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DOES RACE MATTER? AN EXAMINATION OF A POLLUTING PLANT'S LOCATION DECISION

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1. Introduction

The 1982 protest of a polychlorinated biphenyl (PCB) disposal site in North Carolina focused national attention on the potential for disproportionate siting of waste facilities in poor and minority neighborhoods.[1] In the following decade, both federal and state-level governments have made environmental equity a priority. An Office of Environmental Justice was established by the U.S. Environmental Protection Agency (EPA) in 1992,[2] and an executive order was put in place in 1994 calling for the explicit consideration of disproportionate impacts on poor and minority populations of new federal actions.[3] Numerous state governments have also established agencies, offices, or departments dedicated to examining environmental justice issues. Between 1993 and 1998, 51 cases alleging environmental inequity against particular facilities had been filed with EPA.[4]

This increased awareness and attention on environmental justice issues by the government stems from the publication of two widely cited studies. The GAO (1983) published a study of four hazardous waste landfill sites, pointing out that these sites are surrounded by predominantly poor and minority communities. Likewise, the United Church of Christ (1987) studied U.S. commercial treatment, storage, and disposal facilities for hazardous waste (TSDFs) and found evidence of a disproportionate location pattern.[5] These studies, and many that followed, have argued that the correlation between waste facility location and poor and minority communities points to a disturbing trend of siting discrimination.

[1] See Godsil (1991).
[2] According to the Office of Environmental Justice at EPA, environmental justice exists when "no group of people, including racial, ethnic, or socioeconomic group, … bear[s] a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations."
[3] Executive Order 12898, entitled "Federal actions address Environmental Justice in minority populations and low-income populations," was issued by President Clinton in 1994.
[4] From the EPA web site: www.epa.gov
[5] The GAO study examine four offsite landfills in the U.S. and their surrounding populations at a fairly aggregate level. It finds that in three cases the majority of the nearby community is African American in 1980. The UCC study examines 415 U.S. hazardous waste sites at the zip code level. Using a difference of proportions test, race, household income, and property value are found to be significant in 1980.

Because these studies match current socioeconomic data to facility location, it is only possible to say that sites are disproportionately located in neighborhoods in which the current population is poor or minority. These studies do not allow one to discern whether the relationship between race, income, and site location existed at the time of siting, or if it developed over time. Current socioeconomic data do not accurately reflect a firm's possible location decision variables at the time of siting. To determine whether a firm took into account differences in race or income across neighborhoods in its location decision, the characteristics of the neighborhood at the time the siting decision was made are the most relevant.

Recent studies that match site location to current socioeconomic characteristics to explore the issue of environmental equity report mixed results.[6] Zimmerman (1993) finds that a greater percent of minorities live near inactive hazardous waste sites that appear on the National Priority List, but that the population living below the poverty rate does not differ significantly from the national average. Boer et. al (1997) find a significant and positive relationship between the location of hazardous waste TSDFs and race in Los Angeles, California. Sadd et.al. (1999) find little evidence of a correlation between the location of TRI plants and race in Los Angeles at the census tract level, but find evidence of a positive and significant relationship for tracts within 1 mile radius of the plant. Income is significant for both sets of regressions. Goldman and Fitton (1994) reexamine and update data analyzed in the United Church of Christ study. Examining the correlation between the location of commercial hazardous waste TSDFs and race, the authors conclude that "the disproportionate impacts first identified and documented in the 1987 report…have grown more severe." Both Anderton et. al (1994), and Davidson and Anderton (2000) find only limited evidence of disproportionate numbers of hazardous waste facilities in minority or poor neighborhoods.

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[6] A wide variety of analytical techniques are used in these studies, ranging from an examination of simple correlation coefficients and differences in means across samples to binary logit regressions.

There are a handful of studies that have examined the relationship between neighborhood characteristics and facility location decisions at the time of siting. Been (1994) reexamines site location data used by the GAO (1983) and Bullard (1983) studies,[7] properly matched to socioeconomic characteristics at the time of siting. Even without additional explanatory variables, Been obtains much more mixed evidence of environmental inequity at the time of siting than the original studies. The GAO data still demonstrate a case for disproportionate siting in minority communities, while the Bullard data indicate that at least part of the relationship developed after siting. Been and Gupta (1997), using a much large data set, also obtain mixed evidence for the hypothesis that race played a role in the siting of active commercial hazardous waste TSDFs in the U.S. While waste disposal sites are correlated with certain 1990 socioeconomic characteristics such as race and income, neither the percent poor nor the percent African-American in a neighborhood are significant factors at the time of siting. The percent Hispanic remains significant at the time of siting.[8] Baden and Coursey (2002) examine the location of CERCLIS sites in Chicago and find that sites were disproportionately located in poor neighborhoods in the 1960s but not in the 1990s. They find little evidence for disproportionate exposure of African Americans either currently or at the time of siting.

Lambert and Boerner (1995) examine TSDFs, landfills, and inactive hazardous waste sites in the St. Louis, Missouri area at the time of establishment in the context of changing socioeconomic dynamics. They do not find large initial differences in the percent of poor and minority residents between neighborhoods with and without waste sites. However, it appears that housing values grew less rapidly in neighborhoods with waste sites and that minority populations moved into these neighborhoods at a faster rate. Hersh (1995) conducts a historical analysis of the change in racial and industrial dynamics in the Pittsbugh area for firms reporting to the Toxic

[7] Bullard (1983) examined several landfill and incinerator sites in the Houston area and found that the vast majority of these sites are located in African-American neighborhoods.

Release Inventory (TRI). Hersh finds that, in general, industries and blue-collar neighborhoods located near each other for job-related reasons. Also, he notes that both white and rich residents took flight to cleaner parts of the city after firms located in a particular neighborhood, and that there was an eventual movement of minorities into more polluted areas. Krieg (1995) examines Superfund sites in and near Boston. He finds that race is associated with the number of waste sites in areas with a long history of industrial activity and that class is more closely associated with the number of waste sites in areas with more recent industrial activity.

In this paper, I match the plant to the neighborhood at the time of siting to examine whether community socioeconomic characteristics are related to facility location decisions. I examine the location decisions of plants that report to the Toxic Release Inventory (TRI) in Texas after 1975. These plants are typically larger polluters of toxic substances and therefore pose a potential health hazard to populations located nearby. While only manufacturing plants report to the TRI on approximately 330 toxic substances, this still allows for much more variability than is present in many previous studies. Texas also seems particularly relevant as a focus for several reasons. First, during the period of study it ranks second among U.S. states in both land area and population. Second, Texas had the second highest number of blacks and Hispanics living near uncontrolled hazardous waste sites in 1980 (UCC 1990).

