Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims

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INTRODUCTION

The environmental justice movement asserts that low-income and minority neighborhoods are exposed to greater risks from environmental hazards than other neighborhoods because of racism and classism in the siting of locally undesirable land uses (LULUs), the promulgation of environmental and land use regulations, the enforcement of those regulations, and the effort spent on cleaning polluted areas.[1] These claims, and the movement's demands for a more equitable distribution of environmental "goods", like clean air, and of environmental "bads", like waste facilities, are increasingly central to deliberations about environmental and land use policy in the United States.[2] President Clinton signed an Executive Order in February 1994 that requires every federal agency to "make achieving environmental justice part of its mission . . . ."[3] The Environmental Protection Agency (EPA) has created a national Environmental Justice Office, the National Environmental Justice Advisory Committee, and environmental justice coordinators within each of its departments and

1. For a description of the environmental justice movement, see, for example, Robert D. Bullard, *Anatomy of Environmental Racism and the Environmental Justice Movement*, *in* CONFRONTING ENVIRONMENTAL RACISM, VOICES FROM THE GRASSROOTS 15 (Robert D. Bullard ed., 1993) [hereinafter CONFRONTING ENVIRONMENTAL RACISM]. For a survey of much of the legal literature on environmental justice, see Robert W. Collin, *Review of the Legal Literature on Environmental Racism, Environmental Equity and Environmental Justice*, 9 J. ENVTL. L. & LITIG. 121 (1994). For collections of the literature, see Symposium, *Environmental Justice: The Merging of Civil Rights and Environmental Activism*, 9 ST. JOHN'S J. LEGAL COMMENT. 437 (1994); *Third Annual Stein Center Symposium on Contemporary Urban Challenges*, 21 FORDHAM URB. L.J. 425 (1994); Symposium, *Earth Rights and Responsibilities: Human Rights and Environmental Protection*, 18 YALE J. INT'L L. 215 (1993); Symposium, *Race, Class, and Environmental Regulation*, 63 U. COLO. L. REV. 839 (1992); Symposium, *Environmental Equity in the 1990s: Pollution, Poverty, and Political Empowerment*, 1 KAN. J.L. & PUB. POL'Y 1 (1991). See also the readings collected in ROBERT D. BULLARD, UNEQUAL PROTECTION: ENVIRONMENTAL JUSTICE AND COMMUNITIES OF COLOR (1994); CONFRONTING ENVIRONMENTAL RACISM, *supra*; ENVIRONMENTAL JUSTICE (J. Petrikin ed., 1995); KENNETH A. MANASTER, ENVIRONMENTAL PROTECTION AND JUSTICE—READINGS AND COMMENTARY ON ENVIRONMENTAL LAW AND PRACTICE (1995); RACE AND THE INCIDENCE OF ENVIRONMENTAL HAZARDS: A TIME FOR DISCOURSE (Bunyan Bryant & Paul Mohai eds., 1992) [hereinafter INCIDENCE OF ENVIRONMENTAL HAZARDS]; TOXIC STRUGGLES: A THEORY AND PRACTICE OF ENVIRONMENTAL JUSTICE (Richard Hofrichter ed., 1993) [hereinafter TOXIC STRUGGLES].

2. For an overview of the impact the environmental justice movement has had on executive and legislative decisionmaking at the federal and state levels, see Vicki Been, *Environmental Justice and Equity Issues*, *in* ZONING AND LAND USE CONTROLS § 25D.06 (Patrick J. Rohan ed., 1995).

3. Exec. Order No. 12,898, 59 Fed. Reg. 7629 (1994). For discussion of the Executive Order, see Been, *supra* note 2, at §25D.06[1]; Rodolfo Mata, *Environmental Equity: The Next Generation of Facility Siting Programs*, 16 CHICANO-LATINO L. REV. 1, 19-22 (1995); Meredith J. Bowers, Note, *The Executive's Response to Environmental Injustice: Executive Order 12,898*, 1 Envtl. L. 645, 657-58 (1995); Roliff H. Purrington, Jr., *Putting Justice into the Calculus*, TEX. LAW., Sept. 19, 1994, at 18; David Schoenbrod, *Environmental "Injustice" Is About Politics, Not Racism*, WALL ST. J., Feb. 23, 1994, at A21; Reed D. Rubinstein, *Rethinking Environmental Justice*, CONN. L. TRIB., Dec. 12, 1994, at 6.

regional offices in order to address environmental justice issues.[4] Environmental impact statements prepared under the National Environmental Policy Act of 1969[5] (NEPA) now address environmental justice concerns.[6] At least seven states have adopted legislation regarding environmental justice, and many more are now considering such legislation.[7]

While the environmental justice movement broadly addresses the distributional implications of all environmental and land use decisions, one of the movement's central concerns has been the siting of undesirable land uses, like waste facilities. According to environmental justice advocates, such facilities either are placed deliberately in minority neighborhoods, or at least are sited in a manner that results in minority neighborhoods hosting a disproportionate share of these facilities.[8]

To support this argument, environmental justice advocates point to a score of studies that analyze the correlation between the location

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4. U.S. Envtl. Protection Agency, ENVTL. JUSTICE 1994 ANN. REP. 3-5 (1995).

5. 42 U.S.C. §§ 4321-4335 (1994).

6. In a memorandum accompanying his Executive Order, President Clinton urged all agencies to use NEPA's environmental impact statement requirement to achieve environmental justice goals. Memorandum on Environmental Justice, 30 WEEKLY COMP. PRES. DOC. 279 (Feb. 14, 1994). For an example of an impact statement that addresses the environmental justice implications of a proposed project, see, for example, Aspen Envtl. Group, Impacts on Minority Populations and Low-Income Populations, in Pacific Pipeline Project, Draft Environmental Impact Statement/Subsequent Environmental Impact Report, Part C.16, (April 1995) (on file with California Public Utilities Commission).

7. Environmental justice legislation has been passed in Alabama, ALA. CODE § 22-3-5.1 (1990); Arkansas, ARK. CODE ANN. §§ 8-6-1501 to 8-6-1504 (Michie 1993); Florida, FLA. STAT. ANN § 760.85 (West 1996); Georgia, GA. CODE ANN. § 12-8-25.4 (1996); Louisiana, LA. REV. STAT. ANN. § 30.2011(D)(5) (1996), as amended by 1993 La. Acts 767; and North Carolina, N.C. GEN. STAT. § 160-A-325 (a) (1994). The Tennessee and Virginia legislatures both have passed resolutions regarding environmental justice. *See* H.R.J. Res. 146, 98th Leg., 1st. Reg. Sess. (Tenn. 1993); H.R.J. Res. 529, 1993 Reg. Sess. (Va. 1993). New York City has enacted environmental justice regulations intended in part to promote environmental justice, City Planning Comm'n, Criteria for the Location of City Facilities art. 5.1 (Dec. 3, 1990). Environmental justice legislation currently is pending in Alabama, S. 528, 1996 Extraordinary Sess. (1996); Colorado, H.R. 1092, 60th Leg., 2d Reg. Sess. (1996); Illinois, H.R. 3224, 89th Leg., 1995-1996 Reg. Sess. (1996); Minnesota, H.R. 2023, 79th Leg., 1996 Reg. Sess. (1996); Mississippi, H.R. 658, 72d Leg., 1996 Reg. Sess. (1996); New York, S. 653, 219th Leg., 2d Reg. Sess. (1996); Pennsylvania, H.R. 2321, 108th Leg., 1995-96 Reg. Sess. (1996); Tennessee, H.R. 2661, 99th Leg., 2d Reg. Sess. (1996); Texas, S. 984, 74th Leg., 1995 Reg. Sess. (1995); Washington, H.R. 1409, 54th Leg., 1995 Reg. Sess. (1995); and Wisconsin, S. 434, 92d Leg., 1995-1996 Reg. Sess. (1995). Other states have made unsuccessful attempts to pass environmental justice legislation. *See, e.g.*, H.R. 204, 143d Leg., 1995-96 Reg. Sess. (Ga. 1995) (died in committee March 8, 1996). Many of the proposed bills are based on the Model Environmental Justice Act proposed by the Center for Policy Alternatives and the National Black Caucus of State Legislators. *See* Center for Policy Alternatives, Model Legislation Series: Environmental Justice Act (1994).

