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Abstract

In the environmental justice literature, evidence of disproportionate siting in poor or minority neighborhoods is decidedly mixed. Some allege this is due to the difference in whether the study looks at evidence at the national, state, or city level. Here, I compare results from two of the largest cities in Texas to results for the state overall to discern whether important demographic or other differences are evident at the city level that may be masked at a more aggregate level of analysis.

I examine four possible hypotheses for why plants may locate in poor or minority neighborhoods: profit maximization (or cost minimization); relatively low willingness-to-pay for environmental amenities; a lower propensity for collective action by the community; and finally, the desire on the part of the firm to discriminate against particular groups of people. Specifically, I match the location of manufacturing plants that reported to the Toxic Release Inventory to US Census information at the census tract level at the time when the siting decision occurred. I then combine this information with a variety of other data, including voter participation, wages, and crime rates at the county-level. The main findings of this paper is that the principle driver of plant location decisions is profit maximization and that variables associated with the collective action and discrimination hypotheses are largely not significant, population density excepted. These findings appear to hold both at the city and state level. Variables associated with willingness-to-pay for environmental amenities appear somewhat sensitive to geographic scope: poverty is sometimes significant at the state level but never significant at the level of the city.

Key Words: plant location, environmental justice
Subject Matter Categories: air pollution (4), industrial source (19)

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Introduction[1]

It is fairly common in the environmental justice literature to focus on the relationship between contemporaneous socioeconomic characteristics and site or plant location for purposes of investigating disproportionate impacts. The studies that have examined whether socioeconomic factors contribute to location decisions at the time of siting often exclude variables recognized in the firm location literature as important determinants of location choice; for instance, the costs of land, labor, and transportation. In this paper, I use a similar approach to Wolverton (2009) - I examine plant location decisions at the time of siting but incorporate variables recognized as important in the firm location or environmental justice literatures into a single analysis. While most environmental justice studies that model location choice use a binary response model, I allow for multiple location alternatives to more closely approximate a firm's evaluation of potential substitute sites to the location chosen.

Unlike Wolverton (2009), this paper examines the potential influence of geographic scope on the analytic results. Studies in the environmental justice literature report mixed results with regard to the relevance of race, ethnicity, poverty, and income to location decisions. Mohai and Bryant (1992) point out that one possible reason for such a mix of findings may be that the scope of the analysis differs so widely by study – some focus on a particular urban area or region, while others are national in scope.[2] Results from city-specific analyses cannot be easily generalized to other geographic contexts. However, more aggregate studies - those on the state or

[1] For their helpful comments and suggestions, I thank Spencer Banzhaf and the participants of the 2008 "Markets for Land and Pollution: Implications for Environmental Justice" workshop. I also thank Emma Roach for her superior GIS skills.

[2] Other reasons for differences in results include variation in neighborhood definition, empirical technique, control variables, and type of facility examined.

national-level - may mask the importance of socio-economic factors in firm decision-making. This paper examines factors related to a polluting plant's decision of where to locate within two large Texas cities - Dallas-Fort Worth, and Houston – at the time of siting between 1978 and 1985 using a conditional logit framework and then compares these results to those for the state of Texas while using consistent methodology and sets of variables.

The Environmental Justice Literature

Early studies that match site location to contemporaneous socioeconomic characteristics often rely on simple statistical techniques and tend to find strong evidence of a relationship between race and poverty variables and site location. [3] Later studies that examine similar relationships often use more sophisticated techniques and therefore tend to be more careful in the interpretation of results. Scope varies widely across these studies – some focus on a particular urban area or region, while others are national in scope.[4]

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 in poverty does not differ significantly from the national average. This trend is found to hold at the regional level as well. Baden, Noonan, and Turaga (2007) find that race and ethnicity are correlated with the presence of a Superfund site at the national level, but find that this relationship is sensitive to changes in both geographic

[3] For instance, see Bullard (1983), GAO (1983), and United Church of Christ (1987).
[4] Ringquist (2005) presents the results of a meta-analysis with regard to environmental equity studies. He finds that studies that are national in scope tend to result in smaller estimates of race-based inequities than studies at a more disaggregated level. However, Ringquist lumps together studies at the time of siting with those that examine characteristics after the fact and does not include this as a relevant factor for explaining differences across studies included in his meta-analysis.

scale and scope (i.e., how the neighborhood is defined). On the other hand, Anderton et. al (1994) find only limited evidence of disproportionate numbers of hazardous waste facilities located in minority or poor neighborhoods. This result is also found to hold at a more disaggregated level - when the country is divided into ten regions.[5]

There are a handful of studies that examine the relationship between neighborhood characteristics and facility location decisions at the time of siting. These studies also find a mixed record with regard to the importance of socio-economic variables to plant location decisions. Unlike studies that match site location to contemporaneous socioeconomic characteristics, however, they rarely examine how results change with the scope of the analysis. Been and Gupta (1997) obtain mixed evidence that race played a role at the time of siting for 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 percent poor nor percent African-American in a neighborhood are significant factors at the time of siting. The percent Hispanic remains significant at the time of siting. Pastor, Sadd, and Hipp (2001) examine the location of TSDF sites in Los Angeles County and find greater evidence of disproportionate siting in established Latino and African American communities than minority move-in after the TSDF establishment. Baden and Coursey (2002) examine the location of Superfund sites in Chicago and find that sites were disproportionately located in poor neighborhoods in the 1960s but not in the 1990s. However, they find little evidence for disproportionate exposure of

[5] Bowen et. al (1995) does not examine site location, instead focusing on how releases of toxic chemicals vary with study scope. They find that releases and minority populations are highly spatially correlated at the state level but that this relationship disappears when the study scope is limited to the metropolitan area. The authors posit that a state level analysis is less appropriate in this instance since both industry and minority populations are concentrated in the metropolitan area in their sample.

African Americans either currently or at the time of siting. Jenkins, Maguire, and Morgan (2004) study compensation to communities in exchange for hosting municipal solid landfills. Controlling for tipping fees paid from the landfill to the community, they find that socioeconomic characteristics such as income and race do not matter at the city level but do appear to matter at the county level.[6] Finally, Wolverton (2009) examines the siting decisions of TRI plants in the 1980s and 1990s in the state of Texas and finds that input-related cost factors are consistently more important than determinants related to the socio-economic characteristics of the surrounding neighborhood. Race and ethnicity are not related to plant location decisions, while poverty appears to act as a deterrent.

The Firm Location Literature

In the economics literature, a firm is assumed to evaluate 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 related to production and transportation costs that may affect potential profits in each potential location. 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

[6] Lambert and Boerner (1995) examine site location 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, 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 for firms reporting to the Toxic Release Inventory (TRI). He 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) 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. Noonan (2009) examines how environmental quality is capitalized into property values when both residents and environmental quality are changing over time.

regulations. Transportation costs include freight rates, distance to input markets, and distance to output markets. Most studies of new plant location do not have measures for all production and transportation costs due to data limitations but do usually include measures of labor costs, land costs, transportation costs, energy costs; and/or level of taxation.[7] It is also important to consider any offsetting location benefits from agglomeration economies such as a shared infrastructure or labor pool.

Some environmental justice studies include variables to proxy for land and labor costs but rarely include other variables associated with firm location (for instance, Davidson and Anderton 2000). Kriesel et al. (1996), while focusing on the incidence of emissions rather than plant location, is a notable exception within the environmental justice literature. Along with land and labor costs, they include proximity to an interstate highway and find that the inclusion of these factors renders race and poverty insignificant. This finding points to the importance of including such variables in any study site location decisions. Wolverton (2009) includes measures of labor costs, land costs, distance to major highways and/or rail, and possible agglomeration economies. She also finds that traditional firm location variables dominate in importance and render race variables insignificant.