This study differs from other environmental justice studies of plant location in several important ways. First, I use a conditional logit model to represent the choice of a particular location from a set of many neighborhoods. A firm is allowed to select a location for its plant from the actual location chosen and a given number of randomly selected alternatives drawn from the full choice set. Davidson and Anderton (2000), Been and Gupta (1999), Boer et. al (1997), and Anderton et. al (1994) all have used a binary response model to examine plant or waste site location. Binomial logit regression allows for the comparison of neighborhoods with plants or

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[8] One serious problem with the study is the limited sample size of the original data sets. The GAO study only has a sample size of four, while the Bullard study (after Been's adjustments) has a sample size of ten.

waste sites to neighborhoods without a plant or waste site. Conditional logit regression allows one to examine a firm's choice of plant location from a set of feasible options. Allowing for multiple location alternatives seems appropriate, since firms typically choose from a spectrum of competitive locations when deciding where to site a new plant or waste site. It also allows a plant to choose from neighborhoods that may already have another plant located there.

Second, I include a number of variables that are often left out of environmental justice studies but are included in other types of studies on firm location. Traditional location theory identifies differences in input costs as key determinants of firm location decisions. Most studies of new plant location include measures of labor costs, land costs, energy costs, and/or level of taxation.[9] A few environmental justice studies include variables to proxy for land and labor costs but rarely do they include any other variables associated with firm location. Kriesel et. al (1996), while focusing on the incidence of emissions rather than plant location, is one of the few exceptions. Along with land and labor costs, they include proximity to an interstate highway, and find that the inclusion of these factors renders the race and poverty variables insignificant. While several of industry location variables are unavailable for any years prior to 1990 and therefore not included in this study, I do include costs of land and labor, a measure of the quality of labor, the degree of urbanization, and a measure of average plant size in this study.

I also attempt to control for the effect of pre-existing TRI sites on plant location decisions. These pre-existing sites may indicate to the firm how much it can pollute if it also locates there or may serve as an indication of agglomeration economies. None of the previous environmental justice studies control for the possible effect of the existence older hazardous waste sites in the neighborhood.

Finally, I consider the possible effect of the collective action of a neighborhood on a plant's location decision. Neighborhoods that are less likely or able to express opposition through

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As Been correctly points out, however, her research does effectively illustrate gaps in the literature.

political or community action are posited to require less potential compensation to offset the effects of polluting activities. Hamilton (1995), using voter participation data, finds that firms do take into account the likelihood of a neighborhood to engage in collective action when deciding whether to expand waste facilities. Likewise, Arora and Cason (1998) substitute variables representing a population's stake in the neighborhood for voter participation and find several of these variables to be significant. It stands to reason that such considerations would be equally relevant to a firm's initial decision of where to locate a new plant.

When the locations of TRI plants for Texas are matched only to current socioeconomic characteristics results are broadly consistent with those of many previous studies and with what the environmental justice literature predicts. Race is significant and positively related to plant location, while income is significant and negatively related to plant location. Poverty is either insignificant or of the opposite sign of what the environmental justice literature would predict.

When plant location is matched to socioeconomic characteristics at the time of siting, empirical results suggest that, contrary to results cited in the environmental justice literature, race is not significantly related to plant location. Income remains significant and negatively related to plant location. Poverty rates, another variable of concern in the environmental justice literature, remain significant but continue to act as a deterrent to plant location.

The presence of pre-existing TRI plants in a neighborhood and average plant size, variables left out of previous environmental justice studies, are both significant at the one percent level. Other variables traditionally considered in the firm location literature but often omitted from environmental justice studies - such as land and labor costs, and the quality of labor - are also significant.

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[9] See Carlton (1983), Bartik (1985), Lee and Wayslenko (1987), McConnell and Schwab (1990), Finney (1994), and Levinson (1996).

2. Firm Location Theory

A firm evaluates potential locations for a new plant based on the principle of profit maximization. In doing so, the firm takes into account many location-specific attributes that may affect potential profits in each of these locations. Two types of costs that vary with location, identified in the firm location literature, are production costs and transportation costs.[10] Production costs include costs related to relatively immobile inputs such as land, labor, and housing, and costs related to operation such as taxes, public utility fees, and environmental regulations. Transportation costs include freight rates, distance to input markets, and distance to output markets. It is also important to consider any offsetting location benefits from agglomeration economies such as a shared infrastructure or labor pool.

Hamilton (1995) offers three additional theories for why a plant may locate in a poor or minority neighborhood. The first theory of plant location stems from Coase (1960): a plant is established where residents' valuation of environmental quality, and therefore the potential compensation by the firm to the neighborhood residents, is lowest. Since local willingness to pay for environmental quality is positively correlated with income, firms will tend to locate plants in poorer neighborhoods to minimize the costs of compensation.[11]

The second theory for why plants may locate in poor or minority neighborhoods is that firms - or rather their managers or owners – gain utility from discriminating against a particular demographic group by locating a heavily polluting plant in that community. Since it is easier and therefore less costly to discriminate in neighborhoods with a substantial minority population, plants tend to locate in these neighborhoods.

Hamilton's final theory is that firms locate polluting plants where the likelihood of a community engaging in collective activities to negotiate compensation or voice opposition is

[10] See Harrington and Warf (1995) and Beckman and Thisse (1986).
[11] Compensation can be thought of generally as both monetary and non-monetary forms of renumeration given by the firm to the community to offset the perceived risks of an increase in pollution due to the location of a new plant in the area.

relatively low. In this case, a firm owes less to the community in the form of compensation not because the neighborhood values the externality any less than other communities, but because the transaction costs of collective action are high. A less-politically-powerful community may have a limited ability to participate in the political or legal processes through which opposition is voiced and compensation is gained.

3. A Model of Plant Location

Levinson (1996) models new plant births in a particular location using a reduced-form latent profit function. A firm has an unobserved profit function for each possible location that is a function of location-specific variables such as factor prices, fixed inputs (land, labor) and the stringency of environmental regulation.[12]

One can add to the list of location-specific variables considered by the firm, the cost of discrimination in the form of foregone profits and the cost of required compensation. Adapting Levinson's model, a firm *i* that is considering the location of a new plant has an unobserved profit function for each feasible neighborhood *j* :

$$\pi_{ij}^{*} = g\left[f_i\left(p_j, x_j, d_j, c_j\right), s_{ij}\right] \qquad (1)$$

where p_j is neighborhood-specific input prices, x_j is neighborhood-specific fixed inputs, d_j is foregone profits due to discrimination, c_j is the level of required compensation, and s_{ij} is other firm or plant-specific factors that may vary by neighborhood.

The firm will choose to locate a plant in the neighborhood that yields the highest potential profit. An increase in the cost of a location – due to an increase in input prices, the cost of discrimination, or the level of compensation required - implies a decrease in profits. An increase in the availability of inputs implies an increase in profits.

