yet understanding the relative roles played by these causal channels is important for two reasons. First, it helps to narrow down the locus of injustice. Is it in the discriminatory actions of firms? The lack of participation of households in citing procedures? In the underlying distribution of income? Second, it can help inform any potential policy responses. Moreover, because economics specializes in causal identification, this may be an area where economists can best contribute to the environmental justice discussion.

Accordingly, in this section, we consider some of the possible causal mechanisms giving rise to environmental justice correlations. In particular, we consider four categories of mechanisms: disproportionate siting on the firm side, "coming to the nuisance" on the household side, market-like coordination of the two, and discriminatory politics and/or enforcement. After first introducing each mechanism, we consider its implications for environmental justice considerations and policy. Finally, we evaluate the evidence in support of each.

3.1. Disproportionate Siting

With its origins in the debates over siting in Warren County, a central focus of the environmental justice literature has long been whether, taking residential locational patterns as given, firms site (or, historically, have sited) polluting activity in poor and/or minority neighborhoods. Such disproportionate siting might occur for three broad reasons.

The first and arguably simplest reason for disproportionate siting is taste-based discrimination, in which firms incorporate into their decision-making a preference for protecting whites from pollution, or indulge a malevolent preference to harm other groups (Becker 1957). Most economists, when first hearing about environmental justice concerns, assume this is what activists have in mind. In our experience, though, this argument is a red herring. Few activists or non-economists think in these simplistic terms. Rather, they have a much more sophisticated understanding of the socio-economic processes at work.

A second, alternative explanation is that firms site their polluting activity based on local economic conditions, but that these conditions in turn are correlated in space with residential demographic patterns. For example, firms might seek access to inexpensive land, low-wage labor, or transportation networks (Wolverton 2009). These features might happen to be correlated with locations of poorer households for any number of reasons. Poorer households might also seek inexpensive land, for example, and they have lower wages almost by definition. Too, the correlations might arise indirectly from other types of discrimination. For example, industrial facilities may be attracted to locations near expressways or railroads, but those transportation routes might be located where they are because of past discriminatory transportation siting.

A third possibility is that government agencies themselves make decisions about the location of such facilities, push the permitting process, or otherwise create an incentive structure that steers firms to such locations.

3.2. Coming to the Nuisance

A very different perspective on the contemporaneous correlations between demographics and pollution takes the pattern of pollution as given, and considers where households move based on their willingness to pay (and ability to pay) for a clean environment (Been 1994, 1997; Hamilton 1995). For economists, this perspective is an application of Tiebout's (1956) canonical model of residential sorting. In Tiebout's theory, households choose a location subject to a budget constraint and desirable neighborhood amenities like a clean environment, green spaces, school quality, public safety, and access to employment centers and retail outlets. Because households prefer nicer neighborhoods, their demand for such neighborhoods is higher and, hence, ceteris paribus, so is the price of housing. Households therefore must make tradeoffs between consumption and local neighborhood amenities, "voting with their feet" to reveal their willingness to pay more for public goods through higher gross-of-tax housing costs. How much a household is willing to pay for these amenities depends on its preferences and budget.

Consider an economic model in which a household gets utility from environmental quality and other local amenities g and all other goods that it can purchase with its income y after paying for a house with price *p*. Assume, for simplicity, that all households have the same preferences (generalized versions of the model easily avoid this assumption). Because of diminishing marginal rates of substitution, if two households with different incomes were located in the same neighborhood, the richer household would have a higher willingness to pay to move to a neighborhood with a cleaner environment. If this is true at any baseline bundle, the indifference curves of the households in the space of amenities and housing prices will only cross once. Figure 5 illustrates this scenario. The x-axis shows *g*, a public good; the y-axis shows *p*, the price of housing. The figure shows indifference curves for two households, A and B, with household B being the richer of the two. Note that, because prices are on the vertical axis, utility is increasing to the "southeast." Household B's indifference curve is steeper at each value of *g*, indicating a greater willingness to trade off higher housing prices for higher *g*.

For each pair of neighboring communities with different levels of *g*, there will be a set of "boundary" households (defined by income $\tilde{y}$) that are indifferent between those communities. Figure 6 illustrates this case. Household B, with the higher income, obtains greater utility from the high-*g* community. Household A, with the lower income, obtains greater utility from the low-*g* community, not because it prefers it per se, but because, given its income, it prioritizes other things, like food and clothing. In between, a household with income $\tilde{y}$ is just indifferent between the two communities. In this way, households "sort" by income across levels of amenities, a process also known as "stratification." Poorer households end up in more polluted areas, just as they obtain less of many of the other things money can buy. Moreover, if one demographic group (say, whites) is richer than another group throughout the distribution in the sense of first-order stochastic dominance, then the poorer group will have more exposure to pollution, on average (Banzhaf and Walsh 2013).

This process creates a correlation between pollution and demographics in equilibrium. Figure 7, reproduced from Banzhaf and McCormick (2012), illustrates these effects in what they call "pyramid of environmental gentrification". Correlation between environment and demographics may have a direct causal link (line 2). Or they may arise from higher real estate prices in nicer areas (line 1) combined with the fact that the rich can afford to pay higher prices (line 3).

Multiplier Effects

Moreover, an initial sorting process like this may lead to additional effects on neighborhood characteristics, effects that feedback and reinforce the initial sorting patterns. For example, if initial patterns signal neglect of or disregard for the neighborhood, polluting facilities may undermine the provision of local public goods, a kind of "broken windows" effect. Additionally, once an initial sorting occurs because of the pollution, different demographic groups may create different neighborhood environments, based on their taste or their ability to pay for them. They may attract different types of retail, and richer neighborhoods may have a greater capacity than poorer neighborhoods to provide public safety, school quality, and so forth. As depicted in the left side of the figure, such effects can further drive sorting, creating a multiplier effect (Banzhaf and Walsh 2013; O'Sullivan 2005; Sethi and Somanathan 2004). As Schelling (1969) showed many years ago, if people have even a modicum of taste to be with their own group, the dynamics of sorting can creating "tipping patterns" such as white flight, driving further segregation.

