THE ROLE OF LOCATION COST CONSIDERATIONS OF FIRMS ON WATER POLLUTION

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Abstract. Environmental justice scholars have found correlation between poverty, race, and the distribution of environmental pollution. Hypotheses that have been used to explain the correlation includes; the location cost considerations of firms, pure discrimination, and the migratory responses of people to pollution. This study examines the role of location cost considerations of firms on water pollution. The hypothesis is that firms locate their pollution-generating facilities based on economic factors that maximize their profits, and because those factors are correlated with income and race, the poor and minorities are disproportionately affected. Secondary data was collected at the census tract level on input, transportation, and socioeconomic factors that relate to firm location costs. Using logistic regression, results show that land and transportation costs, the quality of labor, political participation, and a high percent of Blacks, Asians and Foreign-Born population in a community have statistically significant influence on the location choice of water polluting firms. However, contrary to environmental justice predictions, a higher percent of Blacks and Asians reduce rather than increase the likelihood of a polluting firms to locate in a community. Socioeconomic factors such as the level of income and poverty, as well as the rurality of a community have no impact on the location choice of polluting firms in this study. Although future research that uses multiple cross-sections rather than a single-cross section may find differing results, the implication of the findings in this study is that policies that increase quality education and political participation in communities are potentially effective policy strategies to remedy environmental injustices. Also, the findings confirm that water pollution is in fact a part of the environmental justice discourse and that disproportionate pollution is not limited to land and air pollution.

INTRODUCTION

Considerable number of environmental justice research has found that poor and minority households are disproportionately affected by environmental pollution. These households live in more polluted areas than others (Bullard, 1983; Goldman, 1994; Agyeman, 2005; Brulle and Pellow, 2006; Mohai, Pellow, and Roberts, 2009; Banzhaf, 2011). Politically uninvolved individuals have also been added to the list of those disproportionately affected by pollution (Capria, 2013). Given the various statistically supported research findings, this paper seeks to understand the factors contributing to such unequal distribution. Rather than focusing only on 'what is', the paper seeks to understand 'why' such correlations exist. Understanding the contributing factors to a problem is the first step to solving the problem. It helps to focus policy solutions on the real problem rather than the symptoms.

Using economic theories, Hamilton (1995) offer three hypotheses for why exposure to environmental risks may vary by race and income: pure discrimination by polluters in their siting decisions; differences in willingness to pay for environmental amenities; and variations in the propensity of communities to engage in collective action. Banzhaf (2011) expanded these hypotheses and put them in 5 categories: pure discrimination; cost efficiency considerations of firms; coming to the nuisance; Coasian bargaining; and collective action. According to Banzhaf (2011), these five hypotheses are not mutually exclusive. Pure discrimination occurs when firms choose to locate their polluting facilities to disfavor or discriminate against certain populations. For example, a firm that values the welfare of whites than those of minorities, will locate its polluting facility in communities where a greater number of minorities live. Similarly, the location cost efficiency hypothesis assumes that a profit-maximizing firm will locate its polluting facility in a low-income neighborhood if it is more cost efficient than locating in a higher-income neighborhood.

The idea that disproportionate pollution among groups is a result of migration rather than discrimination is what Banzhaf (2011) tagged "coming to the nuisance". The logic of the hypothesis here is that when pollution occurs in a community, residents will find it undesirable, and because this community is no longer desirable, demand for real estate in the community will fall, so also will the value for real estate fall. The poor, being unwilling (and unable) to pay higher housing costs required to obtain a cleaner environment are the most likely to remain, or even to move into the polluted areas. "Coming to the nuisance" hypothesis assumes that low-income and minority populations moved to polluted communities after polluting facilities had been sited. Following Coase theorem, the Coasian bargaining hypothesis assumes that polluting facilities locate in communities that are willing to accept the smallest compensation in return for allowing the facility to be sited nearby (Hamilton, 1995; Banzhaf, 2011). Lastly, the collective action hypothesis holds that

firms are less likely to locate their polluting facilities in communities that engage in collective action. This paper examines the role of location cost considerations of firms on disproportionate water pollution. It seeks to identify the relationship between the cost factors that firms consider in their location decisions and where they choose to locate in Georgia.

LITERATURE REVIEW

Defining Environmental Justice

Environmental justice has been viewed from different lenses. While some scholars and agencies define it in terms of distributive justice, others define it in terms of procedural justice. According to Schlosberg (2009), the concept of justice proceeded from the theories of John Rawls where justice is conceptualized in terms of the distribution of goods in a society, and the best principles by which to distribute those goods. Any activity or decision that violates the distributive principles of Rawls therefore is regarded as unjust. However, Schlosberg (2009) agreed that environmental justice movements use a wide range of conceptions of justice beyond Rawl's distributional theory. These include; capability theory (Sen, 2009) and procedural theory. The capability theory of Amatyr Sen focuses on the capacities necessary for individuals to fully function in their chosen lives. It goes beyond the distribution of goods to how the goods are transformed into the flourishing of individuals and communities. According to Sen's capability justice, any action or decision that limits the flourishing or the capability of individuals and communities is unjust. On the other hand, procedural justice emphasizes the level of participation in the decision about the distribution of goods in a society.