Without price rigidities or other market failures in the input market, an increase in the availability of inputs will also result in a decrease in their price. Thus, input availability can be eliminated as a separate variable in the latent profit function. In addition, compensation is a function of two components: the value placed on environmental amenities in the neighborhood e_j, and the propensity of the neighborhood to engage in collective action a_j. Equation (1) can be rewritten as follows

$$\pi_{ij}^* = g\left[f_i\left(p_j, d_j, e_j, a_j\right), s_{ij}\right]. \tag{2}$$

4. The Econometric Model

A number of environmental justice studies use binary response models to analyze plant location decisions.[13] Most of these studies compare neighborhoods with plants or waste sites to neighborhoods without a plant or waste site. Multiple choice models seem more appropriate for the analysis of plant location, since firms choose from a spectrum of competitive locations when deciding where to site a new plant, including those that may already have another plant located there.

I use a conditional logit model that allows for analysis of the location decision relative to choice and plant-specific attributes. Assume that firm *i* faces *J* possible plant location alternatives and that these *J* choices are independently and identically distributed. The firm will choose location *j* when its profits are maximized in that particular location compared to all other possible choices. In other words, $\pi_{ij} \geq \pi_{ik} \quad \forall k \neq j$ where π_{ij} represents firm *i*'s profits if it decides to locate in *j* and π_{ik} represents firm *i*'s profits if it decides to locate in *k*. It is possible to write firm *i*'s profits as follows.

[12] Because I examine the location decisions of plants in only one state, environmental regulation is not included as a variable. While stringency and enforceability may still differ substantially within a state, little data are available at such a disaggregated level.

$$\pi_{ij} = \beta' z_{ij} + e_{ij} \tag{3}$$

where z_{ij} is defined as a set of observed characteristics specific to location j and plant i.[14] Specifically, $z_j = \left(p_j, d_j, e_j, a_j, s_{ij}\right)$. Assume that the error term e_{ij} has a Weibull distribution. If the firm's underlying production function is assumed to be Cobb-Douglas, then profits will be log-linear.[15]

Conditional on the decision to open a new plant, the probability that firm i will choose particular location k can be written as:

$$Pr(ik) = \frac{e^{\beta' z_{ik}}}{\sum_{j=1}^{J} e^{\beta' z_{ij}}} \quad . \tag{4}$$

4.1 Defining Alternative Plant Locations

When the full choice set of feasible location alternatives is small, firms may choose among all possible location alternatives in an empirical model.[16] However, when the number of location alternatives is large relative to the number of observations, they must be restricted to allow for the practicable study of plant location. The data set used in this study has approximately 350 plants and over 2,300 possible locations from which each plant may choose.[17] I define the reduced choice set for the plant as the selected location and a given number of randomly selected alternatives from the full choice set.[18] This technique yields consistent

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[13] See Anderton et al (1994), Been and Gupta (1997), and Boer et al (1997).
[14] In this particular case, the firm and plant are virtually interchangeable entities. Over 85 percent of the parent firms in the data set have only one plant in Texas. Ten percent of the parent firms have two plants in Texas.
[15] See Bartik (1985), and Levinson (1996).
[16] See Levinson (1996), and Finney (1994).
[17] These 2,300 census tracts are a subset of possible locations in Texas. Feasible alternatives are limited to census tracts that are defined in both the 1980 and 1990 census. Census tracts were not defined for many rural counties in Texas in 1980 and are therefore excluded from the choice set.
[18] See McConnell and Schwab (1990), and Friedman, Gerlowski, and Silberman (1992).

estimates and has the added advantage that the likelihood function is identical to that used for estimating a conditional logit with the full choice set (McFadden 1978).

4.2 Independence of Irrelevant Alternatives

A conditional logit model requires the assumption of independence of irrelevant alternatives (IIA), which does not allow for correlation across subsets of choices. However, if profits are correlated across regions, then the IIA assumption is inappropriate. Just as states in a particular region in the country may have correlated disturbance terms due to regional market trends, so may census tracts in a particular city or part of the state. While it appears that correlation between states in a region is often a concern (Bartik 1985, Levinson 1996), McConnell and Schwab (1990) find little evidence of correlation between counties in four broad regions. Carlton (1983) notes that at the SMSA level, geographic regions are quite distant from each other and therefore not likely to be correlated

One method of relaxing the IIA assumption is to estimate a nested logit (McFadden 1978). A firm is assumed to choose to locate in a particular region or city according to criteria that determine feasibility. The firm then selects a particular location within that region or city as determined by profit maximization. In this latter stage, it is often assumed that the firm is choosing a particular location from a set of geographically adjacent neighborhoods, although this need not be the case. It is in this way that the probability of firm i choosing to locate in neighborhood j is adjusted for the correlation between locations in the same city or region.

A simpler but less elegant method of relaxing the IIA assumption is to include regional dummy variables in the conditional logit estimation for those characteristics likely to be correlated across geographic units (Bartik 1985). To examine the validity of the IIA assumption for census tracts in Texas, two sets of regional dummies representing location in a county along the Mexican border and location in a county adjacent to the Gulf of Mexico are included in the regression.

4.3 Defining the Neighborhood

How a researcher defines the neighborhood may affect the empirical results of a study. Broad neighborhood definitions may hide important underlying trends in plant behavior, while narrow definitions may exclude areas that should be included in the neighborhood.[19] Early work related to environmental justice uses fairly broad neighborhood proxies in the form of counties or zip codes (GAO, UCC). Later studies have defined the relevant neighborhood based on concentric circles surrounding a site, or at the census tract level.

The use of circles is meant to approximate the range of distances at which a resident is concerned about the location of a hazardous waste facility. Glickman and Hersh (1995) prefer concentric circles to a census-based neighborhood definition for several reasons. First, a census-based definition ignores how households or different socioeconomic groups are distributed within the neighborhood. Second, a census-based definition often reflects topographical features that may exclude a large portion of those who, although separated by some physical feature, receive a large portion of the negative externalities from the site or plant.

One reason for not using the concentric circle technique is the arbitrary choice of a radius: the circles drawn are unlikely to reflect community-defined borders between neighborhoods. The census tract allows for a fine degree of analysis, tends to be consistently defined over time, is generally a comparable unit of analysis,[20] and is usually defined by the community itself to reflect its own view of the neighborhood (Been and Gupta 1997). For the purpose of this study, I define the neighborhood as the census tract.

5. Data

[19] See Anderton et al (1994).