In consideration of these feedbacks, cleaning up polluted areas may cause "environmental gentrification" (Sieg et al. 2004; Banzhaf and McCormick 2012). By the logic of Tiebout sorting, the poor, when sorting into a more polluted area, are signaling that other uses of their money (e.g., putting food on the table) are a higher priority than avoiding local pollution. Cleaning up the environment may increase demand for housing and, subsequently, prices. If richer households bid up housing prices to reflect their own higher willingness to pay, it could more than offset the direct benefit to the poor of the cleaner environment. This logic suggests that policy responses should target the *people* in need rather than the places they reside if market forces offset any direct benefits.

Environmental gentrification also highlights an important distinction between renters and owners. Because they have a more valuable asset, owners benefit from the increased house value accompanying an environmental improvement. Renters, on the other hand, only face higher rents, while landlords reap the gains. In this way, environmental justice considerations are not only wrapped up in the underlying distribution of income, but also potentially in historical policies such as red-lining that have exacerbated disparities in home-ownership (Aaronson et al. 2017).

A different kind of multiplier effect may result from the intergenerational transmission of poverty. A large literature shows that pollution exposure *in utero* and in early childhood can have lifelong effects. The idea that nutrition *in utero* is important for determining adult health outcomes is articulated in the "fetal origins" hypothesis and popularized in work by David J. Barker. It posits a biological mechanism through which *in utero* health can persist through adulthood. While the initial hypothesis focused on adult health outcomes, economists have expanded the scope of the fetal origins hypothesis to include other dimensions of well-being, such as human capital accumulation and labor market outcomes, family structure, and welfare dependency, bolstering the idea that health at birth is a product of both genetic predisposition and environment. Combined with the evidence on sorting (Banzhaf and Walsh 2007) and that, more generally, parental socioeconomic status (SES) affects children's health (Currie and Niedell 2007; Currie and Moretti 2007), the fetal origins hypothesis presents an alternative pathway that reinforces environmental inequities. Low SES parents may sort into polluted neighborhoods in Tiebout fashion; their children are disproportionately exposed to pollution *in utero* and in early childhood, which impacts the children's health (e.g. Chay and Greenstone 2003; Currie and Neidell 2007; Currie and Walker 2011; Currie et al. 2015); as early childhood health can have persistent human capital impacts (e.g. Black et al. 2007; Currie and Moretti 2007; Oreopoulos et al. 2008; Royer 2009; Sanders 2010; Figlio et al. 2014; Persico et al. 2016), this renders the children of low SES adults to be of low socioeconomic status themselves in adulthood. Finally, as adults, this next generation again chooses high exposure given their preferences and income. The cycle continues. Moreover, given self-productivity of and dynamic complementarities in cognitive and non-cognitive skills over time (Grossman 1972; Heckman 2007; Cunha et al. 2010), intergenerational accumulation (or deprivation) of health and related human capital may even compound observed inequitable exposure.

Implications

To the extent that the simplest of these Tiebout sorting processes are responsible for the observed correlations between demographics and pollution, there are three policy implications. First, the observed patterns may be "efficient"—*given underlying distribution of resources*. That is not to say the outcome is "best", but only that the poor are best able to judge how to make use of the limited resources available to them. If they sort into more polluted areas, it is because they are giving higher priority to other things – doing the best they can with what they have. Second, this pushes back the locus of injustice from environmental inequities per se to the underlying distribution of income. The same could be said of a variety of inequalities (e.g., food, energy, housing). All are evidence of a deeper inequality.

The feedback, or multiplier, effects add further nuance to the interpretation of environmental justice. If households sort on their own group, or other amenities associated with the group, as well as environmental amenities, it can create a kind of "tax" on minorities' ability to obtain a clean environment. They have to pay, in the form of higher housing costs, for the clean environment per se, but also to live in the white community, for which they might get little utility (Banzhaf and Walsh 2013; Ford 1994). Additionally, the feedback effects of the exposure of infants to pollution on health and human capital could create a kind of poverty trap. Poorer people sort into polluted areas, but the pollution itself can perpetuate poverty, which leads people to sort into polluted areas…. Such cycles are similar to other kinds of poverty traps, such as the absence of networks for transmitting human capital (Bowles, et al. 2006; Loury 1981).

Empirical Evidence

Questions about "which came first", siting of industrial facilities or household location, tend to present observed contemporaneous correlations as a chicken-and-the-egg problem. To unscramble this problem, analysts have looked at local demographics *at the time of siting* as well as subsequent changes in demographics after either siting or closure/exit of polluting facilities. Results from this literature have been mixed. It appears that, at the time of siting, firms do go to areas that have a disproportionate share of minorities, or at least some types of minorities (Been 1997; Pastor, Sadd, and Hipp 2001; Baden and Coursey 2002). Modeling firm location as a decision variable, Wolverton (2009) finds that this pattern seems to arise more from economic factors such as land, labor, and access to transportation, rather than directly from local demographics.