Hamilton (1995) offers three additional reasons for why a plant may locate in a poor or minority neighborhood. The first hypothesis 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

[7] See Carlton (1983), Bartik (1985), Beckman and Thisse (1986), Lee and Wayslenko (1987), McConnell and Schwab (1990), Finney (1994), Harrington and Warf (1995), and Levinson (1996).

income, firms will tend to locate plants in poorer neighborhoods to minimize the costs of compensation.[8] The second hypothesis for why plants may locate in poor or minority neighborhoods is that firms locate polluting plants where the likelihood of a community engaging in collective activities is 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. Hamilton's final hypothesis is that firm owners or managers trade off profits in favor of 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.

Empirical Model and Approach

I adopt the empirical model of firm location decisions first developed by Levinson (1996) and then adapted by Wolverton (2009) for purposes of incorporating Hamilton's additional hypotheses related to firm location. Levinson (1996) assumes that each 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. Wolverton (2009) includes the cost of discrimination in the form of foregone profits and the cost of required compensation, which is a function of the value placed on environmental amenities in the neighborhood, and the propensity of the neighborhood to engage in collective

[8] Compensation can be thought of as both monetary and in-kind (e.g. free access to certain services, the building of a community park) 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.

action. Based on the assumption that firms profit maximize, a firm then chooses 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.

Most environmental justice studies that model location choice use a binary response model.[9] Allowing for multiple location alternatives seems more appropriate, since firms typically choose from a spectrum of competitive locations when deciding where to site a plant. Following Wolverton (2009), I use a conditional logit model to represent the choice of a particular location from a set of many neighborhoods. 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. It is possible to write firm *i*'s profits as follows:

$$\pi_{ij} = \beta' z_{ij} + e_{ij} \qquad (1)$$

where z_{ij} is defined as a set of observed characteristics specific to location *j* and plant *i*. 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.

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

[9] See, for example, Pastor et al (2001), Davidson and Anderton (2000), Been and Gupta (1999), Boer et al. (1997), and Anderton et al. (1994).

$$Pr(ik) = \frac{e^{\beta' z_{ik}}}{\sum_{j=1}^{J} e^{\beta' z_{ij}}} \quad . \tag{2}$$

Due to the limited number of observations in the Dallas-Fort Worth and Houston areas, a firm is modeled as selecting a location for its plant from the actual location and nine randomly selected alternatives drawn from the full choice set. This technique has been shown to yield consistent 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).

Data

In this paper, I focus on location decisions in two urban areas of Texas in the 1980s: the Houston and Dallas-Fort Worth areas.[10] These are two of the largest cities in Texas, and both rank within the top ten largest cities in the United States by population. These two cities differ in a number of interesting ways that may influence plant location decisions. For instance, Houston has a much more concentrated industry profile than Dallas, with the majority of its industry focused in chemical manufacturing. Houston also does not limit land use through zoning restrictions, while Dallas-Fort Worth does.

I examine the location decisions of manufacturing plants sited between 1976 and 1985 in the Houston and Dallas-Fort Worth areas that reported to the Toxic Release Inventory (TRI). Each TRI plant in Texas is matched to the census tract in which it is located. Any plant that appears in the TRI at least once is eligible for

[10] The metropolitan statistical areas are based on the definitions used in 1980 by the US Census Bureau.

inclusion.[11] A total of 106 plants in the Dallas-Fort Worth area and 56 plants in the Houston-Galveston area make location decisions during this time period.[12] The location of these plants is matched to the appropriate census tract and socioeconomic characteristics from the 1980 U.S. Census of Population and Housing. Data are also drawn from the U.S. Census of Manufactures, the County and City Data Books, and several directories of manufacturers for the state of Texas.[13]

Variable Definitions

I utilize variables associated with each of the four relevant considerations for plant location decisions that were outlined previously: profit maximization;[14] willingness-to-pay for environmental amenities; propensity to engage in collective action; and opportunities to discriminate.

I capture differences in the cost of land, labor, and transportation through the use of the average property value of owner-occupied housing in a neighborhood, $PROPERTY_j$,[15] the average wage of a production worker in manufacturing at the

[11] 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 air, land, or water.
[12] I do not include plant decisions that occur later in time – between 1986 and 1993 – because the data set becomes too small to include a reasonable number of control variables and alternate locations before running out of degrees of freedom. I have data on only 32 plant locations in the Dallas-Fort Worth are and 26 plant locations in the Houston-Galveston area for this time period.
[13] The establishment date for each plant is collected from 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).
[14] A number of other variables are potentially important to location decisions, for instance differences in energy costs and property taxes may matter. Unfortunately, no information is available on the cost of electricity by location during the 1980s. Property tax rates by county in Texas are only available beginning in 1991. Because they fluctuate across time, it seems inappropriate to use 1991 tax rates as a proxy unless the relative difference in rates stays roughly constant across counties over time. That said, when the 1991 tax rate is included, it is insignificant.
[15] 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. Property values acts as a proxy for land values faced by firms when making location decisions, which is unavailable at the census tract level in 1980.

county level, $WAGE_j$, and the average distance of a given neighborhood from the nearest railroad, $RAIL_j$.[16] To control for potential differences in the costs of environmental regulation, I also include the percent of years for which a county was out of attainment for ozone and total suspended particulates over the years studied, $NATTN_j$.[17] This is a potentially relevant factor since it is arguably more difficult to locate a polluting plant in a county already out-of attainment with existing regulations. Following Arora and Cason (1998), I also include percent of population employed in manufacturing, $MANUF_{ij}$ to capture potential trade-off between jobs and environment. To account for the role that zoning or agglomeration economies may play, the number of pre-existing TRI facilities in the same census tract, $OLDSITE_j$, is included. Finally, a variable measuring how urban an area is, $URBAN_j$, is also included in the analysis. More urbanized areas may offer more immediate access to large labor pools, better infrastructure, and easy access to public services. However, they also tend to have higher taxes, more traffic, and more crime.[18]

The potential compensation a firm pays to a neighborhood depends on willingness to pay for environmental quality and the neighborhood's propensity for collective action. Residents' willingness to pay for environmental amenities is most closely associated with income levels, $INCOME_j$. The percent of households living

[16] I also explore a variable measuring the average distance to a major highway. It was not significant in any of the regressions nor changed the sign or significance of other variables.
[17] Shadbegian and Gray (2009) speak to potential differences in regulatory costs in the environmental justice context: They examine whether regulators focus more regulatory attention on plants in rich, white neighborhoods than in poor, minority neighborhoods.
[18] Average plant size is a significant explanatory variable in Wolverton (2008). In that paper, I used a MSA-level definition. It is not included here, though I am waiting for access to 1982 Census data at the county level by two-digit SIC and plant o include it in subsequent version of this paper.

below the poverty line, $POVERTY_j$, is also included as a variable. If a firm compensates each member of the neighborhood, then the more densely populated a neighborhood, $POPDENS_j$, the more costly to the firm and the less likely it will locate a plant.[19] Following Arora and Cason (1998) I also include variables that affect a population's "stake" in the neighborhood as well as their desire to free ride: the average number of children per household, $CHILD_j$; the percent over the age of 65, $AGE65_j$; and the percentage of households that are renters, $RENTER_j$.[20]

Two variables are included to represent the possibility that firms seek out neighborhoods where it is easier to discriminate on the basis of race or ethnicity: percent nonwhite, $NONWHT_j$, and percent foreign-born, $FOREIGN_j$.[21]

Multicollinearity

A few of the independent variables described in the previous section are highly correlated. For instance, use of property values in the same regression as income is potentially problematic since they have a correlation coefficient above 80 percent. Likewise, the percent in poverty is highly correlated with income and percent non-white. Because the traditional environmental justice literature includes these variables indiscriminately, I include one specification that ignores these multicollinearity problems. However, I also explore an alternate specification: I use

[19] Since census tracts vary in size we include population density instead of population.
[20] Percent who voted in the Presidential election was used in Wolverton (2008) to represent the propensity to engage in collective action. It was significant. However, this variable does not have enough variation at the county level to allow for inclusion here.
[21] Because Hispanics are included in both percent nonwhite and percent white in the US Census, using percent Hispanic directly in the regression is problematic. In Texas the percent foreign-born is strongly correlated with percent Hispanic.