To analyze plant location in the context of environmental equity, I use the Toxic Release Inventory (TRI), the U.S. Census of Population and Housing, the U.S. Census of Manufactures, and several directories of manufacturers for the state of Texas.[21] Texas seems particularly relevant as a focus for several reasons. First, during the period of study it ranks second among U.S. states in both area and population. Second, Texas had the second highest number of blacks and Hispanics living near uncontrolled hazardous waste sites in 1980 (UCC 1990). Plants that report to the TRI are also particularly suitable for a study of environmental equity. These plants are typically larger polluters of the 329 TRI-listed toxic substances and therefore pose a potential health hazard to populations located nearby.[22]

Each TRI plant in Texas is matched to the census tract in which it is located.[23] Any plant that appears in the TRI at least once between 1988 and 1993 is eligible for inclusion. A plant is dropped from the data set if the street address in the TRI cannot be matched to a census tract, if the plant's establishment date is unavailable,[24] or if the plant was established prior to 1976.[25] Plants established between 1976 and 1985 are matched to the 1980 census tract and socioeconomic characteristics from the U.S. Census of Population and Housing, while plants established between 1986 and 1993 are matched to the 1990 census tract and accompanying

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[20] A census tract usually consists of 2,500 to 8,000 people, with an average of 4,000 residents. The spatial size of a tract, however, may vary depending on population density.

[21] The establishment date for each plant in the data set is collected from several directories of Texas manufacturers, including the Bureau of Business Research Directory of Texas Manufacturers: Volume I (1990-1993), the Harris Texas Manufacturers Directory (1995), the Texas High Technology Directory (1995), and the Texas Manufacturers Register (1994).

[22] Plants that use more than 10,000 pounds or manufacture more than 25,000 pounds of the 329 listed toxic chemicals are required to report how much of each chemical is released into the air, land, or water. Many plants submit more than one report, depending on the number of chemicals they emit that are above the reporting standard. One limitation is that the TRI excludes a number of important toxic chemicals and important non-industrial sources of pollution, such as dry cleaning establishments.

[23] Due to unreliability of the data, 1987 TRI data are not used. This was the first year that firms were required to report to the TRI, and mistakes were often made.

[24] I was unable to find an establishment date for 377 of the 1,670 plants listed in the TRI between 1988 and 1993.

[25] Plants sited prior to 1976 are not included in the analysis due to unavailability of many of the variables in the U.S. Census prior to 1980. Three hundred sixty-eight TRI plants for which I have establishment dates were sited after 1975. While older plants' location decisions are not analyzed, these plants are taken into account as a possible explanatory variable for the location of plants of more recent vintage.

socioeconomic data.[26] Two steps are taken to ensure that plants select a location from the same alternative choice set across census years. First, only counties for which tract definitions are assigned in both 1980 and 1990 are included in the study. Second, tract definitions that have changed from one census year to the next are aggregated to a common tract definition. The Census of Manufactures is also used to add average wage and average plant size in the same industry at the county and MSA-level to the data set.

5.1 Discrimination Costs

Two variables are closely associated with the theory that when firms want to discriminate against a particular population, they will find it easier and therefore less costly to do so in neighborhoods in which a greater number of that group live. Percent nonwhite in a census tract, $NONWHT_j$, is used to represent the racial composition of a neighborhood. Ethnic or immigrant populations may also be subject to discrimination.[27] Percent foreign-born, $FOREIGN_j$, captures the segment of the population least likely to be assimilated into mainstream American culture and arguably most subject to discriminatory behavior on the part of the firm. The more minorities or foreign-born residents, the more likely it is for a firm to discriminate through the simple act of locating a polluting plant in that neighborhood.

5.2 Compensation Costs

The potential compensation a firm pays to members of a neighborhood depends on the neighborhood's willingness to pay for environmental quality and its propensity for involvement in collective action. If a firm compensates each member of the neighborhood, then the more people living in a neighborhood, the more costly to the firm and the less likely it will locate a plant. To

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[26] Results are not sensitive to one or two year shifts in the set of years matched to each Census.

measure this effect, the number of people affected, POP_j, and the housing vacancy rate, $VACANCY_j$, are included as variables. Residents' willingness to pay for environmental amenities is most closely associated with income levels, $INCOME_j$. If environmental quality is a normal good, then higher income will lead to greater demand for clean air and a higher level of compensation for plants to dirty the air. Firms will seek to avoid this cost by locating in neighborhoods with lower incomes. The percent of households living below the poverty line, $POVERTY_j$, is also included as a variable.

Arora and Cason (1998) include variables that affect a population's "stake" in the neighborhood as well as their desire to free ride. Neighborhood residents that have a higher stake will tend to engage in collective action more often, while those with a lesser stake in the well-being of the neighborhood will attempt to free ride on the participation of other residents. A firm wishing to minimize the potential costs of compensation will locate in neighborhoods that have fewer of the more active types of residents. Included as collective action variables are the average number of children per household, $CHILD_j$; the percent over the age of 65, $AGE65_j$; and the percentage of renter-occupied housing units, $RENTER_j$.[28] Neighborhoods that have a higher percent of households with children, older residents, or homeowners are expected the engage in higher levels of collective action and should therefore be negatively related to a firm's propensity to locate a plant in that neighborhood.

5.3 Input-Related Costs

[27] Because Hispanics are included in both percent nonwhite and percent white in the US Census, using percent Hispanic directly in the regression may be both confusing and redundant. However, in Texas the percent foreign-born is strongly correlated with percent Hispanic.

The cost of inputs to production is important in a firm's evaluation of possible plant locations. The average property value of owner-occupied housing in a neighborhood, $PROPERTY_j$, is used as a measure of the cost of land.[29] It is assumed that housing values represent a more general trend associated with the price per acre, regardless of whether it is dedicated to residential or industrial use. Given a firm's desire to minimize cost when establishing a plant in a particular location, it is expected that higher property values decrease the likelihood of locating in that neighborhood.[30]

Labor costs in a given location are related to the wage a plant pays to its workers, the ease with which the plant is able to hire workers, and the qualifications of those workers. All else equal, a firm will prefer a location that provides access to a large yet inexpensive pool of available workers who match the hiring needs of the plant. The average wage of a production worker in manufacturing at the county level, $WAGE_j$, is used as a proxy for the market wage in a particular neighborhood. The unemployment rate in a neighborhood, $UNEMPLOY_j$, provides information regarding current labor market conditions and reflects the degree to which workers are available. To the extent that the unemployment rate reflects worker availability, it will be positively related to the likelihood of plant location. If instead the unemployment rate is viewed as a general indicator of the health of the economy in that area, it will be negatively related to the likelihood of plant location. The quality of workers available in a neighborhood is measured by

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[28] Many researchers also use voter participation to measure the cost of collective action (See Hamilton 1995, Zimmerman 1993, and Arora and Cason 1998). Voter participation data for all counties in Texas are available for a number of state elections from 1986 to the present. Data prior to 1986 are only available for some counties. Because voter participation is closely related to education, age, and number of children in a household, these variables are used instead.