Studies of subsequent changes in demographics, using difference-in-differences or similar methodologies, have yielded mixed results.[7] However, these studies have proven

[7] Evidence in favor of post-siting sorting can be found in Baden and Coursey (2002), Banzhaf and Walsh (2008), Depro, Timmins and O'Neil (2017), Gamper-Rabindran and Timmins (2011), Lambert and Boerner (1997), Oakes, Anderton, and Anderson (1996), and Wolverton (2011). Evidence against can be found in Been (1997), Cameron, Crawford, and McConnaha (2011), Cameron and McConnaha (2006), Greenstone and Gallagher (2008), and Pastor, Sadd, and Hipp (2001).

difficult to interpret. There are at least three reasons why *changes* in demographics may not appear to be correlated with *changes* in pollution, even when cross-sectional correlations truly are driven by Tiebout sorting. First, in even the simple model described above, improvement in a community's amenities will increase population and housing prices, but changes in demographic composition may be hard to detect (Banzhaf and Walsh 2008, 2013). If a community's amenities increase, richer people may move in, but if the in-migrants are the poorest members of the comparison community, *both* communities can become richer on average, making the prediction for differences-in-differences ambiguous. The story is even more complicated for demographic groups (like racial groups), because the effects additionally depend on the relative density of each group at the marginal level of income where adjustments are occurring. Depro, Timmins and O'Neil (2017) show that, without additional structure, individual sorting behavior with respect to pollution is not even identified from aggregate population flows. Imposing some structure on individual utility, they find that minorities do indeed show less of a tendency to move away from pollution disamenities, a fact driven largely by income inequality.

Second, generalizations of the above model introduce the possibility of some hysteresis, or stickiness, in community compositions over time. For example, suppose an area initially is polluted and households sort on this pollution. Suppose then the area is cleaned up. If perceptions are sticky, so that people believe it is still dirty, or if there is any other "stigma" associated with the original state, the initial sorting may not be reversed. Scholars looking for such a reversal may thus fail to find it (Cameron and McConnaha 2006; Messer et al. 2006). Third, the multiplier effects discussed above also can create hysteresis. Changes in local amenities resulting from demographic sorting will themselves have feedbacks on housing prices, which induce further changes in socio-demographics. Consequently, even if the nuisance is eventually cleaned-up, housing prices may not bounce back because of these other changes, which themselves occurred as a result of Tiebout sorting. Indeed, Banzhaf and Walsh (2013) show that if such effects become more salient after cleaning up pollution (because there is less reason to sort on environmental quality once it is cleaned), then the correlation between pollution and demographics can become *stronger* over time, as racial differences increase and pollution differences decrease.

3.3. Coasean Bargaining

The Coase Theorem states that, under well-defined property rights and in the absence of transaction costs, it does not matter who holds the property rights to the use of the environment because negotiation and market transactions will ensure the same, efficient use of resources (Coase 1960). Put simply, through negotiation, the right to pollute (or to be spared pollution) will end up in the hands of the individuals or firms who value it most, and all parties will be appropriately compensated for any nuisance or foregone profits they consequently bear. However, the distribution of wealth will depend on the initial allocation of property.

A Coasean perspective on environmental justice in many respects triangulates on the first two causal mechanisms discussed. From a Coasean perspective, firms have preferences over where to locate their industrial facilities and a willingness to pay to locate at a certain place. At the same time, households have a tolerance for pollution and some willingness to accept compensation for industrial activity nearby. Where the previous two mechanisms discussed take each of these perspectives in isolation, a Coasean perspective sees (the potential for) transactions between the two sides.

Consider a facility that emits pollution into the surrounding environment at zero private cost (i.e., cost incurred by the facility). Each additional unit of pollution emitted creates a benefit to the facility in terms of not having to use an expensive abatement technology or not having to forego production. These marginal benefits to the facility from emitting pollution, $MB(E)$, are declining until a point where they reach zero, as depicted in Figure 8 at E_0. With no private costs of generating pollution, the facility would choose to generate additional units of pollution up to E_0. But pollution also affects nearby households (and perhaps business too), in the form of increased health risks, unpleasant odors, and other disamenities. For simplicity, we assume that each additional unit of emissions inflicts a constant marginal external cost on local residents, $MEC(E)$.

Suppose further that local residents hold the relevant property rights, in the sense that they can veto polluting activities or accept them. Even if legislation does not explicitly recognize this right, local residents may be able to assert it through torte law, zoning laws, holding up permitting processes, political protest, and so forth. In the absence of any sort of compensation, local residents would prefer that the facility release no emissions. From a

Coasean perspective, however, they would be willing to accept payments greater than or equal to *MEC*(*E*) per unit of pollution. For example, for E^* units they would accept payments greater than or equal to area B in Figure 8. Meanwhile, the polluter will be willing to pay the residents up to A+B for the right to generate E^*. This creates the opportunity for trade, maximizing social surplus at E^*, with a division of the Coasean surplus (area A) in some fashion between the two parties, according to their relative bargaining power. Such payments may be cash transfers, or they may take the form of local jobs, investments in parks and community centers, and so forth.

Note that polluters have an incentive to locate where *MEC* (and, therefore, willingness-to-accept compensation of local residents) is low, so as to lower their required compensation payments (area B). A lower *MEC* is also compatible with a higher efficient level of pollution. *MEC* might be low for two reasons. First, the location may be remote, with fewer people, so that total injuries are lower. Second, local residents' willingnesses-to-accept compensation for injuries may be lower. In either case, Coasean bargaining theory would treat this incentive as one leading to economic efficiency. However, this latter incentive might also give rise to environmental justice correlations (Hamilton 1995). It is likely to be poorer or minority households who have a lower willingness to accept compensation, perhaps because they have a high marginal utility of income and prioritize consumption of other important goods. Note that this is the same dynamic we saw at play in Tiebout sorting.

Implications

As with the Tiebout mechanism, the model of Coasean bargaining suggests that the observed distribution of pollution is efficient—given the distribution of income. Likewise, it also shifts the locus of injustice back to inequality in the underlying distribution of income and wealth. However, in the Coasean case, the environmental resource is a valuable asset, and its allocation itself represents part of the distribution of wealth. Combining Coasean insights with the insights of the environmental justice movement, there would be important justice arguments for allocating the right to the environment to local communities.