8. *See, e.g.*, Robert D. Bullard, *The Threat of Environmental Racism*, 7 NAT. RESOURCES & ENV'T 23 (1993); Luke W. Cole, *Empowerment as the Key to Environmental Protection: The Need for Environmental Poverty Law*, 19 ECOLOGY L.Q. 619, 628-30 (1992); Karl Grossman, *Environmental Justice*, E MAG., May-June 1992, at 29, 31.

of LULUs and the demographics of the neighborhoods.[9] The most prominent research is a nationwide analysis of the demographic characteristics of areas surrounding commercial hazardous waste facilities that the Commission for Racial Justice (CRJ) published in 1987. The CRJ found a significant correlation between the number of commercial hazardous waste facilities in a zip code and the percentage of minorities in the zip code's population.[10] The percentage of minorities in areas with one operating facility was almost twice that of areas without facilities.[11] As the number or noxiousness of facilities in a neighborhood increased, so did the percentage of minorities in that neighborhood.[12] In 1994, the CRJ updated its study using 1990 census data, and again found that zip codes hosting one facility had more than twice the percentage of minorities as zip codes hosting no facilities.[13] At least twenty other studies have reached similar conclusions based upon case studies of particular cities, counties or regions.[14]

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9. The environmental justice movement includes African Americans, Hispanics, Native Americans, Asian Americans, and other non-white groups under its umbrella. The studies discussed here often focus on particular racial or ethnic groups, as indicated in the text or notes describing each study. Similarly, while the environmental justice movement is concerned with low-income neighborhoods, the studies define those neighborhoods differently.

10. UNITED CHURCH OF CHRIST COMMISSION FOR RACIAL JUSTICE, TOXIC WASTES AND RACE IN THE UNITED STATES 13-14 (1987). "Minorities" are defined in the study as "Blacks, Hispanics, Asians and Pacific Islanders, American Indians, Eskimos, Aleuts and other 'non-White' persons." *Id.* at 9.

11. *Id.* at 13, 41-44.

12. *Id.*

13. BENJAMIN A. GOLDMAN & LAURA FITTON, TOXIC WASTES AND RACE REVISITED 3 (1994).

14. *See* AFRICAN AMERICAN ENVIRONMENTALIST ASS'N ET AL., OUR UNFAIR SHARE: A SURVEY OF POLLUTION SOURCES IN OUR NATION'S CAPITAL 64 (1994); Lauretta Burke, NAT'L CENTER FOR GEOGRAPHIC INFO. & ANALYSIS, Environmental Equity in Los Angeles 74 (1994); PAT COSTNER & JOE THORNTON, GREENPEACE USA, PLAYING WITH FIRE: HAZARDOUS WASTE INCINERATION 48-49 (1990); FLORIDA ENVIRONMENTAL EQUITY AND JUSTICE COMMISSION, FINAL REPORT 9-36 (1996); JOINT LEGISLATIVE AUDIT AND REVIEW COMM'N OF THE VIRGINIA GEN. ASSEMBLY, SOLID WASTE FACILITY MANAGEMENT IN VIRGINIA: IMPACT ON MINORITY COMMUNITIES 32-40 (1995); TED GLICKMAN & ROBERT HERSH, RESOURCES FOR THE FUTURE, EVALUATING ENVIRONMENTAL EQUITY: THE IMPACTS OF INDUSTRIAL HAZARDS ON SELECTED SOCIAL GROUPS IN ALLEGHENY COUNTY, PENNSYLVANIA (1995) (Discussion Paper 95-13); MICHAEL GREENBERG & R. ANDERSON, HAZARDOUS WASTE SITES: THE CREDIBILITY GAP 158-59 (1984); U.S. GEN. ACCOUNTING OFFICE, GAO/RCED-83-168, SITING OF HAZARDOUS WASTE LANDFILLS AND THEIR CORRELATION WITH RACIAL AND ECONOMIC STATUS OF SURROUNDING COMMUNITIES (1983); E.B. Attah, *Demographics and Siting Issues in EPA Region IV*, *in* PROCEEDINGS OF THE CLARK ATLANTA UNIVERSITY AND ENVIRONMENTAL PROTECTION AGENCY REGION IV CONFERENCE ON ENVIRONMENTAL EQUITY 3-4 (B. Holmes ed., 1992); Robert D. Bullard, *Solid Waste Sites and the Black Houston Community*, 53 SOC. INQUIRY 273 (1983); Michael Greenberg, *Proving Environmental Inequity in Siting Locally Unwanted Land Uses*, 4 RISK—ISSUES HEALTH & SAFETY 235, 241-43 (1993); James Hamilton, *Testing for Environmental Racism: Prejudice, Profits, Political Power?*, 14 J. POL'Y ANALYSIS & MGMT. 107 (1995); Jane Kay, *Minorities Bear the Brunt of Pollution*, SAN FRANCISCO EXAMINER, Apr. 7, 1991, at A1, A12; Paul Mohai & Bunyan Bryant, *Environ-*

I cautioned against making policy changes based on this evidence in early 1994, arguing that the research failed to examine whether the host communities were disproportionately poor or minority at the time the sites were selected, or whether they became so following the siting.[15] Although the CRJ study and similar research were being used to support calls for fundamental reforms in siting processes,[16] the research provided absolutely no evidence that the siting process caused any current disproportion in the percentages of racial or ethnic minorities or the poor living in host neighborhoods.

Instead, the research left open the possibility that the sites for the facilities originally were chosen in a manner that was neither intentionally discriminatory nor discriminatory in effect, but that market responses to the facilities led the host neighborhoods to become disproportionately populated by the poor, and by racial and ethnic minorities. I posited one theory about how that could happen: if the facility was perceived as a nuisance or undesirable neighbor, neigh-

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mental Injustice: Weighing Race and Class as Factors in the Distribution of Environmental Hazards, 63 U. COLO. L. REV. 921 (1992); Dennis Pfaff, *Pollution and the Poor*, DETROIT NEWS, Nov. 26, 1989, at A1; Philip H. Pollock, III & M. Elliot Vittes, *Who Bears the Burdens of Environmental Pollution? Race, Ethnicity, and Environmental Equity in Florida*, 76 SOC. SCI. Q. 294 (June 1995); Harvey White, *Hazardous Waste Incineration and Minority Communities*, *in* INCIDENCE OF ENVIRONMENTAL HAZARDS, *supra* note 1, at 126, 132; Bunyan Bryant & Elaine Hockman, Hazardous Waste and Spatial Relations According to Race and Income in the State of Michigan (1994) (unpublished paper, on file with author); Martin R. Brueggemann, Environmental Racism in Our Backyard: Solid Waste Disposal in Holly Springs, North Carolina (1993) (unpublished M.A. thesis Univ. North Carolina, on file with author); Leslie Nieves & Alvaro Nieves, Regional Differences in the Potential Exposure of U.S. Minority Populations to Hazardous Facilities 14 (Nov. 15, 1992) (Paper presented at the Annual Meeting of the Regional Science Ass'n, Chicago, IL, on file with author); Leslie Nieves, Not in Whose Backyard? Minority Population Concentrations and Noxious Facility Sites, (Feb. 9, 1992) (Paper presented at the American Academy for the Advancement of Science Meetings, Chicago, IL, on file with author). For reviews of the literature, see Been, *supra* note 2, at § 25D.02[2]; BENJAMIN A. GOLDMAN, NATIONAL WILDLIFE FEDERATION, NOT JUST PROSPERITY: ACHIEVING SUSTAINABILITY WITH ENVIRONMENTAL JUSTICE 3-25 (1994).

15. Vicki Been, *Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?* 103 YALE L.J. 1383 (1994).

16. *See, e.g.*, The Environmental Justice Act of 1992, S. 2806, 102d Cong., 2d Sess (1992) (proposed by then Senator Albert Gore and Congressman John Lewis, declaring a moratorium on the siting or permitting of any new polluting facilities in "environmental high impact areas"); The Environmental Equal Rights Act of 1993, H.R. 1924, 103d Cong., 1st Sess. (1993) (proposed by Congresswoman Cardiss Collins, allowing any citizen in a state to petition to prevent the siting of certain facilities in "environmentally disadvantaged communities," defined to include any area with disproportionate percentages of minorities or the poor); S. 533, 103d Cong., 1st Sess. (1993) (amending the Solid Waste Disposal Act to require that the process for permitting new waste facilities include consideration of a "community information statement"). In introducing the 1993 version of the Environmental Justice Act, Senator Max Baucus quoted the findings of the CRJ study. 139 CONG. REC. S8107 (daily ed. June 24, 1993) (statement of Senator Baucus). Similarly, the "findings" section of the Environmental Equal Rights Act refers to the CRJ study's conclusions. H.R. 1924, 103d Cong., 1st Sess. (1993).

boring property values would decrease[17] and cause those in the community who could afford to leave to do so.[18] The combination of the out-migration and the decrease in property values would then make the neighborhood's housing more affordable for lower-income households and for those whose housing choices were limited by racial discrimination in the residential housing market.[19] Thus, over time, the undesirability of the facility would cause the neighborhood to become poorer and populated by higher percentages of racial and ethnic minorities than it had been prior to the siting of the facility.[20]

I also argued that whether the sites came to low-income or minority neighborhoods or the poor and minorities came to the sites mattered a great deal for public policy. At the time, the solutions proposed for perceived environmental injustices were directed primarily at the siting process.[21] If research revealed that market dynamics, rather than siting processes, were at fault, however, those solutions had little chance of saving low-income or minority neighborhoods from noxious facilities over the long term. Instead, solutions that focused on the dynamics of the residential housing market would be required.[22] More fundamentally, if research revealed that current disparities in the siting burdens borne by the poor and minorities resulted from market forces, many would argue that government inter-