[29] Both property values and household income are adjusted to 1980 dollars. The consumer price index for the southern region of the United States is used to make this adjustment.

[30] Property values may be positively related to plant location if higher land values also proxy for increased quality or usefulness of land, and if quality is an important consideration in the location decision.

the percent with at least a high school diploma, $HIGHSCH_j$.[31]

Arora and Cason (1998) also include percent of population employed in manufacturing, $MANUF_{ij}$. In their analysis, the percent of workers in manufacturing is meant to reflect the way in which workers evaluate the trade-off between jobs and environment, which in turn may depend on whether their income is directly generated from the polluting industry. However, from the firm's perspective, percent employed in manufacturing may function as an indicator of how many workers matching the hiring needs of a new plant are located in the area.

A firm may consider how many pre-existing polluting plants there are in a particular neighborhood as a criterion in its initial location decision. The number of polluting plants may indicate the existence of agglomeration economies. The firm would have an incentive to locate a plant in a neighborhood with other polluting plants to take advantage of spillover effects from other firms that reduce productivity costs. The number of polluting plants may also serve as an indicator of the amount a plant can pollute if it locates in that neighborhood (for instance, due to zoning, or people's tolerance for relatively high levels of pollution). To account for the role that such factors play in the location decision, the number of pre-existing TRI facilities in the same census tract is included as a variable, $OLDSITE_j$. It is expected that the higher the number of pre-existing TRI plants in a neighborhood, the more likely a plant will locate in that neighborhood.

To take advantage of localization economies, a plant may locate near other plants in the same industry. The larger the industry, the lower the production costs to a locating plant. The average number of workers per plant at the two-digit SIC level in a MSA, referred to as

[31] Percent with high school degrees is used instead of college educated, because percent with college degrees is highly correlated with income while percent with high school degrees is not.

$SCALE_{ij}$, is used to control for industry size.[32] It is expected that the larger the average plant size in the area, the more likely a plant will locate in that neighborhood.

Finally, a variable measuring whether a tract is in an urban area, $URBAN_j$, is also included in the analysis. Urban areas offer access to large labor pools, a potentially large output market, better infrastructure, and easy access to public services. However, they also tend to have higher taxes, more traffic, and more crime.[33] If the benefits of locating in an urban area are greater than the costs, then urban areas may attract more plants. If however the additional costs of locating in an urban area dominate the benefits, the urban area may attract fewer plants.

6. Previous Studies

[32] Where a plant locates also depends on plant-specific characteristics: what type of product it manufactures, the desired plant scale, the type of technology used, the input mix used in production. However, to include firm-specific factors one would have to interact them with *all* possible location choices. Unless the data set is quite large or the choice set is small, there are not enough degrees of freedom to accommodate such a procedure.

[33] Ideally, I would include a measure of the level of taxes faced by plants in each neighborhood. However, such data are unavailable for the 1980s.

This section briefly presents results for a simple set of regressions that match all Texas plants reporting to TRI regardless of establishment date to current 1990 characteristics. This set of plants is directly comparable to data matched in previous studies to current socioeconomic characteristics.[34] The results are useful for two reasons. First, these regressions allow for the examination of the current pattern of plant location and neighborhoods to ascertain whether certain populations are disproportionately affected. Second, it allows for an assessment of the consistency of this data set with others that have found evidence of environmental inequity. To examine the consistency of my data set with those used in other studies that claim environmental inequity, I run regressions that use variables similar to those presented in three recently published studies.[35] In each case, a logit regression is used where a value of one signifies the presence of a TRI plant of any vintage, and zero signifies the absence of a TRI plant.

For all of the logit regressions in Table 1, percent nonwhite and foreign are significant and positively related to plant location, confirming the potential for current disproportionate impacts. Percent living in poverty is not significant, except for in the Goldman and Fitton regression and is opposite in sign from what the environmental justice literature predicts. Median income is only included in one of the regressions but is also significant and negatively related to plant location. In other words, richer neighborhoods are less likely to attract a TRI plant to locate there. In the regressions in which it is included, property values are also negatively related to plant location. All three sets of results are consistent with allegations of environmental inequity and are broadly consistent with those from the studies they attempt to mimic. The one exception worth noting is that race is not a significant variable in regressions reported by Kreisel et. al,

[34] Results for regressions based on Texas TRI plants established after 1975 and matched to 1990 socioeconomic characteristics are reported in the Appendix. Results suggest that environmental justice issues related to race are associated with older TRI plants.

[35] Goldman and Fitton (1994), Davidson and Anderton (2000), and Kriesel et. al (1996). Note that Goldman and Fitton only examine mean values and correlation coefficients. Davdison and Anderton calculate odds ratios. Also, while the set of variables used for each of these regressions is similar to those used by the authors, they are not identical. For instance, Kriesel et al uses a measure of proximity to an interstate highway as an independent variable, which is not included here.

while it is significant here.

Table 1: Logit Regressions Using All TRI Plants and 1990 Socioeconomic Characteristics

Variable	Goldman and Fitton	Davidson and Anderton	Kriesel et al
	Coefficient Estimates		
CONSTANT	5.78 ***	-2.63 ***	-6.14 **
NONWHT (percent nonwhite residents)	0.49 **	0.59 **	0.44 *
FOREIGN (percent foreign residents)	1.44 **	1.29 **	1.09 *
POVERTY (percent persons living in poverty)	-2.19 ***	0.25	0.45
LNINCOME (log of median household income)	-0.73 ***		
URBAN (percent persons living in urbanized area)	-0.35 **		
HIGHSCH (percent with high school degrees)		1.67 **	1.60 **
LNVALUE (log of average housing value – owner occupied)		-0.05 **	-0.05 **
MANUF (percent employed in manufacturing)		7.20 ***	7.06 ***
UNEMPL (percent of residents over age 16 that are unemployed)		-1.96	
WAGE (log of average county-level wage)			0.23
LNPOP (log of total population)			0.15 *

* indicates significance at the 10 % level, and ** indicates significance at the 5 % level, and *** indicates significance at the 1 % level. Numbers reported are coefficient estimates and not marginal effects.

7. Summary Statistics

When TRI plant location is properly matched to socioeconomic characteristics at the time of siting, the data set consists of a total of 354 TRI plants that were established in Texas after 1975. Approximately 75 percent of these plants were established between 1976 and 1985 (269 plants), while the remaining plants were established between 1986 and 1993 (85 plants). Across both time periods, approximately 75% of the plants are in five two-digit industries: chemicals and allied products (SIC 28), rubber and miscellaneous plastics (SIC 30), fabricated metals (SIC 34), electronic and other electrical equipment (SIC 36), and industrial/commercial machinery and computer equipment (SIC 35). Ten industries account for 92% of the plants across both time periods.