$PBUILT70_j$, the percent of housing in a neighborhood that was built prior to 1970, as a proxy for land value. This measure is expected to be a rather imperfect substitute since it is related to the housing stock and therefore more closely associated with property values than with land value, but it allows me to explore the robustness of the results. I also use $NOPHON_j$, the percent of households without a phone in their home, to proxy for the poverty rate. This measure is fairly highly correlated with poverty (67 percent) but is far less correlated with the income and race variables.

Matching of All Plants Regardless of When They Are Established

The focus of much of the environmental justice literature is on the correlation between plant location and socioeconomic characteristics without accounting for the timing of the siting decision. To ensure our sample is consistent with previous studies, I match all plants from the TRI for which establishment data are available that have been sited in the Houston-Galveston and Dallas-Fort Worth areas earlier than 1986 to socioeconomic characteristics from the 1990 U.S. Census. A total of 155 plants form our dataset were established in the Dallas-Fort Worth area and 134 plants were established in the Houston-Galveston area prior to 1986.

Table 1 presents summary statistics for the socio-economic characteristics typically discussed in the environmental justice literature. I find that for both the Dallas-Fort Worth and Houston-Galveston areas, the summary statistics show that neighborhoods with a plant generally have, on average, lower incomes, higher percent non-white and foreign-born, higher percent living in poverty, and a greater percent renters. Such a finding is consistent with the correlations observed in the literature

when all plants are matched to contemporaneous neighborhood characteristics regardless of the time of siting. Figures 1 - 4 further illustrate the broad correlation between the location of older TRI plants and two socioeconomic characteristics, percent non-white and per capita income. This correlation is less evident for the subset of plants sited between 1976 and 1985.

Summary Statistics for 1980 Established Plants Only

For the time period studied, plants are concentrated in only a few two-digit industries in the two metropolitan statistical areas. Dallas-Fort Worth appears somewhat more diverse than Houston-Galveston in this regard. In Houston, almost half of the plants are in the chemicals and allied products industry (SIC 28). Another 26 percent are in fabricated metals (SIC 34), and 9 percent are in rubber and miscellaneous plastics (SIC 30) industry. In Dallas-Fort Worth, most plants are spread across five main industries: 24 percent of manufacturing plants are in the chemicals and allied products (SIC 28) industry, 15 percent are in fabricated metals (SIC 34), another 15 percent are in electronic and other electrical equipment (SIC 36), 13 percent are in miscellaneous plastics (SIC 20), and 8 percent are in industrial/commercial machinery and computer equipment (SIC 35) industry.

Several characteristics differ between Houston-area tracts with a TRI plant established between 1976 and 1985 and Houston-area tracts without a TRI plant established in this time period (see Table 2). While the summary statistics generally adhere to expectation with regard to input-related costs, this is not always the case for socio-economic characteristics. Tracts in which a plant locates tend to have a higher percent employed in manufacturing, lower property values, and a greater number pre-

existing TRI facilities. They also tend to be less urban, closer to a rail line, and have lower population densities. With regard to socio-economic characteristics that are often the focus on the environmental justice literature, tracts in which a plant locates tend to have lower incomes but fewer non-white households and less poverty. There is little difference in the percent of foreign-born residents, on average. Contrary to expectations, they also tend to have fewer renters, fewer older homes, and more children. To examine whether socioeconomic characteristics in these communities show closer adherence to the environmental justice story in the subsequent decade, I also examine 1990 socioeconomic characteristics for tracts with and without a plant established in the 1980s. I find a story consistent with the summary statistics presented in Table 2: While average income is higher in census tracts without a plant, percent non-white, foreign, in poverty, and renters are all lower in neighborhoods where a plant was established a decade previously. Thus, a large part of the environmental justice story when contemporaneous socio-economic characteristics are matched to plant location appears to be driven by the existence of older plants.

While many variables for Dallas-Fort Worth look similar to those for Houston, there are a number of differences across the two metropolitan statistical areas worth noting. In Dallas-Fort Worth, tracts in which plants locate between 1976 and 1985 appear to have similar percentages of minority populations to those without plants. This is not the case in Houston, where tracts in which plants locate have, on average, noticeably lower percent minority populations. Likewise, Houston appears to have fewer households with children living in the neighborhoods in which plants locate, while there is little difference in the percentage of children living in neighborhoods with or without a new plant in Dallas-Fort Worth. Houston also appears to have a

much higher percent of renters residing in tracts without plants than in tracts in which they locate. In Dallas-Fort Worth, there is little difference in the proportion of residents who are renters. As is the case with the Houston area, 1990 socioeconomic characteristics for tracts with and without a plant established in the 1980s are consistent with what is presented in Table 2 for the main socio-economic characteristics of interest.

Finally, note that the number of pre-existing TRI sites is far greater in tracts in which plants locate than in tracts where they do not across the two time periods and the two cities. However, while tracts without plants appear to have a similar average incidence of pre-existing sites across the two cities, Houston appears to have a noticeably greater average number of pre-existing sites in tracts with plants than Dallas-Fort Worth.

Results

The first two columns of Table 3 report the results of conditional logit regressions for Dallas-Fort Worth and Houston;[22] the third column contains results for the entire state of Texas using the same set of variables.[23] Two specifications are presented for each geographic region: the first uses alternate measures of poverty and property values – percent of households without a phone and percent of housing built prior to 1970 - to

[22] The majority of census tracts have only one or two TRI plants from the sample sited in them from 1976 to 1985. In Dallas-Fort Worth, 44 of 105 plants are the only plant to locate in a particular census tract during this time period while 34 plants locate in a census tract in which one other plant also was sited. In Houston-Galveston, 33 of 56 plants are the only plants to locate in a particular census tract over this time period, while 8 plants locate in a census tract in which one other plant also was sited. As such, utilizing a count model gives results largely consistent with the conditional logit results here.

[23] In the Texas-level regressions, I utilize a conditional logit model with 49 alternate locations instead of nine. I also include geographic dummies for the Houston-Galveston and Dallas-Fort Worth areas. Neither is significant.

better account for multi-collinearity between these variables and the race and income variables; the second specification ignores the multi-collinearity problem and presents the variables typically used in the environmental justice literature: race, income, poverty, and property values. It is worth noting that the fit of the three regressions varies – the best fit is for Houston-Galveston regression (54-55 percent), followed by Texas as a whole (39 percent), and then Dallas-Forth Worth (28-29 percent).