If allocated those rights, local communities could then keep the right to be free of polluting facilities, or negotiate with polluters, as they saw fit. If they have full information and full power to bargain (admittedly big "ifs"), they cannot be worse off if they allow polluting facilities to operate. That is, in the Coasean case, such pollution not only would be efficient in the sense of a *potential* Pareto improvement, but in the sense of a *strict* Pareto improvement. Both sides are made better off by the exchange. This observation highlights one potential area of tension in the understanding of environmental justice. While in many cases a focus on equity of exposure to pollution (a kind of distributive justice) and a focus on the ability to participate in decision-making (procedural justice) run together, they do not always. Full sovereignty justice entails sovereignty over environmental decisions, and thus the right to accept polluting firms as well as to reject them (Cole and Foster 2001).

This raises the obvious question of why, then, there is an environmental justice movement protesting pollution sitings. Presumably, disadvantaged groups are bearing the brunt of pollution exposure but are not receiving the compensating benefits of such Coasean bargains. Why not? One possibility, of course, is that local communities do not have the property right. Firms, instead, may be given the right to pollute by legislation or the courts. A more nuanced version of this possibility is that the rights are somewhat ambiguous, and environmental justice communities may have difficulty asserting or claiming a right through political action or exploiting channels such as zoning and permitting processes (Hamilton 1995). Less access to the corridors of power, less formal education, language barriers, and other such disadvantages may limit their understanding of what is possible or their ability to exploit it.

By the same token, even if they were in a legally mandated position to negotiate, because of these disadvantages, environmental justice communities may not be able to negotiate as well as other firms or other communities. They also may have more difficulty overcoming the free rider problem on their side of the negotiation: whereas the benefits of polluting are a concentrated interest for one firm, the costs of polluting are dispersed among residents. As a consequence, environmental justice communities, when in negotiations, may end up systematically with a small share of the Coasean surplus. If they are uninformed about the full extent of pollution or its full harm, they might even obtain less than their damages (area B), acting as if $MEC(E)$ were lower than its true value. Reasoning back from such outcomes, this would further undermine their incentive for overcoming the obstacles to assert property rights in the first place. It also would tend to steer firms to those areas.

Stepping back, we might ask what it even means to allocate rights to local communities, and who speaks for the community in negotiations. In some cases, community organizations may assert rights, in the ways discussed above. In other cases, it may be a case of a local government, such as a county, acting on behalf of its citizens. While local governments are more likely to understand and represent local interests than higher levels of government, these scenarios raise potential agency problems, in which those bargaining on behalf of victims are not actually those bearing the costs of the pollution. The marginal cost to victims of another unit of pollution may actually be $MEC(E)$, but the cost internalized by decision makers may be something lower, leading to more pollution and less compensation.

Evidence

Such themes seem to have been illustrated by the case of Kettleman City, California, described in Cole and Foster (2001). In 1988, a waste management firm proposed building a toxic waste incinerator at a nearby dump site. Located in the San Juaquin Valley, Kettleman City was 90% Hispanic, with 40% of residents speaking no English. Through inadequate provision of public notice, the begrudging provision of translators at public meetings, and the scheduling of those meetings in difficult-to-reach locations, it was clear that information asymmetries were part of a strategy to inhibit local participation. Despite vigorous protests from the residents of Kettleman City, Kings County initially approved the deal. The county was to receive $7 million annually from the deal, but these benefits were spread over a 1,400 square mile rural county, with a very different demographic, while the environmental injuries were concentrated in Kettleman City.

The Kettleman City example demonstrates how political economy problems can overcome Coasean forces even at the county level. Such forces may be even stronger at the state level. The Cerrell Report (Cerrell Associates 1984) provides an infamous example of an effort to direct the siting of polluting facilities towards communities that would be ineffective bargainers. A consulting report requested by the California Waste Management Board, a state agency, the report identified characteristics of local communities that would not protest the location of waste sites in their area – in particular, people without a college education, low income, Catholic, and "not involved in voluntary associations." Additionally, one might view the case of Flint as a breakdown of efficient Coasean bargaining. Local preferences were ignored in what were essentially negotiations over local water source and resulting pollution, and were replaced with those of Michigan’s Treasury Department.

Vissing and Timmins (2017) provide a more recent example of information asymmetries in Coasean bargaining. They examine the contents of leases signed between shale gas operators and households in Tarrant County, Texas for the rights to extract natural gas. The terms of these leases dictate both payments in the form of royalty compensation and protective clauses designed to reduce health and environmental risks from the extraction process. After conditioning on income, Vissing and Timmins find that black homeowners are less likely than whites to have any of the protective clauses, and are more likely to receive a smaller lease payment. Hispanics, interestingly, are as likely as non-Hispanic whites to have protective clauses and a similarly high royalty payment *unless* they reside in a census tract where households tend to be linguistically isolated – the latter suggesting a form of information asymmetry in the bargaining process.

Aside from these failures, there is some limited evidence of Coasean logic at work. Coasean dynamics appear to take place in the form of host fees collected by neighborhoods near landfills. Jenkins, Maguire, and Morgan (2004) find that citizen participation in host fee negotiations leads to greater host compensation. Similarly, Hamilton (1993, 1995) finds that communities with lower voter turnout were more likely to see local firms expand their processing of hazardous wastes.

3.4. Political Economy and Government

Much of our discussion in this section already has focused on the role of government and its ability to tip the scale one way or the other as households search for residential options or engage in bargaining with polluters. More generally, there are a number of ways governments can affect the distribution of pollution, including legislation, bureaucratic monitoring and enforcement patterns, and court enforcement patterns.