17. For studies of the effects treatment storage and disposal facilities (TSDFs) or hazardous waste sites have on neighboring property values, see M. Greenberg & J. Hughes, *The Impact of Hazardous Waste Superfund Sites on the Value of Houses Sold in New Jersey*, 26 ANNALS REGIONAL SCI. 147 (1992); Kusam Ketkar, *Hazardous Waste Sites and Property Values in the State of New Jersey*, 24 APPLIED ECON. 647 (1992); Katherine A. Kiel, *Measuring the Impact of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values*, 71 LAND ECON. 428 (1995); Janet E. Kohlhase, *The Impact of Toxic Waste Sites on Housing Values*, 30 J. URB. ECON. 1 (1991); Gary H. McClelland et al., *The Effect of Risk Beliefs on Property Values: A Case Study of a Hazardous Waste Site*, 10 RISK ANALYSIS 485 (1990); Robert Mendelsohn et al., *Measuring Hazardous Waste Damages with Panel Models*, 22 J. ENVTL. ECON. & MGMT. 259 (1992); R. Gregory Michaels & V. Kerry Smith, *Market Segmentation and Valuing Amenities with Hedonic Models: The Case of Hazardous Waste Sites*, 28 J. URB. ECON. 223 (1990); V. Kerry Smith & William H. Desvousges, *The Value of Avoiding a LULU: Hazardous Waste Disposal Sites*, 68 REV. ECON. & STAT. 293 (1986); Gerald E. Smolen et al., *Hazardous Waste Landfill Impacts on Local Property Values*, REAL EST. APPRAISER & ANALYST, April 1992, at 4; David Harrison, Jr. & James H. Stock, Hedonic Housing Values, Local Public Goods, and the Benefits of Hazardous Waste Cleanup (Nov. 1984) (unpublished paper, on file with Harvard University, John F. Kennedy School of Government, Energy and Environmental Policy Center, E-84-09). *But see* David E. Clark & Leslie A. Nieves, *An Interregional Hedonic Analysis of Noxious Facility Impacts on Local Wages and Property Values*, 27 J. ENVTL. ECON. & MGMT. 235 (1994) (finding that hazardous waste facilities had a positive effect on housing prices).

18. Been, *supra* note 15, at 1388-90.

19. *Id.*

20. *Id.*

21. *See* proposals cited *supra* note 16.

22. Been, *supra* note 15, at 1392.

ference in the market would be inefficient or otherwise inappropriate.[23]

Determining whether siting processes, market dynamics, or some combination of the two were responsible for the disproportionate burden revealed by the studies required an analysis of the demographics of host communities at the time their facilities were sited, and of subsequent changes in the demographics of those communities. The EPA funded me to undertake such a study,[24] and this article reports the results of the analysis.

While my research was underway, however, the debate about whether LULUs are disproportionately sited in minority and poor neighborhoods became even sharper. In 1994, researchers at the Social and Demographic Research Institute (SADRI) of the University of Massachusetts released a study that challenged the findings of the CRJ report. SADRI examined the demographics of the census tracts hosting commercial hazardous waste facilities and reached quite different conclusions from the CRJ's study of the zip codes hosting those same facilities.[25] SADRI found that as of the 1990 census, there was no statistically significant[26] difference in the percentages of the population that were African American or Hispanic in host and non-host tracts.[27]

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23. *Id.* at 1391-92. Environmental justice debates recently have begun to focus on whether (and how) the market's distribution of environmental quality and disamenities should be tempered through regulation. *See, e.g.*, CHRISTOPHER BOERNER ET AL., ENVIRONMENTAL JUSTICE? (1994); Seth D. Jaffe, *The Market's Response to Environmental Inequity: We Have the Solution; What's the Problem?*, 14 VA. ENVTL. L.J. 655 (1995); Symposium, *Environmental Justice: The Merging of Civil Rights and Environmental Activism*, *supra* note 1.

24. The Filomen D'Agostino and Max E. Greenberg Research Fund also supported the study, and Dean John Sexton at New York University School of Law gave generously of the Law School's funds to make the research possible.

25. Andy B. Anderson et al., *Environmental Equity: Evaluating TSDF Siting Over the Past Two Decades*, WASTE AGE, July 1994, at 83 [hereinafter *Evaluating TSDF Siting*]; *see also* Douglas L. Anderton et al., *Environmental Equity: The Demographics of Dumping*, 31 DEMOGRAPHY 229 (1994) (reporting results of analysis using 1980 census data); Douglas L. Anderton et al., *Environmental Equity: Hazardous Waste Facilities: "Environmental Equity" Issues in Metropolitan Areas*, 18 EVALUATION REV. 123 (1994).

26. In other words, appropriate statistical tests could not eliminate the possibility that any differences between the demographics of the host neighborhoods and those of the non-host neighborhoods were simply the result of chance. For accessible discussions of the concept of statistical significance, see, for example, DAVID FREEDMAN ET AL., STATISTICS 429-54 (2d ed. 1991).

27. *Evaluating TSDF Siting*, *supra* note 25, at 84. Several other recent studies also found no relationship between race or ethnicity and siting choices. *See* Christopher Boerner & Thomas Lambert, *Environmental Justice in the City of St. Louis: The Economics of Siting Industrial and Waste Facilities* (Center for the Study of American Business Working Paper 156, 1995); James Hamilton, *Politics and Social Costs: Estimating the Impact of Collective Action on Hazardous Waste Facilities*, 24 RAND J. ECON. 101, 117-18 (1993); Don Coursey et al., Environmental Racism in the City of Chicago: The History of EPA Hazard-

Accordingly, it became important for this study to tackle not just the market dynamics versus siting processes issue, but also to examine whether the neighborhoods that currently host LULUs are disproportionately populated by minorities and the poor, compared to neighborhoods that do not host LULUs.

To address both issues, my research team conducted a nationwide study of the demographics of the 544 communities that in 1994 hosted active commercial hazardous waste treatment storage and disposal facilities.[28] We looked first at the demographics of the communities as of the census taken immediately before they became hosts, then examined how the demographics of the host communities changed in each subsequent decade. Finally, we examined the demographics of the host communities as of the 1990 census.

As detailed below, we found no substantial evidence that the facilities that began operating between 1970 and 1990 were sited in areas that were disproportionately African American. Nor did we find any evidence that these facilities were sited in areas with high concentrations of the poor; indeed, the evidence indicates that poverty is negatively correlated with sitings. We did find evidence that the facilities were sited in areas that were disproportionately Hispanic at the time of the siting. The analysis produced little evidence that the siting of a facility was followed by substantial changes in a neighborhood's socioeconomic status or racial or ethnic composition. Finally, the analysis shows that the areas surrounding TSDFs currently are disproportionately populated by African Americans and Hispanics.

Part I outlines the methodology of the study. Part II analyzes the demographics of host communities at the time of the siting. Part III analyzes how the demographics of the host communities changed over time, and part IV discusses the 1990 demographics of all host communities.

I.
METHODOLOGY

A. The Facilities Studied

Our research focused on the same types of facilities that the CRJ and SADRI studied—commercial hazardous waste treatment storage and disposal facilities (TSDFs). We chose to study those facilities for several reasons. First, to engage the prior research most directly, we wanted to study the same type of facility that the most prominent of

ous Waste Sites in African-American Neighborhoods 54-59 (1994) (unpublished work, on file with author).

28. The study included TSDFs located in the continental United States. Alaska, Hawaii, and Puerto Rico were excluded.

the existing studies had addressed. Second, both property value effect studies and attitudinal surveys show that people generally consider hazardous waste facilities to be among the most burdensome of all noxious LULUs.[29] Therefore, if racism or classism affects siting processes, it would be especially likely to affect the siting of hazardous waste facilities. Third, we wanted the study to have a national focus, to avoid any concern that its findings were not generally applicable. Nationwide data about the location of TSDFs, which are primarily regulated by EPA, was more readily available than data regarding the location of facilities such as municipal solid waste landfills, which are primarily regulated at state or local levels. Finally, it was crucial for the study to have data about the date on which the facility opened or began serving as a TSDF, and those dates were more readily available for TSDFs than for other types of facilities.

We compiled lists of the currently operating TSDFs from several sources: EPA's Resource Conservation and Recovery Information System (RCRIS), the 1994 Environmental Services Directory published by Environmental Information Ltd., and various lists of facilities provided by trade organizations and other researchers.[30] The various sources of data had surprisingly little overlap. To ensure that the facilities included on our list were in fact currently operating, and were actually treating, storing or disposing of hazardous waste, we painstakingly cross-checked the information received from any source against all the other sources and resolved the discrepancies through thousands of phone calls to facilities and their regulatory authorities.[31] Our final database consisted of 608 facilities.