Contrary to results cited in the environmental justice literature, there is little evidence to support the hypothesis that firms discriminate on the basis of race or ethnicity, controlling for other location-relevant factors. The results are remarkably consistent in this regard in spite of variation in the scope of the analysis across the three sets of regressions.[24]

With regard to income and poverty, geographic scope appears to have some influence on the results. Neither income nor poverty – or its proxy – is significant for either of the two sets of MSA-level regressions. Income is also not significant at the state level. However, at the state level - depending on the specification - poverty is significant and negatively related to location choice. Note that the sign on the poverty variable is opposite of what has been posited in the environmental justice literature.

Of the variables associated with collective action by the community, only population density is consistently significant across the three geographic areas I examine. The more densely populated an area, the less likely it is that a polluting plant locates there. The percent renters and children are not significant for any of the three geographic areas. The percent over the age of 65 is significant for Texas as a

[24] As an alternative, a count regression model is used to examine what variables are associated with the number of facilities located in a particular neighborhood. The results for race, ethnicity, poverty, and income variables appear to be robust to the regression technique.

whole but for only one of the two specifications presented. It is not significant for the Dallas-Fort Worth or Houston-Galveston areas.

Variables traditionally considered in the firm location literature but often omitted from environmental justice studies – those associated with production and transportation costs - are significant. This finding is consistent with Wolverton (2009); what appears to matter most to a plant location decision regardless of geographic scope, are the variables emphasized in the firm location literature. Without these variables the pseudo R-squared falls to seven percent for Dallas-Fort Worth, 18 percent for Houston-Galveston, and 31 percent for Texas as a whole.

What is perhaps most interesting is that there are differences in the specific profit maximization variables that are significant across the three sets of regressions. County-level wage rate is significant and of the expected sign (negative) for Texas as a whole but is insignificant at the MSA-level. Distance to a major railroad is significant and negatively related to plant location for Houston-Galveston and Texas. Neither of these variables appears to matter to location decisions in the Dallas-Fort Worth area. County-level attainment status for traditional air pollutants is important to plant location decisions in the Dallas-Fort Worth area but not for Houston-Galveston or Texas as a whole.[25] Property value is not significantly correlated with plant location for any of the geographic areas. However, the alternative measure of land value, average age of housing, is significant and negatively correlated with plant location in Dallas-Forth Worth and for Texas. However, its sign indicates that it may

[25] I also explored whether non-attainment status interacted with industry-related variables such as percent manufacturing, county wage, or SIC dummy variables are significant. None of these interaction terms were significant for plant location decisions in the Houston-Galveston area. In the Dallas-Fort Worth area, only one interaction term was significant: between non-attainment status and percent manufacturing. However, when the interaction term is significant, non-attainment status alone is no longer significant.

be capturing factors other than property values – to the extent homes in older neighborhoods are less expensive. Percent urban also follows this pattern: it is significant in Dallas-Fort Worth and Texas as a whole but not for Houston-Galveston.

Two variables are consistently significant across all geographic areas and specifications: percent employed in manufacturing and the presence of one or more pre-existing TRI site. The greater the percent employed in manufacturing, the more likely that a plant will locate in that neighborhood. Likewise, once an older site is located in a particular neighborhood, it is more likely for an additional plant to locate there. This may be due to agglomeration economies or factors not controlled for in these regressions such as taxes and zoning.

Given the importance of pre-existing TRI sites in the regressions, I also examine whether the significance of the main race and income variables change when this variable is dropped. For the MSA-level regressions, percent non-white and percent foreign remain insignificant. However, income is now significant in three of the four MSA-level regressions. Percent poverty becomes significant at the 10 percent level for Dallas-Fort Worth but is still negatively related to plant location: the higher the poverty rate, the less likely a plant is located in that neighborhood. It remains insignificant for Houston-Galveston. Finally, the percent of households without a phone is now significant for both MSA-level regressions and continues to be positively related to plant location. When pre-existing TRI sites is dropped from the regressions for all plants sited in Texas over this time period, results remain unchanged for all race and income variables with one notable exception. Percent foreign is now significant in both specifications at the 1 percent level. This result runs

counter to what was found in Wolverton (2009), but points to the importance of pre-existing sites to the main finding and highlights an area for continued future research.

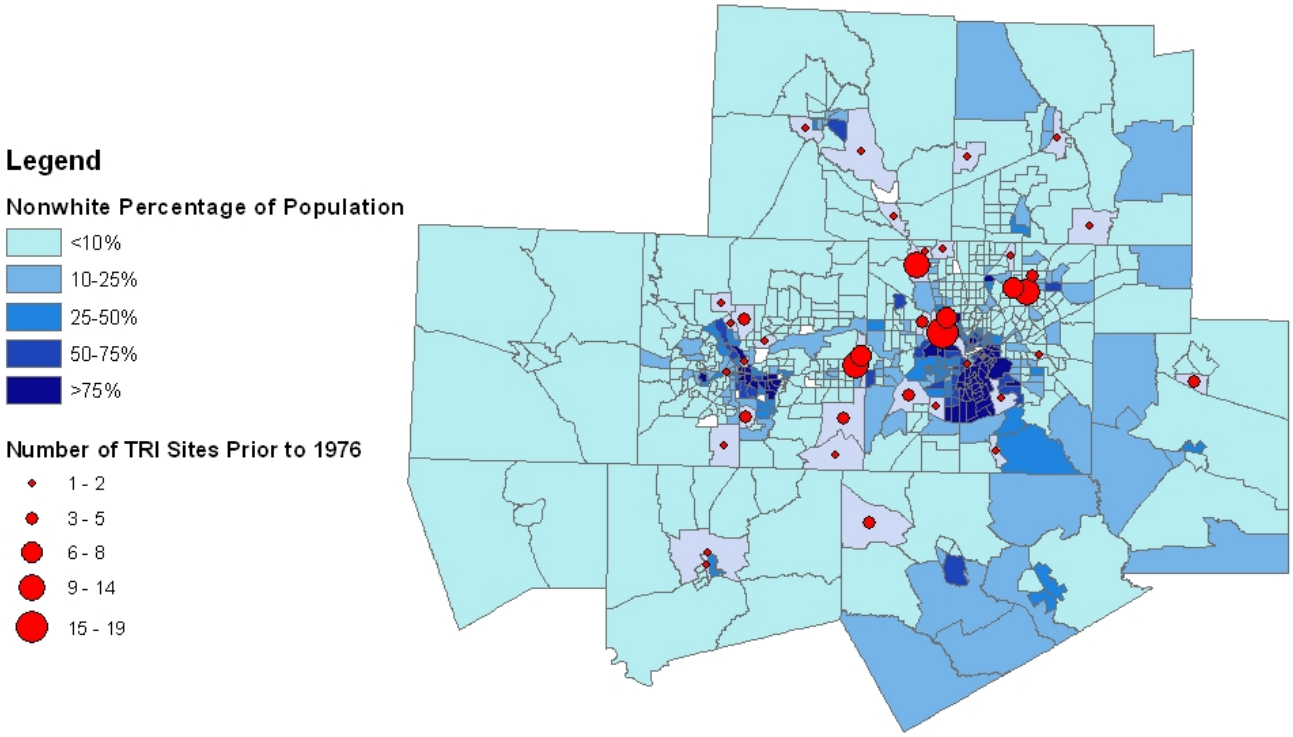
Conclusion

In this study, I examine whether results that examine four possible hypotheses for why plants may locate in poor or minority neighborhoods remain consistent across geographic scope. Specifically, I compare two Texas cities, Dallas-Fort Worth and Houston-Galveston, to state level results. I find remarkably consistent results for most hypotheses. Variables associated with profit maximization appear to contribute most to the overall fit of the regressions, both at the city and state level. Variables associated with possible discrimination or collective action on the part of the community appear to be largely insignificant across specifications and geographic scope, with the exception of population density. Variables associated with willingness-to-pay for environmental amenities appear to be the exception: poverty is sometimes significant at the state level but is never significant at the level of the city.