The U.S. Environmental Protection Agency (EPA) views environmental justice as procedural justice. It defines environmental justice as the "fair treatment and meaningful involvement of all people regardless of race, color, culture, national origin, income, and educational levels with respect to the development, implementation, and enforcement of protective environmental laws, regulations, and policies" (EPA, 2010). Nonetheless, the three theories of justice are intertwined. Participation could influence distribution which in turn can influence capability. For example, by stating that the goal of environmental justice will be achieved when people enjoy the same degree of protection from environmental and health hazards (distribution), and when they have equal access to the decision-making process about healthy environment (participation), the EPA seem to understand the interrelationship between distributive and procedural justice. For this study therefore, environmental justice is understood as distributive, capability, and procedural justice.

Water Pollution and Environmental Justice in Georgia

Georgia, alongside other southeastern states like Tennessee, Houston, and North Carolina, are considered the source and the heart of both the civil rights movement and the grassroot environmental justice movement (Bullard, 1994; Hollifield, 2004). According to Bullard (1994), Dr. Martin Luther King Jr. went to Memphis in 1968 on an environmental and economic justice mission, seeking support for striking garbage workers who were underpaid and whose basic duties exposed them to dangerous environmentally hazardous conditions (pp. 2). Georgia has however received scant academic research on environmental justice concerns, especially as it relates to water pollution.

The US Census Bureau estimates that 32.2% of the population of Georgia identify as "Black or African American alone" in 2018. This percentage is above the national average of 13.4%. Also, 14.9% of the population are in poverty (about 3% higher than the national average of persons in poverty). If race and income are significant variables in environmental justice analysis as sizable research has found, Georgia like other southeastern states is of important interest in environmental justice research. Although extensive research has been done on water pollution in various areas and water bodies in Georgia, none (to the knowledge of this study) relates to the core distributional issues of environmental justice. Also, for the few environmental justice studies in the state, none has thus far examined the role of location cost consideration of firms on pollution in Georgia.

Firm Location Choice and Environmental Justice

Exploring the distribution of solid waste sites in Houston, Bullard (1983) found that 80% of the incinerators in the city, 66.7% of the mini-incinerators, and 100% of the city landfills were in predominantly black neighborhoods. Prompted by the 1982 Warren County sit-in protests, the United States General Accounting Office (GAO) conducted a study using the 1980 Census data. It found that three out of four hazardous waste landfills examined were in communities where African Americans made up at least twenty-six percent of the population, and whose family incomes were below the poverty level.

The United Church of Christ (1987) in its national report on toxic wastes and race also found evidence of disproportionate location of toxic waste sites. Goldman (1994) examined sixty-four studies on environmental disparities that focused on exposure to various kinds of environmental pollution. Sixty-three of the studies found environmental disparity either by race or income. In Goldman's review, race was a more common discriminating factor across the studies than is income. Using census tract-level data however, Anderton, Anderson, Oakes and Fraser (1994) reached a strikingly different conclusion. Their results show no statistically

significant differences between the racial or ethnic composition of tracts which contain commercial hazardous wastes. This made them conclude that race is not a factor in siting decisions, and that some race correlation found by other researchers may be a function of income.

Downey and Hawkins (2008) studied the question of race and found that Black, White, and Hispanic households with similar incomes live in neighborhoods of dissimilar environmental quality. In addition, they found that the association between household income levels and neighborhood hazard levels varies according to neighborhood and household racial composition. In other words, increases in neighborhood and household income levels are more strongly associated with declining hazard levels in black neighborhoods and households than in white neighborhoods and households.

Although these studies found evidence of unequal environmental risks by race and income, more recent studies have found more nuanced results. According to Wolverton (2009), many of the studies that found evidence of racial and income discrimination in location choices only consider contemporary socio-economic characteristics rather than matching their analysis to the socioeconomic characteristics at the time of siting. Wolverton reviewed other studies that considered the correlation between socioeconomic characteristics and the location of polluting facilities at time of sitting and concluded that the evidence is mixed.

For example, Been (1994) who revisited the Bullard and GAO studies determined that some of the socio-economic correlation with pollution in Bullard's study developed after the siting of facilities while the GAO data still showed evidence of environmental inequity at the time of siting. Downey, Dubois, Hawkins, and Walker (2008) also found that residential segregation and racial income inequality are relatively poor predictors of environmental inequality outcomes.