Regulators must choose how to allocate the policy tools at their disposal, prioritizing regulation and remediation across various sites in the face of resource and time constraints. They may make decisions based on technical factors (e.g., size of operating facility, hazardousness of processed materials, potential risks to surrounding neighborhood), polluter factors (e.g., polluter's ability to pay, polluter's violation history, polluter's negotiation/bargaining power), and on the preferences of interest groups that may "capture" the regulatory process. This raises the possibility that the application of pollution regulation could be a source of inequitable exposure to environmental nuisances. According to Becker (1983), households with the highest willingness to pay for avoiding pollution, combined with the greatest ease and ability to influence government, will exert the most pressure on government agencies. Thus, as with Coasean bargaining, differences in the ability to organize, be heard, or be pivotal to government officials can drive different degrees of influence.

There are compelling examples of such patterns at work. Some of the most (in)famous environmental justice cases include government involvement, including the Warren County and Kettleman City examples discussed previously. Another example is the construction of the Genesee Incinerator and Power Station in Flint, MI in 1991. In this case, the Michigan Department of Environmental Quality was accused of taking a lax stance towards the regulation of lead in wood debris that was to be burned at the site, in addition to ignoring the cumulative impact of multiple pollution sources on the community (Dawson 2001; Ward 2013). More recently, of course, insult was added to injury with the more severe contamination of Flint's drinking water.

Evidence

Lavelle and Coyle (1992) examined a large number of U.S. environmental lawsuits, concluding that polluters in areas with larger minority populations faced lower penalties than those in white areas. They also found that, in minority areas, cleanup times were longer and cleanup solutions were less stringent. Others have gone on to study the application of regulation and other pollution policies. For example, Jenkins and Maguire (2012) study the application of hazardous and solid disposal fees levied by states, testing whether racial makeup affects tax rates. Controlling for multiple factors, they find that race does not appear to have an independent effect.

Turning to the executive branch, Gray and Shadbegian (2004) and Shadbegian and Gray (2012) similarly study the determinants of regulatory stringency in communities near polluting facilities, with a focus on the application of penalties and the frequency of inspections. They find measures of the potential for collective action are important determinants of enforcement activities, but also show that race does not have an independent effect and that the effect of income is mixed. Finally, Viscusi and Hamilton (1999) examine remediation activities, focusing on the choice of post clean-up standards. Specifically, they ask whether risk perceptions and political factors divert regulators from choosing the social-welfare maximizing values of cancer risk target (after remediation) and cost per cancer case averted. The authors find, perhaps surprisingly, that higher minority percentages lead to *stricter* risk targets. The same is also true (less surprisingly) of greater potential for collective action. Income and minority percentage do not appear to affect the cost per cancer case avoided, but voter turnout (a proxy for collective action) does.

4. Policy Responses

In this section, we briefly consider possible policy remedies for relieving environmental injustices, given the evidence about the mechanisms discussed above.

Inclusive Decision-Making

A first, simple step would be to ensure local communities have a seat at the table. Warren County, Kettleman City, and Flint are all cases in point demonstrating that this is not the default. Regardless of the mechanism through which inequitable exposure arises, inclusive decision-making is necessary for the voices of local communities to be heard and respected. Together with providing access to productive inputs, such as legal expertise to ensure that property rights lie with the community, these allow disadvantaged communities to effectively bargain based on their preferences. While equity in exposure may not necessarily follow, addressing these inadequacies in participation gives disadvantaged groups sovereignty over pollution exposure, which enables them to more effectively bargain in the Coasean process.

Offsetting, People-Based Investments

Fairness in participation can only achieve so much if the driver of inequitable exposure is ultimately income inequality. In fact, given the distribution of income, it can even highlight and exacerbate inequitable exposure. Moreover, gentrifying forces may undermine the original intention of various place-based environmental remediation efforts. Place-based policies that can offset some of the detrimental impacts of environmental gentrification on renters include subsidized production of affordable housing units, inclusionary zoning ordinances, tax-increment financing, and housing trust funds. Similarly, policies can encourage retention of affordable units (e.g., rent control, federally subsidized affordable housing). Still, since EJ populations are unlikely to own their residences, a combination of sorting or multiplier effects could still increase displacement and potentially leave the intended beneficiaries of a policy worse off.

For these reasons, people-based investments may be more fruitful in both enhancing procedural justice and reducing inequitable exposure. Most directly, targeted environmental education can increase access to information about hazards, allowing for more informed decision-making. Additionally, it could enable more efficient Coasean bargaining if disadvantaged groups can express the true marginal external costs of the burden they shoulder. Other person-based policies can help residents build assets (e.g., individual development accounts, homeownership education and counseling, community land trusts, limited equity housing co-ops, location efficient mortgages, and Section 8 homeownership). Not only do these counteract the negative aspects of environmental gentrification, they directly address the issue of ability to pay given preferences.

With the source of injustice coming more generally from income inequality, and in light of the evidence on sorting, other interventions (e.g., the Supplemental Feeding Program for Women, Infants and Children, Earned Income Tax Credit) that redistribute income or aid in the production of human capital would also eventually feed back to affect environmental inequities. These policies work to reduce *in utero* and neo-natal exposure to pollution, improving the circumstances that children are born into and thereby mitigating inequality at birth and the transfer of poverty, poor health and inequitable exposure across generations.

Incorporating EJ Concerns into Cost-Benefit Analysis (CBA)

The various channels through which inequitable exposure arises suggest that there are multiple policy levers that can mitigate inequality in well-being. The difficulty lies in choosing among alternative policy options. Current EPA practices to incorporate EJ concerns into its rule-making have focused (though not exclusively) on assessing the distribution of health risks and benefits, and use a constant willingness-to-pay (WTP) for all demographic groups to aggregate and compare different outcomes (CBA guidance 2014; EJ guidance 2016).

However, greater consideration is warranted of, the distribution of costs, both direct and indirect, which affect *net* benefits. For example, it is important to consider whether one group disproportionately shoulders the costs of financing a project (Banzhaf 2011). Furthermore, attention to multiplier effects functioning through land or labor markets (e.g., rising rental prices or job creation) may render a policy more (or less) costly and can drastically alter the distribution of *net* benefits.