Table 1: Dallas-Fort Worth and Houston-Galveston Summary Statistics – All Plants Matched to 1990 Socio-Economic Characteristics

Variables	**Houston-Galveston MSA**		**Dallas-Fort Worth MSA**	
	Tracts With Plant (n=134)	**Tracts Without Plant** (n=488)	**Tracts With Plant** (n=150)	**Tracts Without Plant** (n=446)
Non-White	0.36 (0.27)	0.36 (0.30)	0.34 (0.28)	0.29 (0.29)
Foreign-Born	0.14 (0.12)	0.11 (0.10)	0.09 (0.09)	0.08 (0.08)
Poverty	0.20 (0.13)	0.18 (0.13)	0.17 (0.14)	0.15 (0.14)
Average Income	10,006 (4,717)	12,081 (7,530)	10,192 (3,908)	13,625 (9,465)
Renter	0.44 (0.21)	0.42 (0.23)	0.46 (0.23)	0.42 (0.23)

Figure 1: Number of TRI Plants and Percent Non-White in Dallas-Fort Worth



Between 1976 and 1986

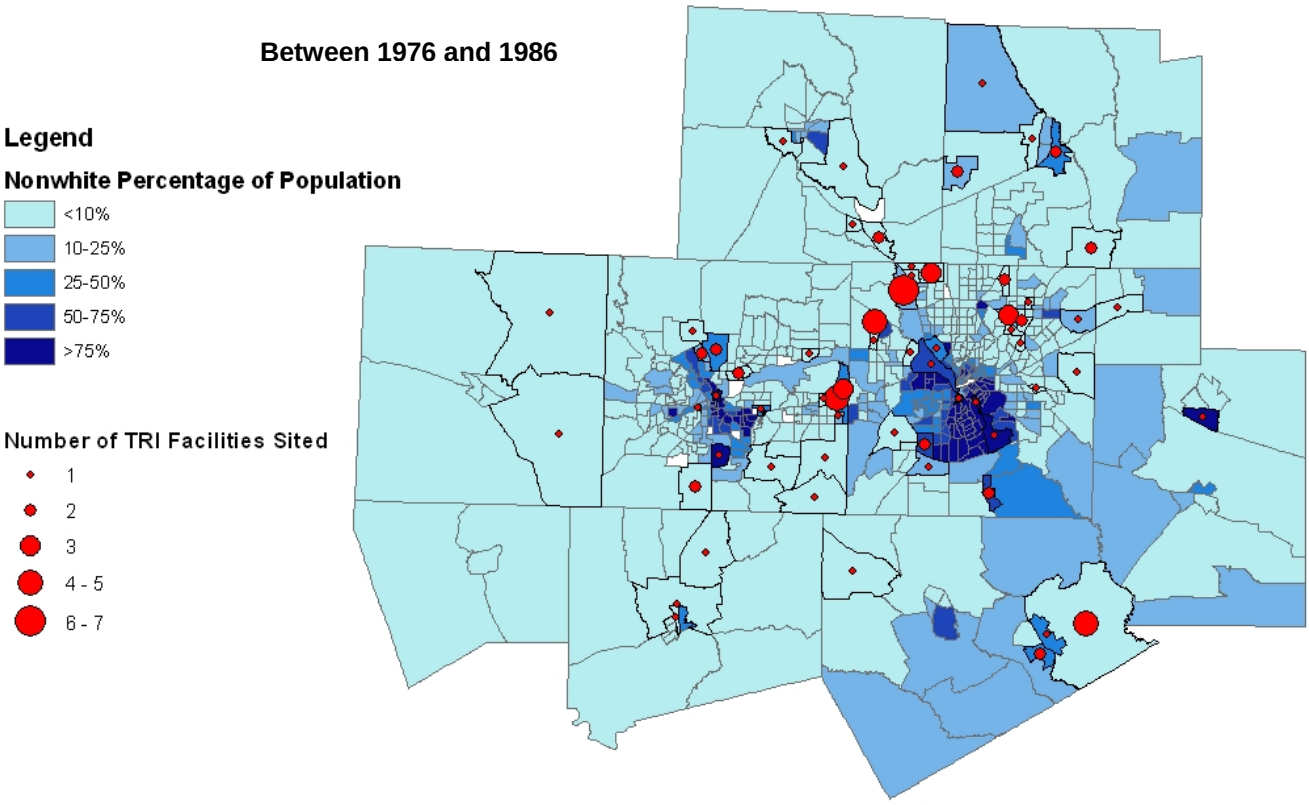
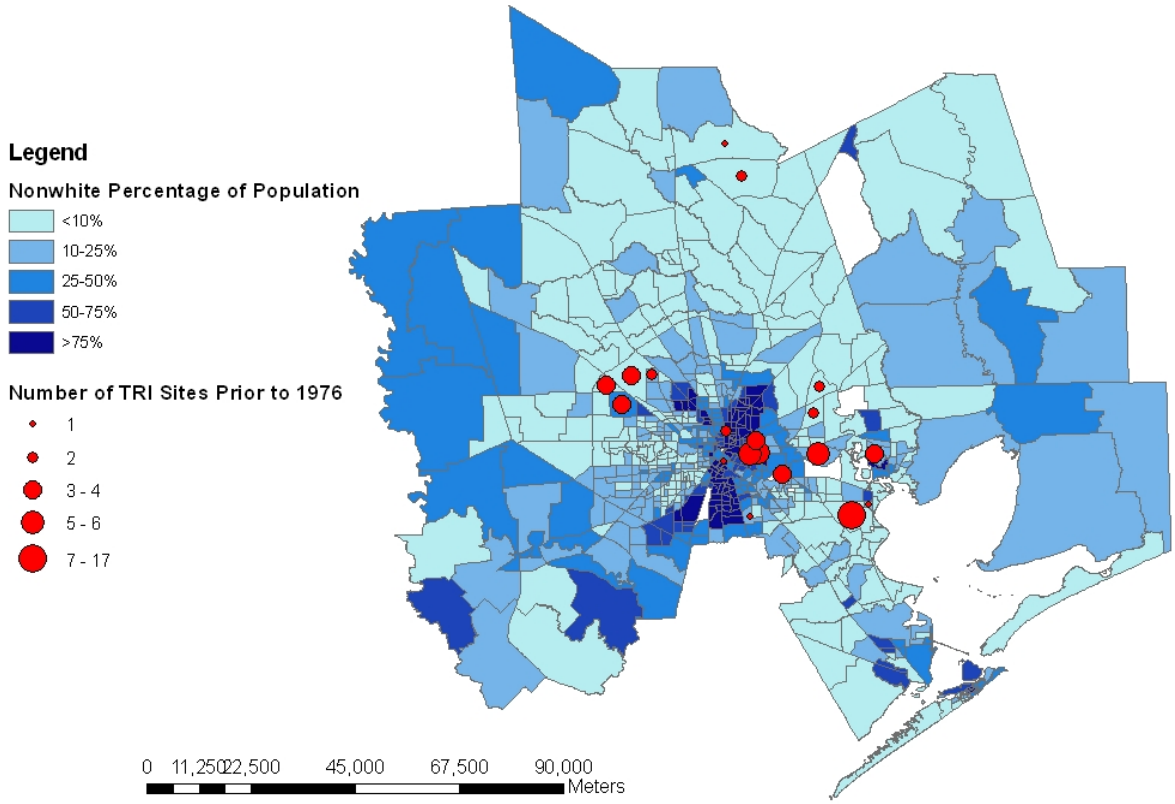