B. The Geographic Area Analyzed

There is a great deal of controversy about whether census tracts, smaller census units like block groups, larger zip code areas, or concentric circles of various radii[32] are the preferred unit of analysis for

29. For studies of the property value impacts of hazardous waste facilities and sites, see sources cited *supra* note 17. For studies of people's attitudes toward hazardous waste facilities, see, for example, Owen J. Furuseth, *Community Sensitivity to a Hazardous Waste Facility*, 17 LANDSCAPE & URB. PLAN. 357, 362-64 (1989).

30. We used, for example, U.S. Envtl. Protection Agency, Office of Solid Waste and Emergency Response, COMBUSTION EMISSIONS TECHNICAL RESOURCE DOCUMENT (draft, May 1994) (listing commercial hazardous waste incinerators, cement kilns, and lightweight aggregate kilns); CEMENT KILN RECYCLING COALITION, PLANT LOCATIONS USING WASTE-DERIVED FUEL (1994) (listing cement kilns burning hazardous waste).

31. We detailed problems with RCRIS and the Environmental Services Directory, and the steps we took to correct those problems in Vicki Been, *Analyzing Evidence of Environmental Justice*, 11 J. LAND USE & ENVTL. L. 1, 8-11 (1995).

32. *See* Figure Twenty-One.

environmental justice studies.[33] For our longitudinal analysis, census tracts were the only option. We needed data for censuses going back to at least 1970. Tract data is available before 1980, but national zip code data is not, and the Geographic Information System (GIS) technology needed for drawing circles around facilities and converting census data to those units is difficult and expensive to apply to censuses taken prior to 1990.

We also needed a unit of analysis that remained constant, or could be reconfigured to be constant, over the relevant decades. Concentric circles offered the greatest consistency over time, of course, but the expense of applying GIS technology to the three decennial censuses at issue in the study was prohibitive. In addition, converting census data into GIS units involves making various assumptions about how the population within a census tract bisected by a GIS circle is distributed, and those assumptions are controversial.[34] As between census tracts and zip code areas, tracts are preferable from the standpoint of consistency. Tracts are intended to remain relatively stable over time. When they change, the exact nature of the change is published. Zip code boundaries, on the other hand, frequently are changed for the convenience of the postal service, and no published record is available to document changes.

Census tracts are preferable to zip codes for several other reasons as well. Census tracts are drawn up by local committees, and are intended to reflect the community's view of where one neighborhood ends and another begins.[35] Zip codes are drawn to enhance the efficiency of mail delivery; they are not intended to reflect neighborhoods.[36] Concentric circles are unlikely to bear much relationship to the community's views of its borders, which often are linked to natural

33. For discussions of the appropriate unit of analysis in environmental justice studies, see, for example, Been, *supra* note 31, at 4-5; Greenberg, *supra* note 14, at 238; Paul Mohai, *The Demographics of Dumping Revisited: Examining the Impact of Alternate Methodologies in Environmental Justice Research*, 14 VA. ENVTL. L.J. 615, 628-41 (1995); Rae Zimmerman, *Issues of Classification in Environmental Equity: How We Manage Is How We Measure*, 21 FORDHAM URB. L.J. 633 (1994); John Fahsbender, Note, *An Analytical Approach to Defining the Affected Neighborhood in the Environmental Justice Context*, 5 N.Y.U. ENVTL. L.J. 120 (1996).

34. As Rae Zimmerman has noted: "The assumption usually made is that population is homogeneously distributed within the intersected units. Although this assumption might work with total population figures, it is not likely to work well with subpopulations, which tend to cluster geographically, and are not typically distributed homogeneously." Zimmerman, *supra* note 33, at 653.

35. *See generally*, MICHAEL J. WHITE, AMERICAN NEIGHBORHOODS AND RESIDENTIAL DIFFERENTIATION 18-20, 289-98 (1987).

36. *See* Mark Monmonier, *Zip Codes, Data Compatibility, and Environmental Racism*, 2 GIS L. 4, 5 (1994).

or physical boundaries such as waterways, highways, or major roads.[37] The importance of tying the unit of analysis to community perceptions is highlighted by the recent suggestion of leading environmental justice researcher, Dr. Paul Mohai, that researchers define units of analysis based on interviews with community leaders, neighborhood residents, and corporate and government decisionmakers.[38] Currently, however, tract boundaries are set by local committees charged with reflecting exactly the kind of community sentiments and practices that the interviews suggested by Dr. Mohai would be designed to uncover. It is possible that interviews conducted in the specific context of environmental justice research would lead to different boundaries than those set by the local committees. That possibility, however, raises the risk that such interviews would introduce biases or would be perceived as gerrymandering. Also, such "custom" designed definitions of the boundaries of neighborhoods may decrease the ability of researchers to compare directly the results of various studies, or to replicate a study for further analysis.[39] In any event, such interviews were not practical for a nationwide study.

Finally, tracts are intended to be comparable—they are supposed to contain between 2500 and 8000 residents, and have an average of about 4000 people.[40] Concentric circles also would be comparable if weighted by population, but were not practical for this study for the reasons already discussed. Zip codes, on the other hand, are not readily comparable because they contain widely different numbers of people, and cover vastly different land areas.[41]

While census tracts were the most appropriate unit of analysis for this study, they are far from the ideal. Any proximity-based unit of analysis assumes that the risk a facility poses bears some relationship to proximity to the facility, an assumption that may be inaccurate in many cases. A better unit of analysis would be one based upon the actual distribution of the risks of the facility, which would further depend upon the type of substances the facility handled, wind patterns, the hydrology and geology of the site, and transportation routes to the facility, among other factors.[42] That analysis is extremely difficult and costly, however, and was impractical for a study of this scope.

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37. For a survey of the literature about how neighborhoods are defined sociologically, see Fahsbender, *supra* note 33, at 124-27.

38. Mohai, *supra* note 33, at 639.

39. For an example of the difficulties posed by sociologically defined neighborhood boundaries, see Been, *supra* note 15, at 1401 & n.72.

40. WHITE, *supra* note 35, at 292-95.

41. For an illustration of the difficulties caused by the fact that zip codes are not readily comparable, see GOLDMAN & FITTON, *supra* note 13, at 13.

42. For an example of such risk-based environmental justice research, see GLICKMAN & HERSH, *supra* note 14.

Further, all proximity-based units of analysis assume that the impact of the facility is primarily felt within the host unit. Our perusal of many census tract maps revealed, however, that facilities often are located at the edges of tracts. Tracts tend to be bounded by transportation networks such as railroad tracks or highways, and it is logical that facilities receiving waste from off-site sources would choose to locate near such networks. Depending upon wind patterns and other factors, a facility located at the border of a tract might have little or no impact on that tract, but considerable impact on adjacent tracts. Data and time constraints precluded us from analyzing the demographics of areas adjacent to the host tracts, but other researchers may wish to pursue that inquiry.

For our purposes, then, census tracts were the preferable, but by no means the perfect, unit of analysis. Of course, the usefulness of any unit of analysis depends upon the accuracy with which facilities can be assigned to the unit. To ensure the accuracy of facility addresses, we verified the addresses of all facilities for which there were inconsistencies among the various databases from which we drew our lists, and also verified addresses whenever we had to survey a facility for any other information. More than two-thirds of the addresses were verified.

The addresses then were provided to one of the nation's leading geocoding services, Geographic Data Technology, which matched the addresses to 1990 and 1980 census tracts.[43] Whenever an address could not be matched with a tract (as was the case for some rural areas and addresses that involved mile markers on highways), we surveyed the facility to obtain more precise locational information.

Geocoding technology was not available for the 1970 census. To place the facilities within tracts for 1970, we worked backwards from the 1980 tracts, identifying which 1970 tract (tracts) was (were) equivalent to the 1980 tract and pinpointing the exact 1970 tract by locating the facility's address within the tract maps published by the Census Bureau.

C. Ensuring a Consistent Unit of Analysis Over Time

As previously noted, although the Census Bureau seeks to have census tract boundaries remain consistent over time, the Bureau also needs the tracts to remain at approximately the same population size over time. In high growth areas, therefore, tracts split into subtracts to accommodate growth. In areas of declining population growth, tracts sometimes merge. In all areas, municipal boundary changes

43. We especially appreciate the efforts Ralph Dreher at Geographic Data Technology made to ensure the accuracy and completeness of the geocoding.

caused by annexations or other reconfigurations of local governments, or by other changes within a municipality, may cause the local committee to reconfigure tracts. According to the Census Bureau, about eighteen percent of all tracts changed significantly between 1970 and 1980, and about twenty-one percent changed significantly between 1980 and 1990.[44]

In order to analyze how the demographics of host neighborhoods changed over time, we had to reconfigure the tracts so that they were equivalent over the decades studied. That task was extremely laborious. The Census Bureau provides computer tapes containing information about how tracts changed between each census and the prior census, and publishes "tract comparability tables" in each volume of its state and metropolitan statistical area reports. We found the computerized versions of the tract comparability tables to be unhelpful for all but the most simple changes, and found the 1970 to 1980 tract comparability computer files to be incomplete. We therefore reconciled each of our host tracts by hand, using the published tract comparability tables.