That distribution of net benefits has generally been secondary to aggregate net benefits in policy evaluation is justified based on the grounds that the winners from a policy could compensate the losers. However, the logic of a *potential* (vs. actual) Pareto test presumes the same group will not consistently be the loser (and so will eventually be the winner and get compensated). The EJ literature, however, suggests this might not be the case. Since compensation in this form has been rare in practice, rulemaking should reflect the distribution of net benefits. CBA could incorporate distributional weights with differentiated WTP.

If our society has ethical preferences relating to distribution, then incorporation of distributional weights into cost-benefit analysis would give regulators a systematic way to implement these preferences and choose policies that improve upon equity (Adler 2016). Moreover, distributional weights would alleviate the concern that using heterogeneous WTP will bias rulemaking to benefit one group over another (Banzhaf 2011). These would help to better incorporate EJ concerns into rulemaking.

5. Conclusions

We conclude with a few observations. First, while the history of the environmental justice movement dates back more than thirty years, disproportionate pollution exposures continue today. Flint is just the highest profile case, but there are many other examples. Second, the mechanisms underlying these disproportionate outcomes are based on economic models, with Tiebout and Coase playing prominent roles in this discussion. Armed with models of residential location and firm entry/siting decisions, economists are in a unique position to contribute to the discussion of "why" environmental injustice arises. With its focus on causal identification, economics can help answer the "chicken v. egg" question of which came first. Finally, economics offers a theory for social welfare analysis that permits a more nuanced evaluation of policy.

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Table 1: Spatial Scale

	(1)	(2)	(3)	(4)	(5)	(6)
Exposure Definition:	*Unit-Coincidence*			*Distance-Based*		
Spatial Scale:	*State*	*County*	*Tract*	*State*	*County*	*Tract*
Percent Black	0.0319	0.0178	-0.00669***	-0.0362	0.0112	0.0238***
	(0.0433)	(0.0166)	(0.00110)	(0.0491)	(0.0102)	(0.00414)
Percent Hispanic	0.139*	-0.0487**	-0.0115***	-0.131	-0.0113	0.0282***
	(0.0749)	(0.0192)	(0.00165)	(0.0850)	(0.00918)	(0.0101)
Median HH Income	4.85e-05	7.92e-05***	-5.58e-06***	-0.000228*	-2.03e-05	-4.51e-05***
	(0.000112)	(2.03e-05)	(1.87e-06)	(0.000128)	(1.89e-05)	(5.48e-06)
Percent Urban	-0.0156	0.0926***	0.00150	0.126**	0.0260***	0.0545***
	(0.0417)	(0.00657)	(0.00143)	(0.0473)	(0.00603)	(0.00266)
Percent Manufacturing	0.127	0.197***	0.0840***	0.129	0.0518***	0.100***
	(0.0898)	(0.0273)	(0.00884)	(0.102)	(0.0166)	(0.0134)
Percent Bachelor +	-0.257*	-0.0435*	-0.0161***	0.276*	0.0443***	0.00310
	(0.134)	(0.0219)	(0.00205)	(0.152)	(0.0126)	(0.00608)
Observations	51	3,141	64,931	51	3,141	64,931
R-squared	0.236	0.442	0.077	0.218	0.162	0.302

Note: The dependent variable for all regressions is the log(total onsite release). All regressions include State-level fixed effects where possible. The geographic scope (i.e. sample) for all regressions is the continental US. Standard errors in parentheses and clustered at the State-level.