Figure 2: Map of Number of TRI Plants and Percent Non-White in Houston-Galveston



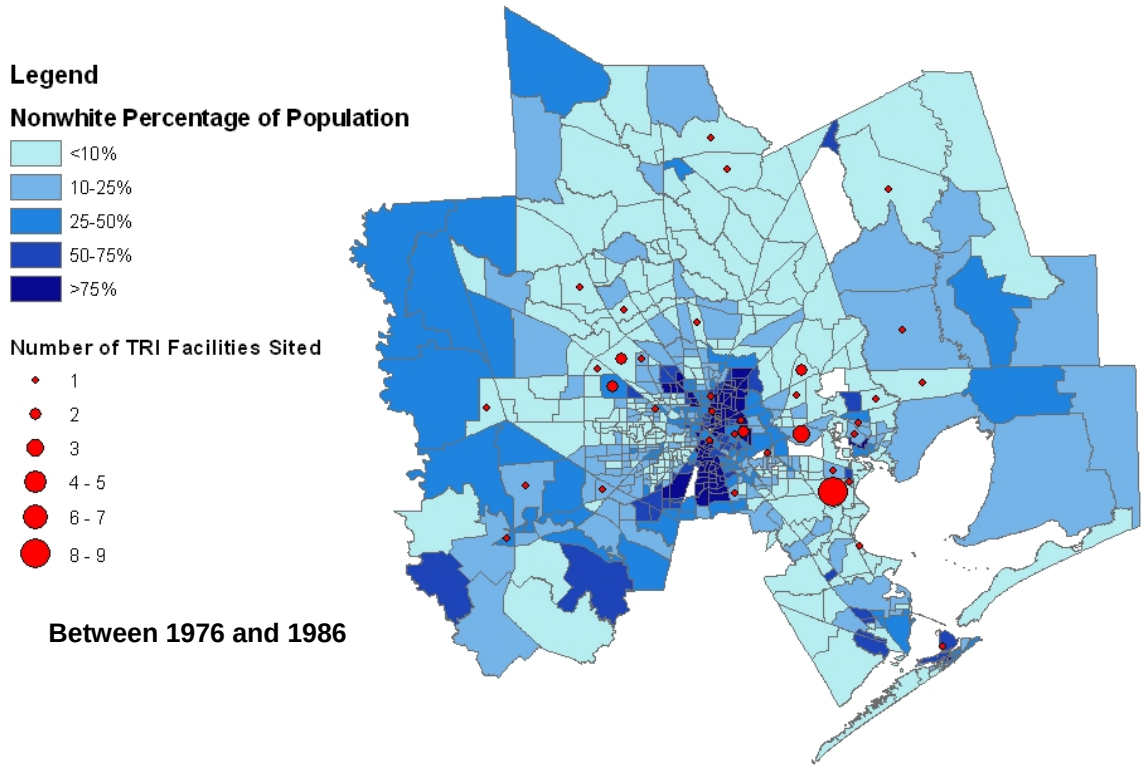
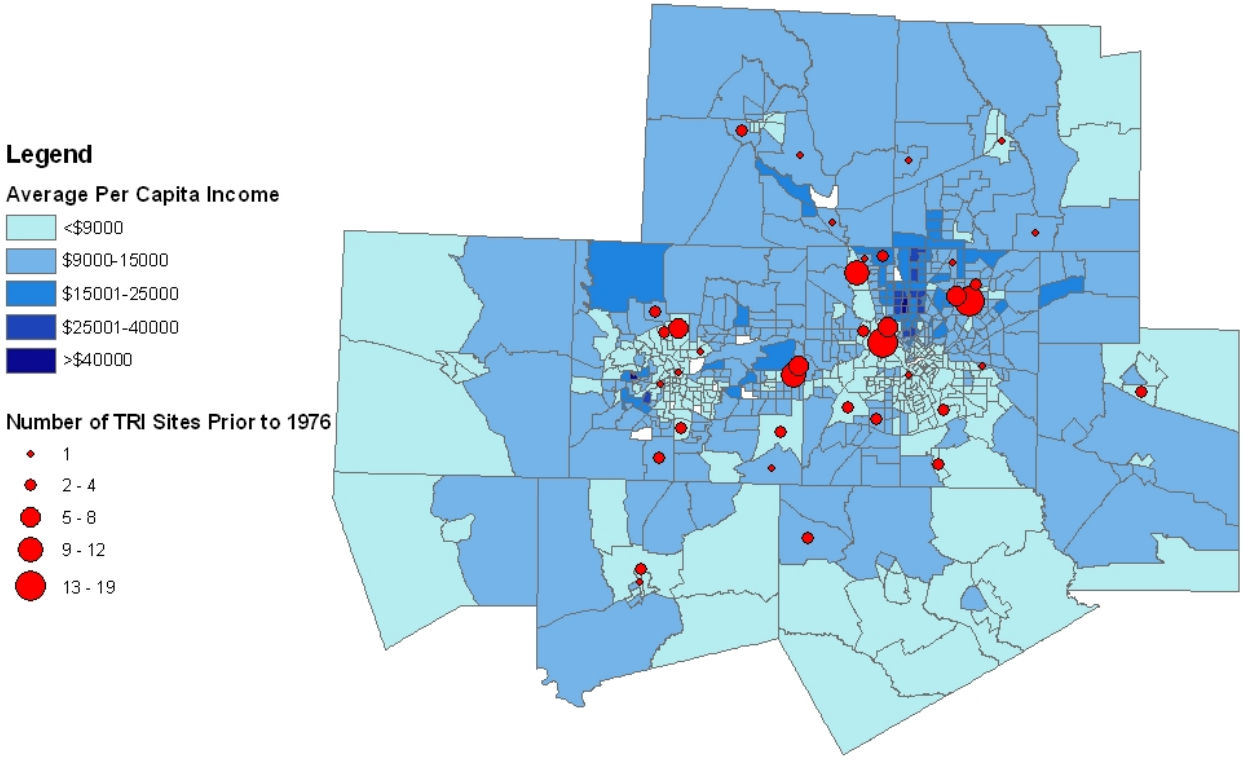