When a tract split into two or more smaller tracts, we added the smaller tracts back together to make them comparable to the original tract. If a tract merged with another tract, we added the original tracts together to make them comparable to the resulting merged tract. When a tract's boundaries changed, we added all the tracts involved in the change together until we reached a unit with borders that were the same across the decades. Where the tract's number changed, we substituted the new number in all analyses involving later censuses.

It was impossible to reconcile all the non-host tracts over the decades (there were about 34,000 tracts in 1970; by 1990, the number had grown to more than 60,000). Accordingly, we drew five one-percent samples[45] of all the tracts in the 1970 census, and five one-percent samples of all the tracts in the 1980 census. We then reconciled the tracts within those samples, and compared the demographic variables for the resulting reconciled areas across decades.

To test for potential biases in the reconciliations we compared the means of the sample tracts for each demographic variable we were studying to the means of the entire population. None of the differences were statistically significant at the ninety-five percent confi-

44. Telephone Interview with Cathy Miller, Geographer, Geography Division, United States Bureau of the Census (July 14, 1995). Ms. Miller and several other members of the Geography Division were extremely helpful in providing information we needed to design the methodology of the tract reconciliations.

45. To draw the samples, we assigned a number to each tract in the total population. Using a random number generator, we randomly selected one percent of those tracts. We repeated the process five times in order to have a sample containing five percent of the total population.

dence level.[46] Similarly, for each demographic variable, we compared the means of the reconciled host tracts to those of the unreconciled hosts. Again, there were no significant differences.

The process of reconciliation, however, may have made both the host and the sample tracts somewhat different from nationwide averages. The entire United States was tracted only for the 1990 census. In prior censuses, rural areas and other areas outside Standard Metropolitan Statistical Areas (SMSAs)[47] often were not tracted.

Accordingly, for analyses based upon the 1980 and 1970 censuses, we had to omit facilities sited in areas that were not tracted as of the census prior to the siting.[48] Our 1980 and 1970 analyses of host tracts therefore are somewhat biased toward urban facilities. Similarly, we drew our samples only from the areas tracted in the census in question. Again, that limitation is likely to bias the reconciled sample tracts toward urban areas. Urban areas tend to have higher percentages of racial and ethnic minorities than rural areas, so the bias toward urban areas is likely to result in an understatement of the relationship between race, ethnicity and siting choices.[49] While the potential for an urban bias is unfortunate, the alternative would have been to mix tracts with much larger units, which would undermine the advantages of census tracts as the unit of analysis.

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46. For a discussion of statistical significance, see FREEDMAN ET AL., *supra* note 26, at 429-54.

47. Standard metropolitan statistical areas (SMSA) were used by the Census Bureau in the 1970 and 1980 censuses to delineate "a large population nucleus, together with adjacent communities which have a high degree of economic and social integration with that nucleus." Each SMSA had "one or more central counties containing the area's main population concentration: an urbanized area with at least 50,000 inhabitants" and "outlying counties which have close economic and social relationships with the central counties . . . have a specified level of commuting to the central counties and . . . also meet certain standards regarding metropolitan density, urban population, and population growth." U.S. DEPT. OF COMMERCE, 1980 CENSUS OF THE POPULATION, GENERAL SOCIAL AND ECONOMIC CHARACTERISTICS, ALABAMA, App. A, at A-2 (1983). In the 1990 census, SMSAs were replaced by metropolitan statistical areas (MSAs), which again consist of a metropolitan area and related outlying counties. BUREAU OF THE CENSUS, 1990 CENSUS OF POPULATION AND HOUSING, TECHNICAL DOCUMENTATION, Summary Tape File 3, Appendix A, at A-8 to A-9 (May 1992).

48. For 1970, we had to drop thirty-three facilities (thirteen percent of the total) from the analysis because they were sited in untracted areas; for 1980, we had to drop twenty-three facilities (eleven percent of the total) from the analysis.

49. We showed in an earlier article that limiting the analysis of the 1990 data to urban areas or rural counties that have at least one facility reduces the differences in the ethnic and racial composition of host and non-host tracts. Been, *supra* note 31, at 12-13, 26. The urban bias introduced into our study similarly is likely to understate somewhat the relationship between ethnic and racial characteristics of tracts and siting choices. Because the earlier article compared host tracts only to metropolitan areas or rural counties with at least one TSDF, which is considerably more restrictive than the limitation to all tracted areas, the bias of this study is likely to be considerably less than that reported in the earlier article.

We originally planned to use the reconciled host and sample tracts only for the purpose of our longitudinal analysis of changes in the demographics of tracts over time. In the course of our research, however, we discovered that population density is an extremely important predictor of whether a tract will be selected to host a facility. Unfortunately, population density data is available only in the 1990 census. Because our reconciliations equated 1990 tracts to earlier tracts, we were able to calculate density values for the reconciled host and sample tracts as of the 1980 and 1970 censuses. As explained in more detail in part II, we therefore chose to use the reconciled host and sample tracts for logit estimations[50] in the cross-sectional portion of the study. Again, that choice may have biased our results somewhat because of the more urban nature of the reconciled host and sample tracts.

D. The Comparison Population

We compared the demographics of host tracts to those of all non-host tracts (or, for the analyses using the reconciled tracts, to those of the sample of all tracts). The SADRI researchers limited their comparison populations to non-host tracts in MSAs[51] or rural counties that contained at least one TSDF. SADRI reasoned that only tracts in the same MSA or rural county as a facility could serve as possible alternative sites for the same market.[52] That limitation eliminated about 18,000 non-host tracts from their analysis of 1990 census data. We examined the effect SADRI's limitation had upon its results, and found that it reduced the differences between the racial and ethnic composition of host and non-host tracts.[53]

While SADRI is correct that some non-host tracts may not be viable candidates for hosting a TSDF, the presence or absence of a facility within a metropolitan area or rural county is, at the very best, an extremely rough proxy for whatever factors are likely to go into the decision to eliminate certain areas from consideration.[54] TSDFs range from huge landfills to small treatment facilities. They vary considerably in the amount of land, the hydrological and geological characteristics of that land, the type of workforce, and the access to

50. For a description and discussion of logit modeling, see ALFRED DEMARIS, LOGIT MODELING: PRACTICAL APPLICATIONS (Sage University Papers, Quantitative Applications in the Social Sciences Series No. 07-086, 1992).

51. For a description of MSAs, see *supra* note 47.

52. *Evaluating TSDF Siting*, *supra* note 25, at 92, 96, 100.

53. Been, *supra* note 31, at 12-13, 26.

54. For criticism of SADRI's methodology, see Mohai, *supra* note 33, at 623-28; GOLDMAN & FITTON, *supra* note 13, at 14; Robert D. Bullard, *The Legacy of American Apartheid and Environmental Racism*, *in* Confronting Environmental Racism, *supra* note 1, at 445, 467-69.

transportation networks that they need. Some serve national markets; others have more limited client bases. The ideal study of the siting of TSDFs would include a model of how facilities are sited, and exclude areas from the analysis on the basis of that model. Until that model is developed, however, we believe that the appropriate comparison group should include all non-host tracts.

E. The Statistical Tests Used

To assess the possibility that TSDFs were sited through processes that had the intent or effect of disproportionately siting facilities in minority, ethnic, or poor communities, we used four types of statistical analyses. First, for each demographic variable at issue, we compared the mean[55] of the set of all host tracts to the mean of the set of all non-host tracts, and tested to determine whether the difference between the means was statistically significant.

We then examined the distribution[56] of the population around the means. While the comparison of means helps illuminate how the average host tract compares to the average non-host tract, it does not reveal much about why those averages deviate, or about how the distributions of the host and non-host tracts on a particular demographic characteristic vary. While a comparison of means might suggest, for example, that the average percentage of Hispanics in host tracts is higher than that in non-host tracts, it does not tell whether that difference arises because some of the facilities are in communities with very high percentages of Hispanics, or whether the host tracts are closely bunched around (but somewhat above) the mean of the non-host tracts. None of the prior literature has reported the results of such a distributional analysis.

To compare the distributions of the host and non-host tracts, we arrayed both sets in terms of the demographic characteristics we were studying. For each demographic variable, we examined what percentage of the non-host tracts fell within each decile, or in some cases even finer groupings, of the distribution of the demographic characteristic. We compared that distribution to the percentage of the host tracts that fell within those same groupings. For example, we looked at what percentage of the non-host tracts had no African Americans, what percentage had less than four percent African Americans, what percentage had between four and eight percent African Americans, and so on. We compared those percentages to the percentages of host tracts that had no African Americans, less than four percent African

55. The mean of each of the demographic variables studied is their average: the sum of all the values for each variable, divided by the number of tracts in the set. *See* FREEDMAN ET AL., *supra* note 26, at 53-72.