*** p<0.01, ** p<0.05, * p<0.1.

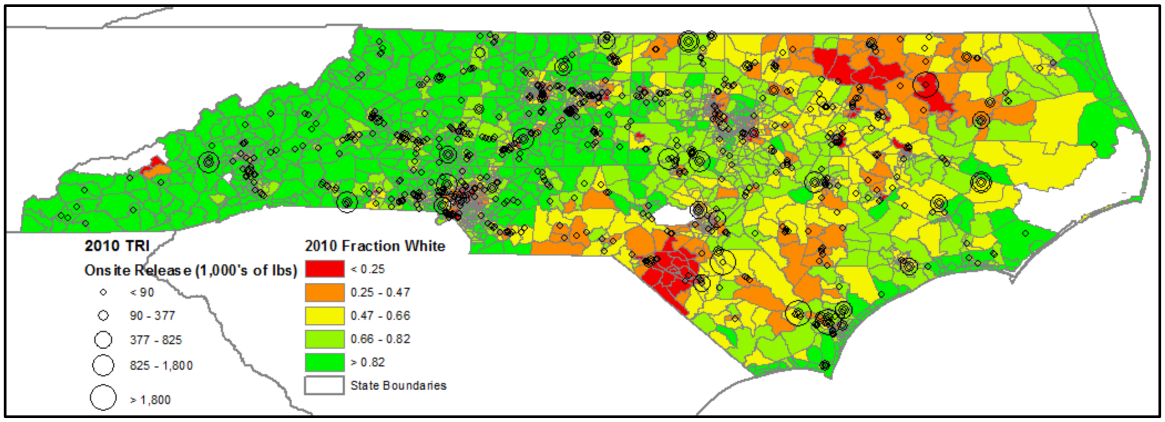

Figure 1. TRI Onsite Release and Fraction Non-Hispanic White

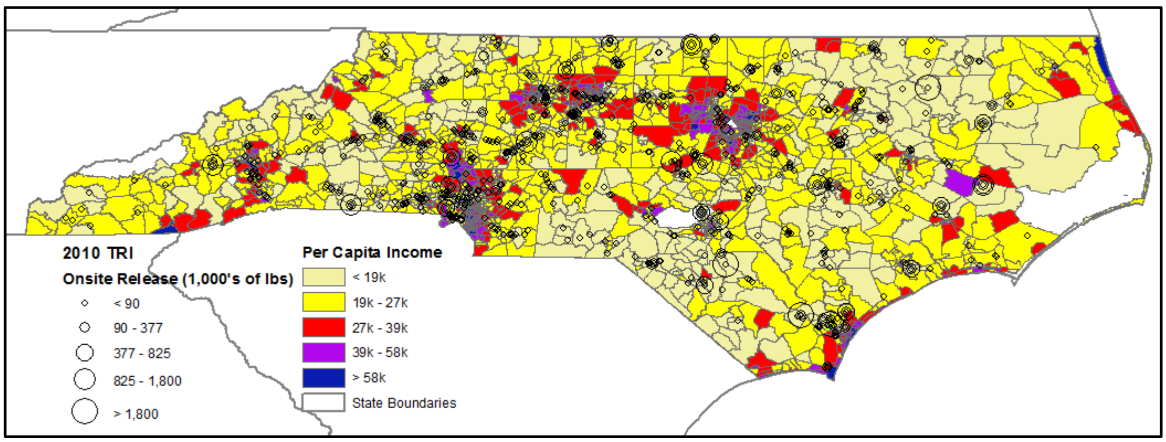

Figure 2. TRI Onsite Release and Per Capita Income

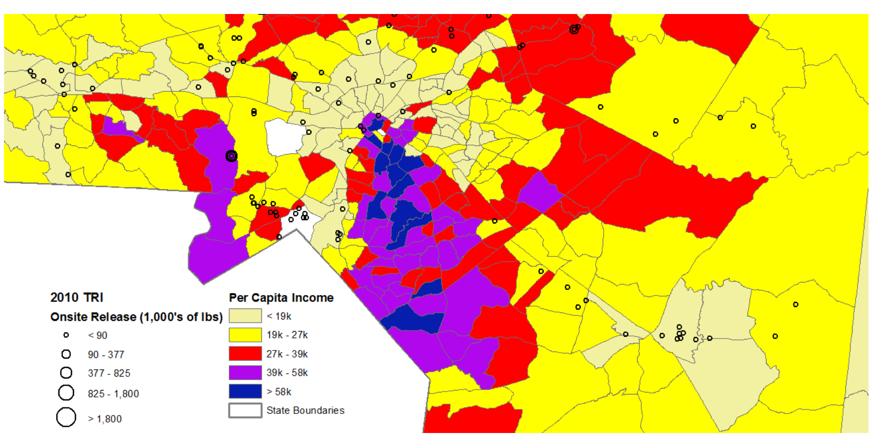

Figure 3. TRI Onsite Release and Per Capita Income (Zoomed)