Figure 3: Number of TRI Plants and Per-Capita Income in Dallas-Fort Worth



Between 1976 and 1986

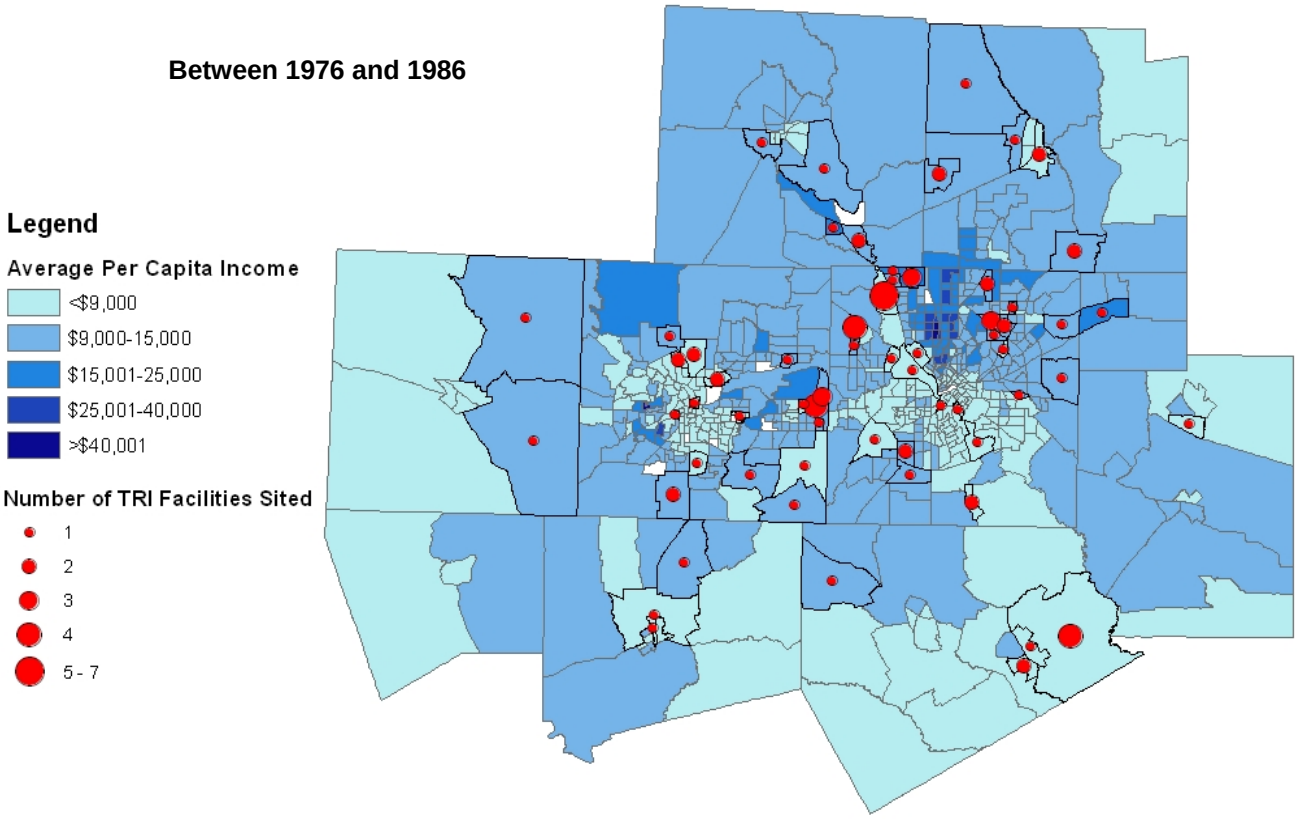
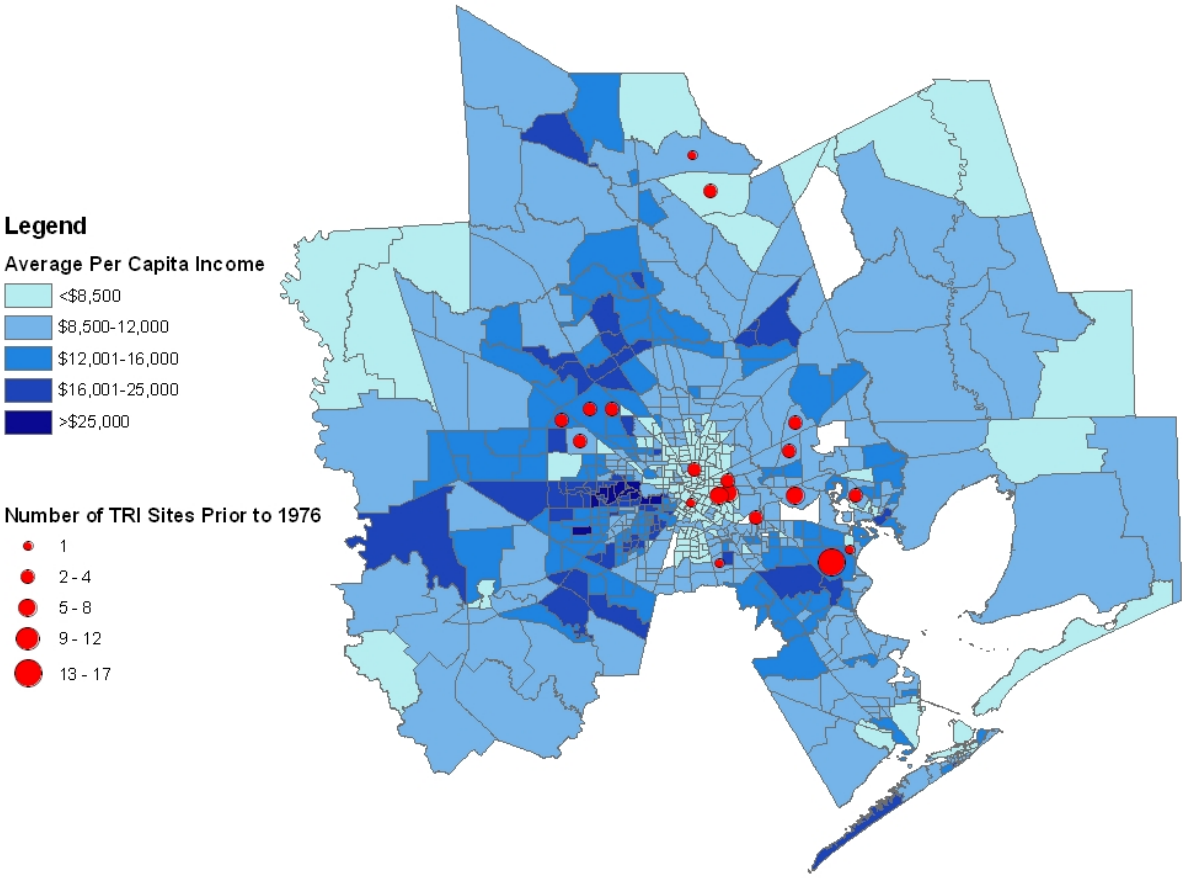