56. For a discussion of distributions, see *id.*

Americans, and so on. If the tracts hosting facilities are distributed in a manner that differs from the distribution of the non-host tracts (for example, if less than two percent of all tracts had between 96 and 99.9% African Americans, but twenty percent of the host tracts had that high a percentage of African Americans), then the analysis may suggest that the siting is disproportionate or unfair.[57]

Both comparisons of means and the distributional analyses provide information about only one characteristic at a time. They reveal neither how the characteristics interact nor when one characteristic might be masking the effect of another. We used logit estimations to control for correlations among the variables, so that we could study the importance of each variable standing alone. We used logits rather than linear regression analysis[58] because our dependent variable was the presence or absence of a site.[59] We used the presence of a site, rather than the number of sites, as our variable because only about sixty tracts contained more than one facility, and only a handful contained more than two facilities.

Our longitudinal analysis of the changes in the demographic variables included the same comparison of means as the cross-sectional studies.[60] We used regression analysis to assess the effect that the presence or absence of a site had on the demographic characteristics of neighborhoods in the decades following the siting.[61]

Finally, in order to try to better quantify the relationships revealed by the logit estimations, we performed comparative static exercises using the coefficients obtained from the logits. As described in more detail in part IV, for each set of tracts (e.g., for the set of 1980 host and non-host tracts), we used the means for all the demographic variables studied to calculate the probability that an "average" tract would be selected to host a facility. We then calculated how that

57. The assumption that a distribution of facilities is unfair if it differs from the distribution of the population is quite controversial. For a discussion of what fairness means in the context of environmental justice, see Vicki Been, *What's Fairness Got to Do With It? Environmental Justice and the Siting of Locally Undesirable Land Uses*, 78 CORNELL L. REV. 1001 (1993).

58. For a good introduction to linear regression models, see ROBERT S. PINDYCK & DANIEL L. RUBINFELD, ECONOMETRIC MODELS AND ECONOMIC FORECASTS 3-18 (3d ed. 1991).

59. For a discussion of linear regression models versus logit models to explain discrete (yes/no) choice variables, see WILLIAM H. GREENE, ECONOMETRIC ANALYSIS 636-59 (2d ed. 1993).

60. We performed distributional analyses as well, but the comparison of how the distributions of the host and non-host tracts changed over time was so ambiguous and difficult to interpret that we have not reported the results.

61. The demographic characteristics studied were continuous variables, so linear regression models rather than logit estimations were appropriate. *See* GREENE, *supra* note 59 at 635-55.

probability changed if the mean for a particular demographic variable was increased or decreased.

II.
WERE HOST COMMUNITIES DISPROPORTIONATELY COMPOSED OF MINORITIES OR THE POOR AT THE TIME THE FACILITY WAS SITED?

A. Comparing the Means and the Distributions of Host and Non-Host Tracts

1. Comparing the Means

Siting processes could result in a distribution of facilities that disproportionately burdens minority[62] or poor communities by deliberately targeting those neighborhoods to serve as hosts,[63] by subconsciously applying siting criteria in a manner that values those neighborhoods less than others, or by relying on criteria that for whatever reason result in sitings that have a disparate impact upon those neighborhoods. To test whether any of those scenarios might actually have occurred, we examined whether the areas selected to host facilities were disproportionately populated by minorities at the time the siting decisions were made.

Our analysis finds no substantial evidence that the siting process was systematically flawed as to African Americans during any of the three decades at issue. There is stronger evidence that the percentage of Hispanics in a tract was correlated with the probability that the tract was chosen to host a facility.

a. Tracts that Became Hosts Between 1970 and 1979

Figure One compares the means of tracts that became hosts during the 1970s to the means of non-host tracts, at the time of the 1970 census. It reveals that the percentage of African Americans was lower in tracts that would become hosts between 1970 and 1979 than in tracts that would not become hosts during those years, although the difference was not statistically significant. The percentage of Hispanics in the tracts that would become hosts, however, was forty-two percent higher than in tracts that would not become hosts, and the

62. The Census Bureau classifies by race (White; Black; American Indian, Eskimo and Aleut; Asian or Pacific Islander; and other) and by Spanish origin. Persons of Spanish origin may be of any race. We use the term "minorities" to mean all persons who are not white and all Hispanics.

63. Indeed, Professor Robert Bullard, one of the pioneers of the environmental justice movement, has claimed that siting decisionmakers adopt a PIBBY strategy—Put It in Black's Backyards. ROBERT D. BULLARD, DUMPING IN DIXIE: RACE, CLASS, AND ENVIRONMENTAL QUALITY 5 (1990).

difference was statistically significant at the ninety-five percent confidence level.

b. Tracts that Became Hosts Between 1980 and 1989

At the time of the 1980 census, as indicated in Figure Two, a comparison of means shows that the tracts that would become hosts between 1980 and 1989 again had percentages of African Americans that were substantially lower than those of tracts that would not become hosts during the decade. The difference was statistically significant. The percentage of Hispanics in the tracts that would become hosts was slightly higher than in the tracts that would not become hosts, but the difference was not statistically significant.

c. Tracts that Became Hosts Between 1990 and 1994

Figure Three reveals that at the time of the 1990 census, the tracts that would become host to the twenty-nine facilities that opened in or after 1990 had higher percentages of African Americans and Hispanics than the non-host tracts, but those differences were not statistically significant. Because the number of facilities sited in the 1990s is so small and the variance among the tracts is relatively large, it would take large differences in means to trigger a finding of statistical significance. The differences in means therefore merit concern, but cannot serve as evidence of a relationship between the racial or ethnic makeup of a community and its chances of being selected to host a facility.

2. Comparing the Distributions

a. By Percentage of African Americans

Analysis of the distributions (as opposed to just the means) of the host and non-host tracts also suggests that communities with significant percentages of African Americans were not disproportionately chosen as sites for facilities. Figure Four compares the distribution of the non-host tracts in terms of the percentages of African Americans in their populations to the distribution of the host tracts in 1980. The dotted line shows the percentage of host tracts that had the percentages of African Americans listed on the vertical axis—slightly more than thirty-five percent of all host tracts had more than zero, but less than two percent African Americans, for example. The solid line shows the percentage of non-host tracts that have the percentage of African Americans listed on the vertical axis. A comparison of the two lines indicates that a higher percentage of non-host tracts had between six and sixty percent African Americans and between eighty and 100 percent African Americans than did host tracts. The line for

host tracts rises above that of non-host tracts only in the neighborhoods that had very low percentages of African Americans, and in the neighborhoods that had sixty to eighty percent African Americans.

Figure Five quantifies the differences in distributions by showing how the number of host tracts falling into each division of the percentage of African Americans compares to the number of host tracts that would fall into that division if the host tracts were distributed in exactly the same manner as the non-host tracts. The chart shows that while the number of host tracts with sixty to eighty percent African Americans was higher than would have been the case if the distribution of host tracts exactly matched the distribution of non-host tracts, the excess amounted to only four facilities (less than two percent of the total number of facilities).[64] Further, the excess was offset by the under-representation of host tracts with more than eighty percent African Americans.

Figures Six and Seven present the same analysis for the facilities sited in the 1970s. The percentage of host tracts with between eight and fifty percent African Americans is higher than the percentage of non-host tracts with those demographics, but Figure Seven reveals the excess to affect only thirteen host tracts, or about six percent of the total.[65]

b. By Percentage of Hispanics

Turning to the distribution of tracts in terms of the percentages of Hispanics in the tracts, Figure Eight reveals that for the facilities sited in the 1980s, a higher percentage of host tracts than non-host tracts have more than six but less than forty percent Hispanics. Figure Nine shows, however, that only eight tracts are affected.[66] Figure Ten shows, for facilities sited in the 1970s, that the percentages of host tracts with more than ten percent Hispanics were fairly consistently higher than the percentages of non-host tracts, indicating some disproportion in the siting of facilities. Figure Eleven quantifies the disproportion as affecting approximately nineteen host tracts, about nine percent of the total.[67]

In sum, comparisons of the means and comparisons of the distributions of host and non-host tracts provide little evidence that between 1970 and 1990 TSDFs were sited in communities that had

64. A chi-square test indicates that the distributions by deciles are significantly different at the ninety-five percent level.

65. A chi-square test indicates that the differences in the distributions by deciles are statistically significant only at the ninety percent level.

66. A chi-square test indicates that the differences in the distributions by deciles were not significant even at the ninety percent level.

67. A chi-square test indicates that the differences in the distributions by deciles is significant at the ninety-nine percent level.

disproportionately high percentages of African Americans at the time of the siting. Both types of tests provide evidence, however, that at least those facilities sited in the 1970s were placed in communities that had higher than average percentages of Hispanics.