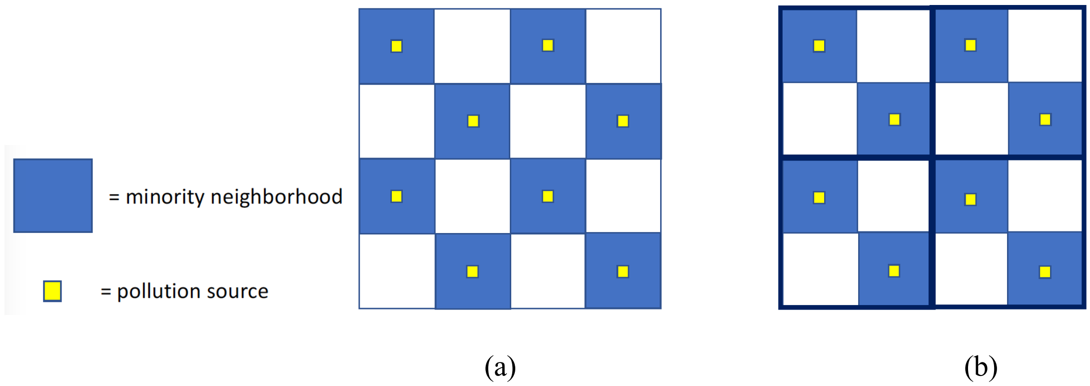

Figure 4. Ecological Fallacy

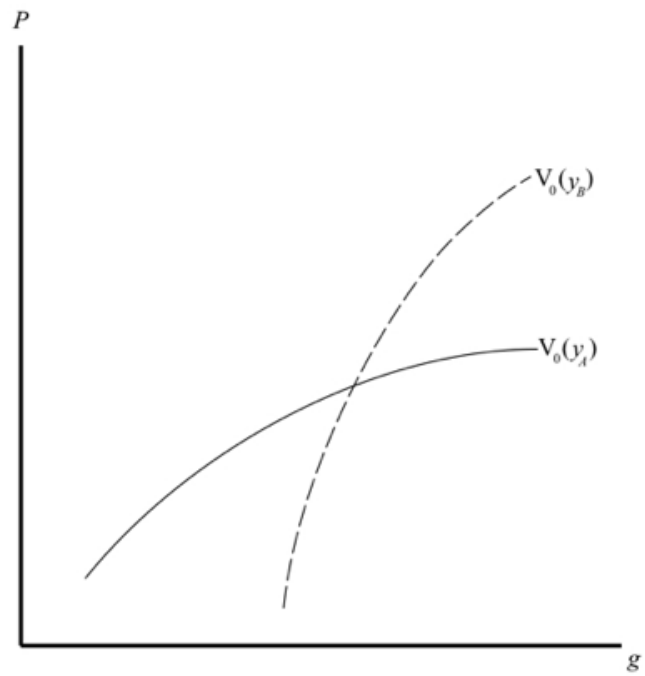

Figure 5. Single Crossing in Preferences

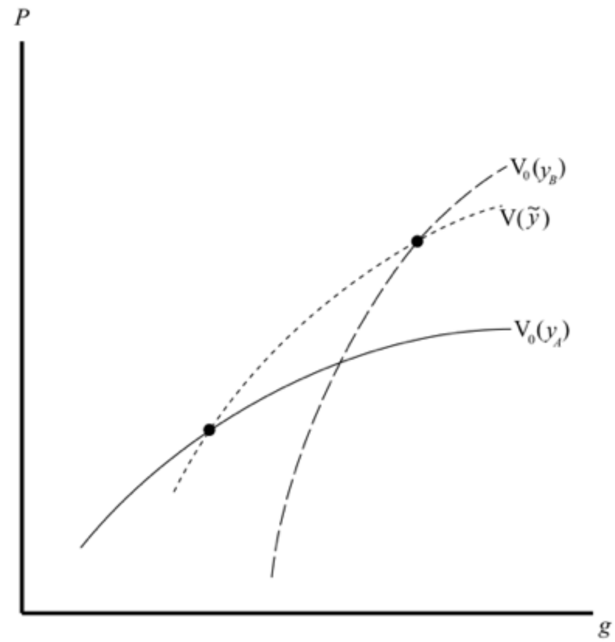

Figure 6. Boundary Indifference

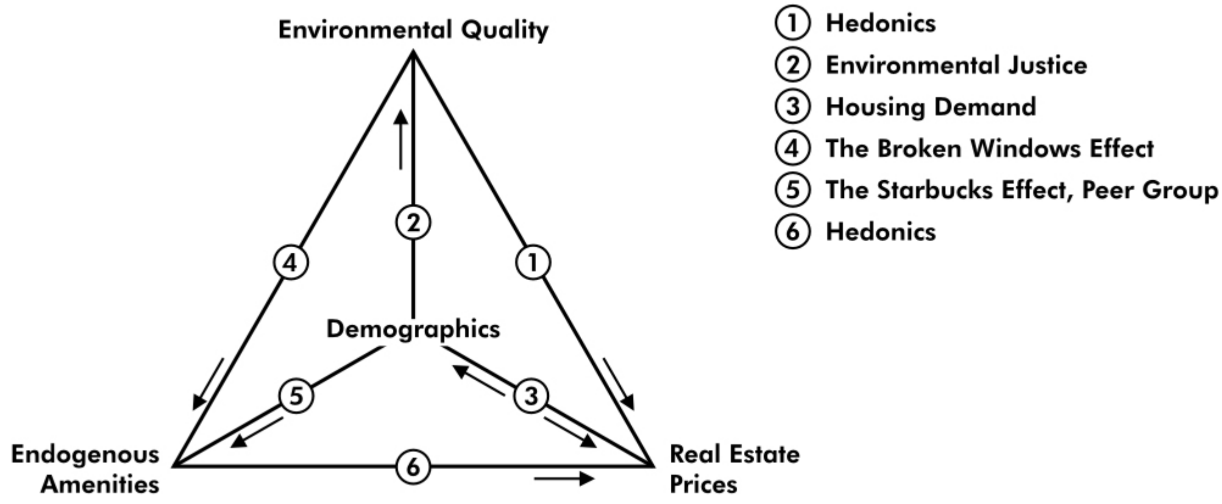

Figure 7. Pyramid of Environmental Gentrification

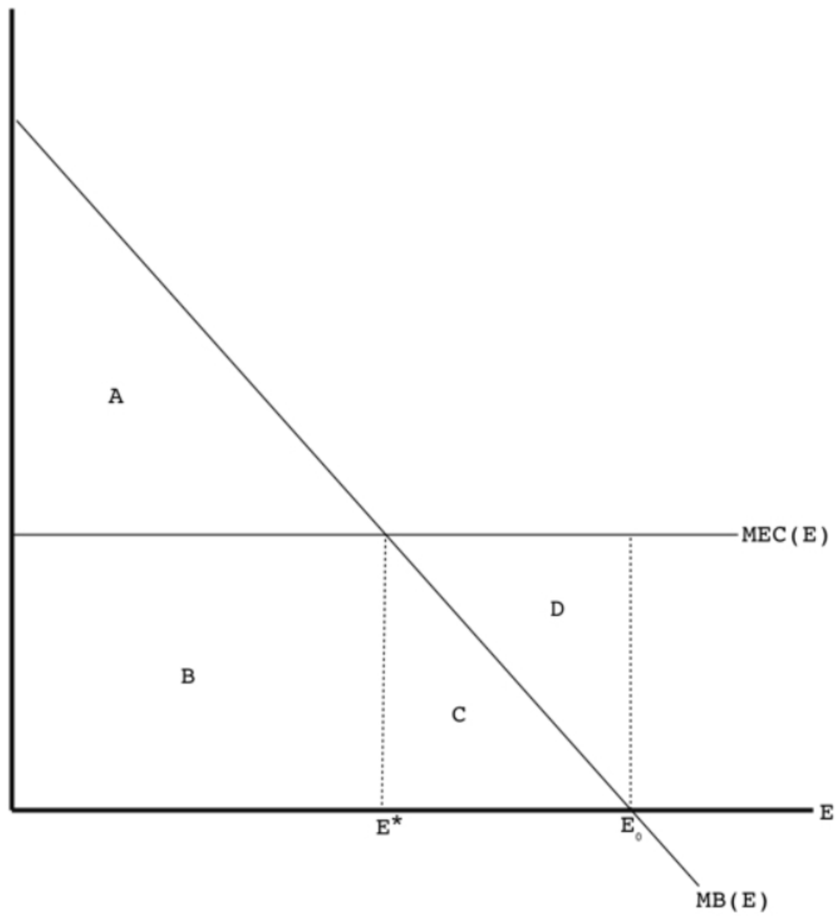

Figure 8: Pollution in the absence of a Coasean bargain