Besides matching environmental justice analysis to socioeconomic characteristics at the time of siting, most environmental justice research on firm location also often leave out traditional cost and production factors that impact location choice of firms (Wolverton, 2009). Examining the location decisions of manufacturing plants in Texas, Wolverton (2009) married both socioeconomic factors emphasized in environmental justice literature and the cost factors considered in traditional firm location cost analysis. He found some evidence supporting the hypothesis of firm location cost considerations in environmental justice.

This study extends the combination of socioeconomic and traditional input factor analysis to the state of Georgia, testing the hypothesis that firm location cost considerations contribute to the unequal distribution of environmental quality.

FIRM LOCATION THEORY

Economic theory holds that a profit maximizing firm will make such decisions that minimize its costs and maximize its profit. The decision on where to locate is no different. Firms consider factors like access to inexpensive land, availability of low-wage labor, access to transportation networks and to other firms in their supply chain in location decisions (Banzhaf, 2011). Polluting firms also consider local regulatory zoning criteria and public opinion (Walsh and O'Leary, 2002). Following firm location theory, firms are assumed to locate their pollution-generating facilities based on economic factors that maximize their profits. The economic factors considered by firms are however correlated with demographics (Hamilton, 1995).

In testing the hypothesis of location cost impacts in environmental justice, Wolverton (2009) considered traditional production and transportation costs like land and labor costs, the quality of labor, distance to rail, energy costs, level of taxation, and average plant size. He also analyzed other socioeconomic factors that have a cost effect on firms. These include proximity of a firm to an interstate highway, degree of urbanization, and the presence of pre-existing TRI plants in a neighborhood. According to Wolverton (2009), the pre-existing sites may indicate to a firm how much it can pollute if it also locates, and may proxy for factors such as zoning restrictions, or serve as an indication of agglomeration economies (pp. 4).

RESEARCH METHODOLOGY

To analyze the research question, secondary data on pollution levels and on cost factors that firms consider in locating their polluting facilities were collected. Census tracts in Georgia are the unit of analysis. The paper collected a single-cross section data for the year 2000 on input, transportation, and socioeconomic factors that relate to firm location costs which are the independent variables. The input costs are land cost and labor costs in terms of the availability and the quality of labor. Land cost is measured by the median property value in a census tract (PROPVALUE).

Availability of labor is measured by the percent of the population in labor force (PCTLABFORCE), and labor quality is measured by the percent of the population with high school degree or higher (PCTHIGHSCH). Transportation cost is measured by the distance of each census tract to the nearest transportation terminal (TRANSDIST).

The socioeconomic factors included are median income (MEDINCOME), percent of persons in a census tract living below the federal poverty line (PCTPOOR), the total population size (POPSIZE), the fraction of active voters in a census tract (PCTVOTER), and the percent of the population that are in major racial categories- White, Black, American Indian, Asian, Hawaiian (PCTWHITE,

PCTBLACK, PCTAMIND, PCTASIAN, PCTHAWAIIAN).

The percent of the population that are foreign born (PCTFOREIGN), as well as an indicator variable showing whether a census tract is predominantly urban or rural (URBAN) are also included as independent variables. Since the active voter data is only available at county level, the fraction of active voter in each census tract (PCTVOTER) is calculated by dividing the number of active voters in the county for which a census tract is located by the total number of active voters in the state and then multiplied by the population of each census tract. This variable is used as a measure of political participation or collective action.

The dependent variable (LOCATE) is a dichotomous variable showing whether a census tract hosts a facility that emits water pollutants. LOCATE is coded "1" if a census tract hosts at least one of such facilities, and "0" if it does not. The data was collected from various sources including the Toxic Release Inventory (TRI) database of the EPA, U.S census of population and housing, active voter database of the Georgia secretary of state office, and the Esri Geographic Information System database. Since the study seeks to know the impact of the cost and socioeconomic variables on the dichotomous dependent variable, a logistic regression is appropriate. The logistic regression model analyzed is as follows:

$$\boldsymbol{Log\ p/(1-p)} = b0 + b1*PROPVALUE + b2*PCTLABFORCE + b3*PCTHGHSCH + b4*TRANSDIST + b5*URBAN + b6*MEDINCOME + b7*PCTPOOR + b8*POPSIZE + b9*PCTWHITE + b10*PCTBLACK + b11*PCTAMIND + b12*PCTASIAN + b13*PCTHAWAIIAN + b14*PCTFOREIGN + b15*VOTER + \cup$$

Where p = probability (LOCATE=1). That is, p is the probability that a TRI facility will locate in a census tract. $\cup$ represents all other factors influencing location choice that is unexplained by this model.