B. Multivariate Analysis

Both the comparisons of means and distributions focus only on one dimension of a neighborhood's demographic profile at a time. They leave open the possibility that although the mean percentage of African Americans is not significantly different in host and non-host tracts, other variables that are closely correlated with the percentage African Americans, such as mean family income, are hiding some of the relationship between race and the probability of a siting. To isolate the influence of each demographic variable if all other variables are held constant, multivariate techniques are necessary. Because the dependent variable—the presence or absence of a facility—is a binary variable, we used logit estimations, rather than regressions.[68]

If the claim that host tracts are disproportionately populated by racial or ethnic minorities is true, one would expect the logit analysis to reveal that the percentages of African Americans and Hispanics in a tract would each be a statistically significant predictor of whether the tract hosted a facility. Each should be positively correlated with the presence of a facility: as the percentage of the group at issue in a tract increases, the probability that the tract hosts a facility should increase.[69] Similarly, the claims of the environmental justice movement would suggest that measures of wealth (such as median family income, median housing value, and the percentage of a tract's population with incomes below the poverty level) also should be significant predictors of the probability that a tract hosts a facility. The poverty rate should be a positive predictor: as the percentage of the poor increases, the probability that the tract hosts a facility should increase. The median family income and median housing value should be negative predictors: as income or housing value increase, the probability of hosting a facility should decrease.

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68. *See* GREENE, *supra* note 59, at 635-55.

69. Although the claims of the environmental justice movement would suggest that the percentages of racial or ethnic minorities in a community would be positively correlated with the presence of a facility, they would not necessarily predict that the correlation would be linear. In other words, it would not be inconsistent with the environmental justice claim for a community whose population was eighty or ninety percent minority to have a lower probability of being sited than a neighborhood with fifty or sixty percent minorities, even though the claim would predict that the latter neighborhood would have a higher probability of being sited than a neighborhood with ten to twenty percent minorities. To the extent that LULUs bring some benefits like jobs (as well as many costs) to a community, it could be that a racially discriminatory decisionmaker would prefer not to provide those benefits to a virtually all African American or Hispanic neighborhood.

Given the environmental justice movement's argument that sitings take the path of least resistance, and target neighborhoods that are less politically powerful than other areas, one also would expect the logit estimations to reveal that other demographic characteristics that are correlated with political power, such as the percentages of the population with no high school diploma or of the unemployed, would be correlated significantly and positively with the presence of a facility.

In addition, one would expect TSDFs to locate near their customers, which tend to be manufacturing and industrial facilities. While direct measures of the presence of such facilities are unavailable, we used the percentage of a tract's workforce employed in manufacturing establishments[70] as a rough proxy for the presence of such establishments.[71] Thus, manufacturing employment should be positively correlated with the presence of a facility.

Common sense also suggests that population density should be negatively correlated with the presence of facilities. As the population density of an area increases, the number of people likely to oppose the siting grows, as does the expected cost of any accident. With greater population density, the probability of hosting a facility should decrease. Unfortunately, no data about the population density of tracts is available for 1970 and 1980, and we were unable to construct a satisfactory proxy for density. As explained in the methodology section, however, we had two sets of data for each decade we studied: data about each individual host tract and non-host tract, and data about the configurations of host tracts and sampled tracts that had been reconciled to be consistent over the three decades we studied. Because we were able to work backwards from the 1990 census in the reconciled tracts, we were able to construct density variables for 1970 and 1980. Therefore, we used the reconciled data sets for the logits.[72]

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70. Manufacturing employment is defined here as employment in precision production, craft and repair occupations (Census Bureau occupational codes 503-699), as machine operators, assemblers and inspectors (codes 703-799), in transportation and material moving occupations (codes 803-859), and as handlers, equipment cleaners, helpers and laborers (codes 863-889). The percentage of workers employed in those categories was calculated by dividing the number of persons employed in those categories by the total number of males and females age sixteen or older employed in the civilian labor force.

71. The percentage of the workforce employed in manufacturing reflects the occupation of the residents of a census tract. Because residents do not necessarily work in or near the tract, the variable is only a rough proxy for the presence of manufacturing activity in the tract. *See* Mohai, *supra* note 33, at 644-45 (indicating that "a close examination of 'percentage employed in manufacturing and industry' . . . [is] a misleading indicator of the industrial nature of the census tracts examined").

72. As discussed in part I, the demographic means for the reconciled hosts were not significantly different from the means for the non-reconciled hosts. Similarly, means for the reconciled sample were not significantly different from the total population of unreconciled non-hosts. The reconciliations may introduce an urban bias into the study, however.

In the logit estimations, the dependent variable is the presence or absence of a facility. The independent variables are the demographic variables (mean family income, median housing values, etc.), density, and the square of each demographic variable, other than those related to housing value. We included the quadratics (squared terms) because the distributional analyses presented earlier revealed that any relationship between race, ethnicity, and class variables and the presence of a facility in a tract tended to be U-shaped. The distributional analyses showed that facilities are under-represented both in the neighborhoods with no African Americans and in those whose population is almost all African American, for example. Similarly, both very poor neighborhoods and very rich neighborhoods have fewer facilities than a proportionate distribution would demand. The U-shaped nature of the distributions suggested that any influence that race, ethnicity or class might have on the probability of a siting might reverse itself as the percentages of African Americans, Hispanics, or the poor increased above a particular point. We therefore believed that including quadratics in the logit would produce a better fit in the estimation.[73]

1. Tracts that Became Hosts Between 1970 and 1979

Figure Twelve presents the results of the logit estimation using 1970 census data for the tracts that would become hosts between 1970 and 1979, and for the non-host tracts. As would be expected if the claims of the environmental justice movement are true, the percentage of African Americans and percentage of Hispanics are both positively correlated with the probability that a tract would become a host, at the ninety percent and ninety-nine percent confidence levels, respectively.[74] The multivariate analysis accordingly reveals a relationship between the percentage of African Americans and siting choices that is obscured by the comparison of means and distributional analyses presented above.[75] The percentages of the poor and the unem-

73. The comparative static exercises reported *infra* part II.C. confirm our decision to include the quadratic terms in the logits because they reveal points of inflection consistent with the results of the distributional analyses.

74. We ran the same logit estimations using 1970 census data for tracts that became hosts between 1970 and 1979, except that we used the unreconciled host and non-host tracts and used the best proxy we could construct for density—the percentage of housing occupied by renters. The percentage of African Americans again was positively correlated at the ninety percent level and the percentage of Hispanics was positively correlated at the ninety-nine percent level. Thus, this finding does not turn on our use of the reconciled tract data.

75. The multivariate analysis uses a different data set—the reconciled host tracts and the reconciled sample tracts—than the comparison of means and distributional analyses, which used non-reconciled host tracts and the entire population of non-host tracts. That difference cannot explain the divergence in results, however. As shown in Figures Fifteen and Sixteen, a comparison of the means of reconciled host and sample tracts (like the

ployed also are positively correlated, as would be expected, but are not statistically significant. Average family income is positively correlated, contrary to expectations, but again, is not statistically significant. Low, moderate, and high housing values each are negatively correlated, but are not statistically significant. As expected, the percentage of the workforce employed in manufacturing was positively correlated, while the population density was negatively correlated, and both were statistically significant at the ninety-nine percent confidence level.

2. Tracts that Became Hosts Between 1980 and 1989

Figure Thirteen presents the logit estimations using the 1980 census data for the tracts that became hosts between 1980 and 1989 and for the non-host tracts. Contrary to what would be expected if the environmental justice claims were true, the percentage of African Americans was negatively correlated with facility locations, but was not statistically significant. As in the 1970 logit, the percentage of Hispanics was a positive and highly significant predictor of whether a neighborhood was selected as a host.[76] Contrary to the expectations generated by the environmental justice claims, the percentage of the poor was negatively correlated and significant, while the average family income was positively correlated and significant. As expected, population density was a significant, but negative, predictor of siting.

3. Tracts that Became Hosts Between 1990 and 1994

Logit estimations of the 1990 data for tracts that would become hosts between 1990 and 1994 were not possible given the small number of host tracts.

C. Determining the Probabilities that a Tract Would be Chosen to Host a Facility Using Logit Estimations and Comparative Static Exercises

To quantify the extent of the influence the percentage of Hispanics or African Americans in a neighborhood had upon the probability that tracts would be selected as hosts, we used the logits and comparative static exercises to calculate how the probability that a tract would be chosen to host a facility would change if the tract's percentage of

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comparison of means of the *un*reconciled tracts reported in Figures One and Two) shows that the percentage of African Americans is *lower* in host tracts.

76. We ran the same logit estimations using 1980 census data for tracts that became hosts between 1980 and 1989, except that we used the unreconciled hosts and non-hosts, and used the percentage of housing occupied by renters as a proxy for density. Again, the percentage of African Americans was not a significant predictor, but the percentage of Hispanics was a significant predictor.

Hispanics or African Americans changed. Using both host and non-host tracts, we first computed the mean for all the tracts for each demographic variable. We then used the logit coefficients to calculate the probability that an "average" tract—one that matched the mean for every demographic variable studied—was a host tract. We then calculated how that probability would change if all tracts added or lost ten percentage points off the mean (but no tract was allowed to fall below zero or rise above 100 for the variable at issue). For example, to calculate the extent of the influence the percentage of Hispanics exerted, we subtracted ten percentage points from the percentage of Hispanics in each tract (without allowing any tract to fall below zero percent Hispanic). We then recalculated the mean percentage of Hispanics for all tracts, and after adjusting that variable (as well as its square in the quadratic terms), but keeping all other variables constant, we recalculated the probability that a tract with the new mean would be chosen.