Several characteristics differ between tracts with a TRI plant established between 1976 and 1985 and tracts without a TRI plant established in this time period (see Table 2). Tracts in which a plant locates tend to have lower property values and poverty rates, and a greater number of people living in them.[36] They also tend to be less urban, have twice as many pre-existing TRI sites, and have larger plants in the same industry. Counter intuitively, tracts in which a plant locates also tend to have fewer renters. Unlike studies that have matched site location to current demographic variables, percent nonwhite is slightly lower in tracts in which a plant locates. Likewise, there are fewer foreign-born residents in neighborhoods with a TRI plant. Average income is not substantially different across the two sub-samples.

Many of the differences between tracts with and without a TRI plant established between 1986 and 1993 are similar to those already discussed for plants established a decade earlier. However, unlike for neighborhoods with plants established between 1976 and 1985, there no longer appears to be any difference in the percent renters or percent urban for neighborhoods with and without a TRI plant. Also, the average number of older TRI plants in these neighborhoods has increased from double to roughly four times the number of old sites in neighborhoods without a plant.

Table 2: Summary Statistics

	Tracts Matched to 1980 Characteristics		**Tracts Matched to 1990 Characteristics**	
Variable	**With a TRI Plant Established Between 1976 and 1985**	**Without a TRI Plant Established Between 1976 and 1985**	**With a TRI Plant Established After 1985** (N=85)	**Without a TRI Plant Established After 1985** (N=2,301)

[36] Percent urban and population are not highly correlated: the correlation coefficient is only 0.11.

	(N=269)	(N=2,179)		
NONWHT (percent nonwhite)	19.76 (22.98)	23.06 (26.26)	26.35 (19.02)	29.57 (25.99)
FOREIGN (percent foreign-born)	4.93 (5.72)	6.24 (7.17)	8.06 (7.63)	9.37 (9.45)
VACANT (percent of housing units vacant)	9.37 (8.30)	9.01 (6.66)	12.26 (6.78)	12.66 (8.30)
PROPERTY (ave. housing value - owner occupied)	$32,794.34 (19,196.07)	$38,413.16 (26,694.64)	$9,515.32 (5,761.31)	$13,970.76 (12,944.52)
INCOME (ave. household income)	$9,533.66 (3,083.54)	$9,859.93 (4,792.51)	$10,601.94 (4,171.24)	$10,696.40 (6,641.28)
POVERTY (percent in poverty)	11.09 (9.49)	14.22 (12.01)	16.08 (10.41)	19.59 (14.57)
UNEMPL (percent unemployed)	2.18 (1.33)	2.68 (1.71)	4.69 (1.78)	5.12 (2.87)
HIGHSCH (percent with high school degree or more)	30.64 (8.20)	28.43 (8.47)	27.49 (5.60)	25.28 (8.12)
CHILD (percent with children under age 18 years)	42.56 (14.45)	40.39 (14.75)	39.46 (11.38)	36.87 (12.48)
AGE_65 (percent over age 65)	7.92 (5.95)	9.54 (6.29)	8.83 (5.61)	11.00 (6.21)
RENTER (percent renting)	33.40 (22.31)	37.87 (22.83)	42.23 (19.16)	41.13 (21.72)
AVEWAGE (county-level average wage per plant)	$16,470.11 (3,620.49)	$16,726.76 (4,261.16)	$21,444.81 (5,598.50)	$21,093.87 (5,502.02)
OLDSITE (number of older TRI sites)	2.46 (3.95)	0.22 (0.65)	4.45 (6.62)	0.35 (1.05)
URBAN (percent living in urban area)	64.03 (44.48)	78.61 (39.28)	87.42 (25.83)	86.60 (29.98)
SCALE (average industry size across MSAs)	82.13 (80.15)	75.54 (84.88)	83.06 (97.59)	68.75 (82.97)
POP (total population)	5,961.17 (5,579.54)	4,798.39 (3,100.21)	8,460.40 (7,225.90)	5,945.99 (5,376.47)

* All means and standard deviations for variables in percentage from are multiplied by 100 for easy interpretation. In the data, percents range from 0 to 1.

Thus, contrary to evidence presented in the environmental justice literature based on current neighborhood characteristics, initial evidence suggests that higher percent nonwhite, percent foreign, and percent poor are not associated with plant location at the time of siting. However, without controlling for other important variables, one cannot definitively say whether race or poverty is an important consideration in a plant's location decision. It is possible that other variables are masking a possible race or income effect. To clearly establish whether this is the case, a conditional logit is estimated, which will present the effect of race and poverty while controlling for other factors.

8. Results

The results of several conditional logit estimations, when each plant has 49 alternatives to its actual choice randomly selected from the overall alternative choice set, are presented in table 3.[37] The first three columns present regression results for equations similar to those found in other studies. In each case, the data and estimation technique utilized differ from what was used originally. Columns (1) and (2) re-estimate equations similar to those analyzed in Davidson and Anderton (2000) and Kreisel et. al (1996) but match plant locations to socioeconomic characteristics at the time of plant siting. Column (3) re-estimates the equation from Been and Gupta (1997). The last two columns present new results. Column (4) presents results when only variables representative of discrimination and compensation costs are included in the regression. Columns (5) presents results when input costs are added to the regression in (4).[38]

[37] The conditional logit is also estimated with nine and 24 alternatives randomly selected from the choice set. For both cases, none of the previously significant results change sign or significance.

[38] Because median income is highly correlated with both average property value and the poverty rate, a regression that eliminates median income from (4) was also run. Neither sign nor significance changed from those presented in column (4) for any of the variables.

First, note that in each specification percent nonwhite and percent foreign are both insignificant.[39] These results run directly counter to those of studies that have matched all plant or waste site locations to the current socioeconomic characteristics of the neighborhood. They also differ from Been and Gupta's results: they find no evidence of a relationship between waste site location and percent African-American at the time of siting, but do find evidence of a relationship between waste site location and percent Hispanic.

Second, note that while percent poor is significant at the five percent level for most regressions, the sign is the opposite of what is predicted in the environmental justice literature.[40] Been and Gupta find a similar result for sites established in the 1980s or 1990s but offer no reason for why this may be the case. One possible explanation may be that firms interpret the percent poor in way similar to the unemployment rate: the higher the percent poor, the worse the general state of the economy and the more unskilled and potentially unemployable workers there are. Third, the input costs added in (5) are all highly significant and render percent graduated from high school insignificant.

Two of the variables related to compensation costs are significant for most of the regressions in Table 4: average income and population.[41] As predicted, income negatively affects the likelihood of plant location. Population is positively related to plant location, running counter to the theory that firms avoid locating plants in neighborhoods with larger numbers of people. Perhaps those neighborhoods with more people living in them have a free rider problem that overwhelms their ability to organize and demand a certain level of compensation. The vacancy

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[39] Results for regressions that include percent African-American and percent Hispanic instead of percent non-white and percent foreign are identical in sign and significance to those presented here.