RESULTS

Population size (POPSIZE), the quality of labor (PCTHIGHSCH), political participation (PCTVOTER), transportation costs (TRANSDIST) and percent of Asian population (PCTASIAN) have statistically significant effects on location choice of water polluting firms. From the sign of the significant coefficients (see table 1), holding other variables constant, higher population and higher transportation costs increase the likelihood that a polluting firm will locate.

The transportation cost effect is not consistent with firm location theory since higher transportation cost is expected to reduce rather than increase the likelihood to locate in a community. Higher quality of labor and political participation in a community, reduces the likelihood that polluting firms will locate in that community.

Table 1: Logistic regression results of input costs, transportation costs, and socioeconomic factors when regressed on location choice

Variable	Coef	Std Err	Signif	exp (B)
PROPVALUE	0.000	0.000	0.165	1.000
PCTLABFORCE	-0.008	0.010	0.443	0.992
PCTHIGHSCH	-0.027	0.009	0.002	0.973
TRANSDIST	0.000	0.000	0.010	1.000
URBAN	0.265	0.162	0.102	1.303
MEDINCOME	0.000	0.000	0.206	1.000
PCTPOOR	-0.014	0.010	0.162	0.986
PCTVOTER	-0.058	0.020	0.004	0.944
PCTWHITE	-0.006	0.030	0.847	0.994
PCTBLACK	-0.013	0.030	0.674	0.987
PCTAMIND	-0.034	0.150	0.822	0.967
PCTASIAN	-0.071	0.038	0.064	0.932
PCTHAWAIIAN	-0.075	0.366	0.837	0.928
PCTFOREIGN	0.022	0.023	0.347	1.022
POPSIZE	0.000	0.000	0.000	1.000
Constant	2.052	2.987	0.492	7.784

Table 2: Stepwise logistic regression of input costs, transportation costs, and socioeconomic factors when regressed on location choice

Variable	Coef	Std Err	Signif	exp (B)
PROPVALUE	0.000	0.000	0.026	1.000
PCTHIGHSCH	-0.025	0.007	0.000	0.975
TRANSDIST	0.000	0.000	0.014	1.000
PCTVOTER	-0.064	0.019	0.001	0.938
PCTBLACK	-0.005	0.003	0.061	0.995
PCTASIAN	-0.072	0.036	0.049	0.931
PCTFOREIGN	0.030	0.011	0.007	1.030
POPSIZE	0.000	0.000	0.000	1.000
Constant	0.461	0.498	0.354	1.586

This is consistent with many environmental justice research findings that communities with lower skilled workforce and low level of political participation are more burdened by environmental pollution.

On the other hand, the result in Table 1 show that communities with higher Asian population are less likely to attract polluters. This is not consistent with previous environmental justice findings that minorities are disproportionately affected by pollution. The population of other racial minorities in a community including Blacks, American Indians, and Hawaiians have no statistically significant impact on location choice in this study.

Even when backward stepwise logistic regression was done (Table 2) and the percent of Blacks, percent foreign born, and property value became significant, communities with higher percent of Black population are less (rather than more) likely to attract polluters. This again is inconsistent with environmental justice predictions. The location effect of property value is also inconsistent with

firm location theory hypothesis since higher land cost is expected to reduce the likelihood to locate rather than increase it.

In Table 2, result show that census tracts with higher percent of foreign-born population attract polluters. This is consistent with environmental justice predictions that certain minority groups are more burdened by pollution than other population.

CONCLUSIONS AND IMPLICATIONS FOR FUTURE RESEARCH

The study analyzed the role of location cost considerations of firms on the distribution of water pollution in Georgia. Traditional input (land and labor) and transportation costs related to firm location theory were examined. Socioeconomic factors that environmental justice scholars have hypothesized and often found to correlate with pollution were also examined. This includes income, poverty, collective action, race, percent of population who are foreign born and the level of urbanization of a community.

The costs and socioeconomic factors were regressed on the location choice of firms. While higher input and transportation costs in a community (census tract) were expected to reduce the likelihood of a community to host polluting firms, the expected relationship between the socioeconomic factors and location of polluting firm vary. According to environmental justice literature, low-income and minority communities are disproportionately affected by pollution. Given this, low-income communities, poor communities, and communities that have high percent of minority groups were expected to attract polluters. Results in this study is however mixed.

Contrary to expectation, higher land and transportation costs increase the likelihood that a community will host a water polluting facility. High percent of Blacks and Asians also reduces the likelihood that a community will host polluters. Consistent with environmental justice predictions however, high quality of labor and collective action reduces the likelihood that a community will host polluting firms, while high percent of foreign-born population increases the likelihood. Highly populated communities also attract polluters. The implication of the findings is that quality education that translates to quality labor as well as policies that encourage collective action or political participation may be effective policy strategies in reducing environmental injustices.

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