Figure 4: Number of TRI Plants and Per-Capita Income in Houston-Galveston



Between 1976 and 1986

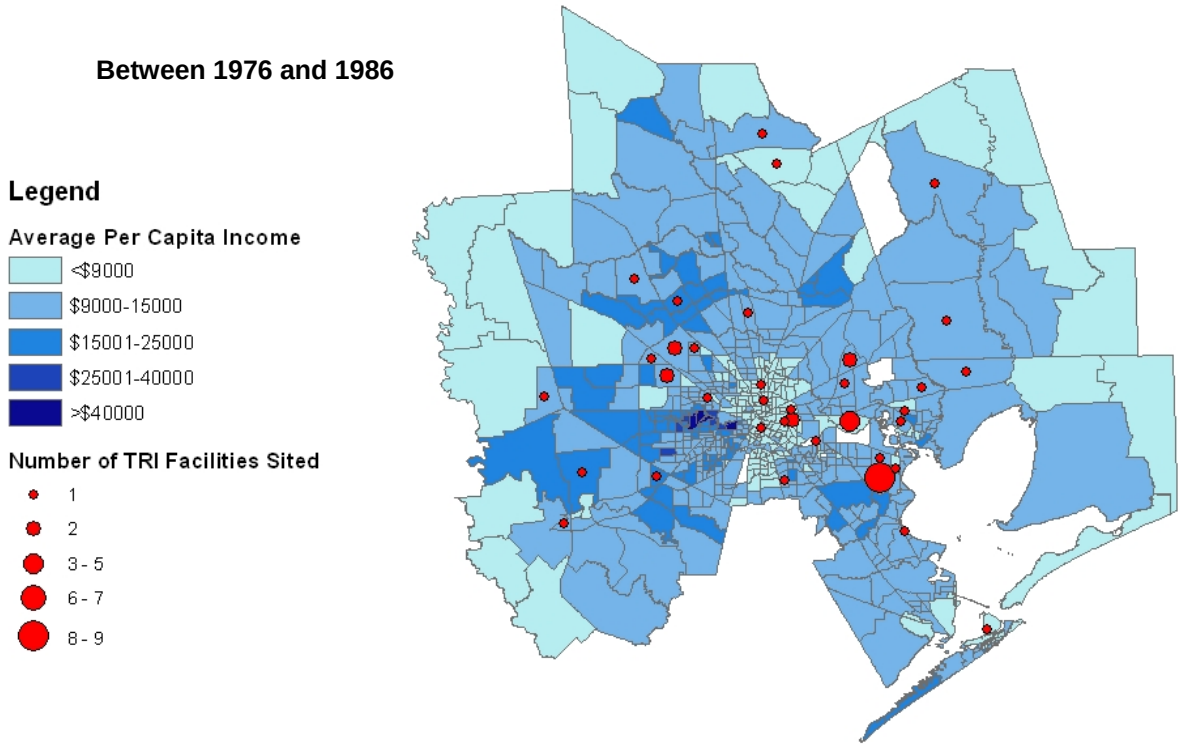


Table 2: Dallas-Fort Worth and Houston-Galveston Summary Statistics – Plants Established Between 1976 and 1985 Matched to 1980 Characteristics

Variables	**Houston-Galveston MSA**		**Dallas-Fort Worth MSA**	
	Tracts With Plant (n=56)	**Tracts Without Plant** (n=584)	**Tracts With Plant** (n=106)	**Tracts Without Plant** (n=529)
Non-White	0.21 (0.28)	0.29 (0.31)	0.21 (0.25)	0.23 (0.30)
Foreign-Born	0.06 (0.07)	0.07 (0.07)	0.04 (0.04)	0.05 (0.06)
Poverty	0.09 (0.09)	0.11 (0.09)	0.11 (0.10)	0.11 (0.11)
Average Income	10,064.69 (3,944.61)	11,334.16 (4,961.67)	9,671.05 (2,949.16)	10.982.96 (6,008.98)
Population Density	828.95 (1068.45)	2822.44 (2594.61)	922.16 (1065.02)	3278.46 (2964.74)
Renter	0.26 (0.19)	0.39 (0.24)	0.38 (0.26)	0.38 (0.25)
Percent With Children	0.47 (0.16)	0.41 (0.15)	0.39 (0.14)	0.38 (0.15)
Percent Over the Age of 65	0.05 (0.04)	0.07 (0.05)	0.09 (0.07)	0.10 (0.07)
Manufacturing	0.21 (0.08)	0.18 (0.07)	0.27 (0.08)	0.22 (0.07)
Average Wage	20,811.34 (1,800.33)	21,110.82 (2,044.82)	15,560.74 (1,773.37)	15,835.02 (1,694.78)
Average Property Value	36,131.34 (18,588.62)	44,978.37 (27,661.09)	31,163.21 (21,799.31)	45,760.67 (33,426.65)
Non-Attainment Status	0.84 (0.37)	0.88 (0.32)	0.71 (0.46)	0.80 (0.40)
Distance to Rail	1.09 (1.35)	1.32 (1.45)	1.06 (1.43)	1.11 (0.99)
Built Prior to 1970	0.49 (0.30)	0.64 (0.31)	0.58 (0.28)	0.71 (0.28)
Number of Old TRI Sites	4.52 (5.91)	0.23 (0.65)	2.87 (3.96)	0.25 (0.78)
Urban	0.71 (0.43)	0.84 (0.35)	0.66 (0.46)	0.84 (0.36)

Table 3: Conditional Logit Regression Results

Variables	Dallas-Fort Worth		Houston-Galveston		All of Texas	
Non-White	0.11 (0.76)	0.48 (0.80)	0.28 (0.93)	-0.08 (1.14)	0.32 (0.37)	0.52 (0.39)
Foreign	-4.52 (3.46)	-3.21 (3.28)	0.57 (3.02)	0.15 (3.00)	-0.23 (1.09)	0.43 (1.00)
Income	-0.51 (0.62)	-0.04 (0.53)	-0.08 (0.24)	-0.73 (0.81)	-0.02 (0.05)	0.02 (0.05)
No Phone	-1.35 (2.12)		1.91 (3.18)		-0.73 (1.00)	
Poverty		-3.37 (2.67)		1.63 (4.72)		-2.58 ** (1.07)
Population Density	-0.18 * (0.11)	-0.23 ** (0.97)	-0.47 ** (0.22)	-0.55 ** (0.24)	-0.28 *** (0.05)	-0.28 *** (0.05)
Renter	0.79 (0.87)	0.88 (0.91)	-0.16 (1.74)	0.11 (1.73)	0.42 (0.32)	0.18 (0.35)
Children	-0.26 (1.51)	0.33 (1.46)	3.30 (2.88)	3.25 (2.93)	0.87 (0.63)	0.83 (0.59)
Over 65 years old	-0.68 (3.17)	-4.42 (2.71)	2.64 (10.05)	0.68 (8.57)	-2.44 (2.06)	-4.66 ** (1.84)
Manufacturing	6.93 *** (1.93)	6.45 *** (1.88)	5.39 ** (2.72)	5.90 ** (2.79)	3.00 *** (0.71)	2.82*** (0.68)
Wage	-0.78 (1.57)	-0.68 (1.52)	1.97 (2.15)	1.53 (2.09)	-0.63 * (0.38)	-0.96 ** (0.39)
Distance to Rail	-0.10 (0.10)	-0.13 (0.10)	-0.41 ** (0.17)	-0.41 ** (0.16)	-0.25 *** (0.05)	-0.23 *** (0.05)
Non-Attainment	1.35 ** (0.56)	1.17 ** (0.59)	-0.61 (0.80)	-0.53 (0.80)	0.06 (0.25)	0.002 (0.02)
Built Prior to 1970	-1.94 *** (0.57)		-0.59 (1.19)		-1.13 *** (0.33)	
Property Value		-0.05 (0.04)		0.62 (0.68)		-0.03 (0.03)
Urban	-1.81 *** (0.54)	-1.86 *** (0.58)	-0.04 (0.91)	0.03 (0.93)	-0.49 ** (0.25)	-0.61** (0.26)
Old TRI Sites	0.19 *** (0.06)	0.18 *** (0.05)	0.49 *** (0.16)	0.50 *** (0.16)	0.22 *** (0.04)	0.22 *** (0.03)
Old * SIC 28	0.25 * (0.14)	0.20 * (0.12)			0.08 (0.06)	0.09 (0.06)
Old * SIC 30	0.22 * (0.13)	0.17 (0.11)			0.01 (0.08)	0.004 (0.08)
Old * SIC 34			0.49 * (0.30)	-0.51 * (0.29)	0.28 ** (0.14)	0.28 ** (0.14)
Log Likelihood	-171.52	-173.94	-63.40	-63.12	-832.77	-834.49
Adjusted R-Squared	0.30	0.29	0.51	0.51	0.40	0.40

* 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.

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