[40] In regressions where percent poor is insignificant, percent unemployed becomes significant. These two variables are highly correlated and therefore are not included together in the same regressions. However while significance does depend on the variables included in the regression, the signs do not.

rate is positively related to plant location but only significant at the ten percent level in specification (5). These results offer mixed support for the theory that firms locate plants in neighborhoods where compensation costs are low.

The only variable related to the collective action hypothesis that is consistently significant when included in the regression is the number of persons over the age of 65.[42] It is negatively related to plant location, which supports the theory that firms avoid locating plants in neighborhoods with more politically active populations.[43]

Many of the signs on the input cost coefficients are fairly intuitive. Plant location is negatively related to wage, property value, and unemployment.[44] As the cost of land and workers increases, a firm is less likely to locate a plant in the neighborhood. The negative sign of the unemployment rate coefficient lends support to the idea that firms interpret higher rates as an indication that the health of the local economy is poor rather than as an indicator of worker availability.

The location of polluting plants is positively related to the number of pre-existing TRI plants in the neighborhood and is significant at the one percent level. This result is robust to the inclusion or exclusion of any of the other variables included in regression (5). The presence of pre-existing polluting plants may serve as a signal that more pollution will not be strongly resisted by the community. Alternatively, the pre-existing plant variable may be acting as a proxy for zoning laws that limit industrial activities in some areas and encourage them in others.

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[41] Several variables are in log form due to the Cobb-Douglas production function assumption: income, wage, property value, population, and scale. If these variables are included in the regression in non-log form, there is no real change in sign or significance. All other variables – except number of pre-existing sites - are in percentage form because: (a) by using percentage, one has already adjusted the data into log-form equivalents, and (b) the log of a percentage approaches negative infinity as the percentage becomes very small (see Bartik 1985 for a more detailed discussion).

[42] I also ran regressions that replaced the collective action variables with voter participation in Texas. The voter participation variable was not significant. The results for the remaining variables were unaffected.

[43] The significance of percent of households with children is masked by the number of pre-existing sites. When this variable is dropped from regression (5), percent with children becomes significant and is of the predicted sign: the more households with children, the less likely that a firm locates a plant in that neighborhood. All other variables maintain the same sign and significance.

It is also possible that locating near other polluting plants allows a plant to take advantage of agglomeration economies from locating near other polluting manufacturing firms. The coefficient on plant size is also positive and significant at the one percent level. The larger are plants in the same industry, the more likely that a TRI plant will locate in that neighborhood. The percent of persons employed in manufacturing is also positive and significant, and may serve as an indicator to the firm of a ready and skilled labor force. If this variable is excluded from the regression, the other variable possibly representative of labor force quality – percent graduated from high school – is still not significant. Finally, firms are less likely to locate a plant in urban areas, indicating that the costs of urban areas outweigh possible benefits. This may be due to factors such as higher tax rates and more crime in urban areas.

It is also worth noting that the regional dummies included to allow for the possible relaxation of IIA, proximity to the border with Mexico and proximity to the Gulf of Mexico, are not significant for any specification and do not significantly improve or change the results. IIA appears to be a valid assumption.

One measure of the possible explanatory power of these regressions is a pseudo-R^2. For specification (5) the pseudo-R^2 has a value of 0.19, meaning 19 percent of the variation in the data is explained. The inclusion of the number of pre-existing TRI plants already established in the neighborhood is paramount to the performance of specification (5): without it in the regression, the pseudo R^2 has a value of only 0.08.

[44] The MSA-level wage is also available. Substitution of this variable into the regression for county-level wage yields similar results.

Table 3: Conditional Logit Estimation – 50 choices

Variable	(1) Davidson and Anderton	(2) Kriesel et. al	(3) Been and Gupta	(4) Without Input Costs	(5) (4) With Input Costs
NONWHT	0.12 (0.28)	0.16 (0.28)	0.02 (0.067)	-0.22 (0.26)	0.05 (0.35)
FOREIGN	-0.43 (0.83)	-1.18 (0.92)	-0.64 (0.89)	-1.13 (1.04)	-1.28 (1.04)
INCOME			-0.23 *** (0.06)	-0.20 *** (0.06)	-0.17 *** (0.06)
POVERTY	-0.81 (0.73)	-2.23 *** (0.75)	-0.65 (0.75)	-1.46 ** (0.67)	-2.25 *** (0.85)
HIGHSCH	2.04 *** (0.65)	1.38 ** (0.66)	1.98 *** (0.62)	2.19 *** (0.61)	-0.02 (0.75)
VACANT				0.67 (0.64)	1.25 * (0.68)
WCHILD				0.04 (0.54)	0.38 (0.53)
AGE65				-3.26 ** (1.50)	-3.12 ** (1.48)
RENTER				0.02 (0.30)	0.44 (0.33)
POP		0.20 ** (0.10)	0.34 *** (0.09)	0.15 (0.10)	0.25 *** (0.09)
UNEMPL	-10.76 *** (3.97)		-13.81 *** (4.64)		
PROPERTY	-0.12 *** (0.01)	-0.13 *** (0.02)	-0.13 *** (0.02)		-0.07 *** (0.03)
WAGE		-0.84 *** (0.25)			-1.06 *** (0.27)
PLANT SIZE					0.31 *** (0.08)
OLDSITE					0.35 *** (0.03)
URBAN					-0.80 *** (0.15)
MANUF	5.34 *** (0.59)	6.18 *** (0.64)	6.17 *** (0.57)		4.45 *** (0.74)
Pseudo R^2	0.06	0.06	0.07	0.03	0.19
Log Likelihood	-1,308.18	-1,300.10	-1,294.57	-1,350.89	-1,118.56

* indicates significance at the 10% level, ** indicates significance at the 5% level, and *** indicates significance at the 1% level. Standard errors are in the parentheses.

A likelihood ratio test is used to examine the overall significance of each of the theories posited by Hamilton for why plants may locate in poor or minority neighborhoods. The null hypothesis in each case is that the set of variables most closely associated with each theory is not relevant to the location decision. The results indicate that discrimination costs are not relevant to the decision of where to locate a polluting plant (see Table 4). However, costs related to the compensation costs are significant. When likelihood ratio tests are conducted for environmental disamenity costs and collective action costs separately, each set of variables is still significant, at the one percent and five percent levels, respectively. Variables related to costs traditionally included in the firm location literature, referred to here as input costs, are the most relevant to a plant's location decision and significant at the one percent level.[45]

Table 4: Likelihood Ratio Tests

Sets of Variables [46]	**Likelihood Ratio Test for Specification (5)**
Discrimination Costs	1.12
Compensation Costs	43.22 ***
Inputs Costs	473.08 ***

* indicates significance at the 10 % level, ** indicates significance at the 5 % level, and *** indicates significance at the 1 % level.

Table 5 presents the marginal effects for the significant variables in specification (5). These marginal effects are only valid for the actual location and the random sample of 49 alternative locations and should not be generalized to the entire sample of alternative locations.

[45] There is no change to the significance of the likelihood ratio tests when percent employed in manufacturing is included as a variable representative of compensation costs (job v. environment trade-off by workers) instead of as an input cost (potential qualified labor pool).

[46] Discrimination costs include percent nonwhite and percent foreign. Environmental amenity costs include percent housing vacant, average income, percent poor, and population. Collective action costs include percent with children, percent over age 65, and percent renters. Input costs include average wage, percent high school educated, percent unemployed, percent urban, and average property value, number of

One can consider the following rather unrealistic story: A firm is asked to choose one of 50 census tracts in which to locate, selected at random from the state of Texas. Given that it will locate in one of these 50 tracts, how important are the variables included in the regression to the decision process? For instance, evaluated at the mean, a one percent increase in residents over the age of 65 results in a 16 percent decrease in the probability of plant location. A one percent increase in the percent employed in manufacturing increases the likelihood of plant location by 23 percent. For every increase in the number of pre-existing sites in a neighborhood by one, the likelihood of plant location increases by two percent.

Table 5: Marginal Effects for Specification (5)

Variable	Own Marginal Effects for Actual Location
ln (INCOME)	-0.01
PERCENT OF HOUSING VACANT	0.07
PERCENT OVER AGE 65	-0.16
ln (POPUlATION)	0.01
ln (PROPERTY)	-0.004
ln (CNTYWAGE)	-0.06
ln (PLANT SIZE)	0.02
ln (OLDSITE)	0.02
PERCENT URBAN	-0.04
PERCENT IN MANUFACTURING	0.23

pre-existing TRI plants, and average plant size. Results do not change if percent poor is included as an input cost variable instead of an environmental disamenity variable.

9. Conclusion

Many environmental justice studies argue that firms locate waste sites or polluting plants disproportionately in minority or poor communities. There are two major shortcomings of these studies. First, site or plant location is matched to current socioeconomic characteristics instead of to neighborhood characteristics at the time that the siting decision was made. Second, variables that are important to a plant's location decision - the cost and quality of labor, the average size of a plant in the same industry, the existence of older polluting plants - are often not included in these studies. Without controlling for such variables, it is difficult to evaluate the importance of socioeconomic characteristics such as race and poverty to a firm's initial location decision.

I address both of these issues in this paper. First, I match actual TRI plant location to the characteristics of the neighborhood at the time of siting for plants established in Texas between 1976 and 1993. I include socioeconomic characteristics such as race, income and poverty rates, as well as variables often omitted of the environmental justice literature such as the quality and cost of labor, plant size, and the existence of older polluting manufacturing plants. Using the assembled data set, I estimate a conditional logit to allow a firm to choose from several alternative locations.

When the location of TRI plants are matched to 1990 socioeconomic characteristics, race and income variables are significant and of the expected sign. These results confirm that a disproportionate number of minority and lower income populations currently live near TRI plants. However, when plant location is matched to neighborhood socioeconomic characteristics at the time of siting, race variables are not significant determinants of TRI plant location in Texas. Percent poor, another variable of concern in the environmental justice literature, is a significant factor, but rather than attracting plants to an area it acts as a deterrent.

Two of the most important variables in this study are left out of previous environmental justice studies: the presence of pre-existing TRI plants in a neighborhood and the average size of a plant in the same industry and region. The fact that plants tend to locate where other TRI plants are already established may indicate that firms use the existence of other polluting plants as an indicator of the acceptability of pollution increases in the area or of the industrial distribution imposed by zoning. Both the existence of older TRI plants and average plant size may indicate that firms are taking advantage of agglomeration economies. Variables traditionally considered in the firm location literature such as land and labor costs, plant size, and the quality of labor are also significant variables.

APPENDIX

A second set of regressions are reported here that match Texas plants established after 1975 and reporting to the TRI to current socioeconomic characteristics (see Table A). These plants are directly comparable to the data used when examining the importance of neighborhood characteristics at the time of siting. These regressions compare neighborhoods that contain TRI plants established after 1975 to those without but match them to current 1990 socioeconomic characteristics. These results demonstrate important differences from when neighborhoods with older plants also are included in the regression.

Table 2: Logit Regressions Using TRI Plants Established After 1975 and 1990 Socioeconomic Characteristics

Variable	Goldman and Fitton	Davidson and Anderton	Kriesel et al
	Coefficient Estimates		
CONSTANT	4.94 ***	-2.14 ***	-0.60
NONWHT (percent nonwhite residents)	0.78	-0.32	0.16
FOREIGN (percent foreign residents)	-0.85	- 1.53 *	-2.36 **
POVERTY (percent persons living in poverty)	-3.41 ***	-1.22	-0.55
LNINCOME (log of median household income)	-0.65 ***		
URBAN (percent persons living in urbanized area)	-0.32 *		
HIGHSCH (percent with high school degrees)		1.07	1.55 *
LNVALUE (log of average housing value – owner occupied)		-0.12 ***	-0.14 ***
MANUF (percent employed in manufacturing)		7.94 ***	8.38 ***
UNEMPL (percent of residents over age 16 that are unemployed)		1.31	
WAGE (log of average county-level wage)			-0.50 **
LNPOP (log of total population)			0.40 ***

* indicates significance at the 10 % level, and ** indicates significance at the 5 % level, and *** indicates significance at the 1 % level. Numbers reported are coefficient estimates and not marginal effects.

Percent nonwhite is no longer significant in any of the regressions presented in Table A.[47] While percent foreign is significant in two of the three regressions, it has switched sign from that reported in Table 1. Instead of plants being located disproportionately in neighborhoods with higher numbers of Hispanic residents as was the case when TRI plants from all establishment years were included, plants of more recent vintage are located in neighborhoods with fewer Hispanic residents. Thus, at least for plants established relatively recently there is little evidence that neighborhoods with more minority residents are disproportionately impacted. It is important to note however that these regressions examine only plant location and not emissions or health risks associated with emissions from these firms.[48]

Most other variables included in these regressions retain the same sign and significance as in the regressions reported in Table 1. One exception worth noting is that the average wage is now significant and negatively related to plant location.

[47] Only the simplest of regressions – including only income and race variables – results in a significant coefficient estimate for percent nonwhite.

[48] Another segment of literature examines how plant emissions and health-related risks from emissions vary across neighborhoods. See Kriesel et. Al (1996), Rinquist (1997), Brooks and Sethi (1997), Arora and Cason (1998), Gray and Shadbegian (2002), and Wolverton (2002).

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