The results of the comparative static exercises are presented in Figure Fourteen. It shows that in 1970, adding ten percentage points to the percentage of African Americans in all the tracts studied would increase the probability that a tract otherwise at the mean would have been a host from 0.025 to 0.029, a sixteen percent increase. Adding ten percentage points to the percentage of Hispanics in all tracts would increase the probability of a tract at the mean being chosen from 0.025 to 0.035, a forty percent increase. In the 1980 logit, adding ten percentage points to the percentage of Hispanics in all tracts would increase the probability of siting from 0.0176 to 0.0257, a forty-six percent increase.

While those percentage increases are substantial, they are increases on small original, or base probabilities. Of course, had we been able to study all the non-host tracts in the nation rather than just a five percent sample of all tracts, the base probability would have been even smaller (because the 1970 comparison would have been to about 34,000 non-host tracts rather than to approximately 1,700 sample non-host tracts, for example). In addition, the results of the comparative static exercises have to be interpreted with caution because the increase in probability would occur only for tracts that otherwise are at the mean for all other demographic variables. Because the percentage of Hispanics tends to be correlated with other significant predictors of siting, such as population density, a relatively small number of tracts would have both the higher percentage of Hispanics and be at the mean for all other variables.

In sum, then, analysis of the demographic characteristics of those tracts chosen to host facilities since 1970, as of the census conducted immediately before the site was selected, reveals scant evidence that

the siting process has a disproportionate effect on African Americans. While there is a difference in the mean percentages of African Americans for the facilities sited in the 1990s, that finding is not statistically significant. The correlation between siting and the percentage of African Americans in a tract revealed by the 1970 logit is significant only at the ninety percent confidence level, which is below the confidence level usually demanded in statistical studies.[77] Thus, as to African Americans, the evidence provides little support for the charge that siting processes since 1970 have been racially discriminatory either in intent or effect. The analysis also provides no support for the notion that neighborhoods with high percentages of poor are disproportionately chosen as sites. Indeed, in 1980, the percentage of poor in a tract was a negative and significant predictor of which tracts would be selected as hosts.

The analysis does support the claim that the siting process was affected, either intentionally or unintentionally, by the percentage of Hispanics in potential host communities. The comparison of means in 1970 reveals a significantly higher percentage of Hispanics in host tracts than in non-host tracts, and the logits for both 1970 and 1980 show that the percentage of Hispanics is positively and significantly correlated, at the ninety-nine percent confidence level, with the probability that a tract hosts a facility.

III.
DID THE DEMOGRAPHICS OF HOST TRACTS CHANGE SIGNIFICANTLY FOLLOWING THE SITING OF A FACILITY?: TESTING THE MARKET DYNAMICS THEORY

A. Comparing Changes in the Means Over the Decades

The primary competing explanation of why facilities might be located in areas that are now disproportionately composed of African Americans and Hispanics blames the residential housing market for the problem.[78] Under this theory, the presence of a TSDF makes the host neighborhood less desirable because of the nuisance and risks the facility poses. Property values therefore fall, and those who move into the neighborhood are likely to be less wealthy and have fewer housing choices than those who leave the neighborhood. The siting of the facility results, then, in a neighborhood with lower housing values, lower

77. If the significance level is less than ninety-five percent, most statisticians do not consider the correlation to be reliable. *See* FREEDMAN ET AL., *supra* note 26, at 436-37.

78. For a full discussion of the theory that the dynamics of the housing market could be responsible for the current demographics of the areas surrounding TSDFs, see Been, *supra* note 15, at 1388-92.

incomes, and higher percentages of those who face discrimination in the housing market—primarily racial and ethnic minorities—than the neighborhood had before the siting.

To test this market dynamics theory, we compared the demographic characteristics of host and non-host neighborhoods as of the decennial census before the siting and as of the 1990 census. As explained in part II, we reconciled both the host tracts and a sample of all tracts so that the units we compared across decades were identical.

Figure Fifteen shows how the tracts that became hosts in the 1980s, as well as the sample of all 1980 tracts, changed between 1980 and 1990. Figure Sixteen compares changes between 1970 and 1990 in the tracts that became hosts in the 1970s and in the sample of all 1970 tracts. Figure Seventeen contrasts changes between 1970 and 1990 in the tracts that became hosts prior to the 1970s (some as long ago as the turn of the century) and in the sample of all 1970 tracts.

The changes provide some evidence that the siting of a facility may have been correlated with declines in the socioeconomic status of the host neighborhoods, but provide limited evidence that the siting was related to increases in the percentage of African Americans or Hispanics in the neighborhoods' population. Figure Fifteen shows that in 1980, mean housing values in the host tracts grew at a lower rate than those in non-host tracts, suggesting that property values may have decreased (relative to other areas) following the siting.[79] In addition, mean family incomes in host tracts grew at a slower rate than in non-host tracts, and both those differences were statistically significant.[80] The percentages of African Americans and Hispanics increased at a slightly higher rate in the host tracts, but those differences were not statistically significant.

Between 1970 and 1990, it is not possible to measure changes in average housing values because average housing values were not reported in the 1970 data set we used. As shown in Figure Sixteen, for facilities sited during the 1970s, average family income grew at a lower rate in the host tracts, as would be expected, but the difference was not statistically significant. The percentage of African Americans and

79. A better technique for measuring whether facilities affect neighboring property values would use hedonic price studies, which carefully control for features of a house and the surrounding community that might affect a house's value. *See, e.g.*, the studies cited *supra* note 17. For general discussions of the hedonic price study technique, see, for example, Maureen L. Cropper & Wallace E. Oates, *Environmental Economics: A Survey*, 30 J. ECON. LITERATURE 675, 706-08 (1992); James R. Follain & Emmanuel Jimenez, *Estimating the Demand for Housing Characteristics: A Survey and Critique*, 15 REGIONAL SCI. & URB. ECON. 77 (1985). Such studies are not practical on a nation-wide scale.

80. We tested the statistical significance of percent increases or decreases in the demographic variables by regressing the 1990 variable against the 1980 variable and a dummy variable (coded 1 if there was a facility, 0 if there was not) to see if the coefficient for the dummy variable was significant.

Hispanics both grew at lower rates in host tracts than in non-host tracts, contrary to expectations.

As Figure Seventeen reveals, for facilities sited before 1970, the average family income of host tracts did not keep up with that of the sample, but again the difference was not statistically significant. Also, the percentages of African Americans and Hispanics grew at a faster rate in the host tracts, but the differences were not statistically significant.

B. Multivariate Analysis

To test further for evidence of a correlation between the siting of a facility and subsequent demographic changes in the host tracts, we performed regression analyses, using the 1990 values for each demographic characteristic as the dependent variable and the values for all the demographic characteristics from the census taken immediately prior to the siting, plus a dummy for the presence or absence of a facility (one if the tract had a facility, zero if it did not), as the independent variables. For example, to test whether the presence of a facility sited in the 1980s had a statistically significant effect upon the 1990 percentage of African Americans, the 1990 percentage of African Americans was regressed against the dummy for the presence or absence of a facility, along with the 1980 percentage of African Americans, the 1980 percentage of Hispanics, and so on.

As indicated in Figure Eighteen, neither the percentage of African Americans nor the percentage of Hispanics in 1990 was significantly related to the presence of a facility sited during the 1980s. Nor was the average family income in 1990 significantly related to whether a facility had been sited in the 1980s.

Similarly, neither the percentage of African Americans, the percentage of Hispanics, nor average family income in 1990 was significantly correlated with the presence or absence of a facility sited during the 1970s. For facilities sited before 1970, the percentage of African Americans in 1990 was correlated with the presence of a facility, but only at the ninety percent confidence level. Neither the 1990 percentage of Hispanics nor the 1990 median family income was significantly correlated with the presence of a facility sited before 1970.

In sum, the study does not support the argument that market dynamics following the siting of a TSDF change the racial, ethnic, or socioeconomic characteristics of host neighborhoods.[81] The analysis

81. While this study was underway, several other researchers also began to explore how the siting of facilities affects the demographics of the host neighborhood. One found evidence supporting the market dynamics theory. Boerner & Lambert, *supra* note 27, at 17-18 (in St. Louis neighborhoods hosting active waste facilities and inactive CERCLIS sites, the percentages of the poor and minorities increased at a faster rate than in non-host

suggests that the areas surrounding TSDFs sited in the 1970s and 1980s are growth areas: in host areas, the number of vacant housing units was lower than in sample areas, and the percentage of housing built in the prior decade was higher. Such growth suggests that the market for land in the host areas is active and should respond to any nuisance created by the TSDFs. It also may suggest that the burdens of the TSDF are being off-set by the benefits, such as increased employment opportunities.

IV.
THE CURRENT DEMOGRAPHICS OF HOST NEIGHBORHOODS

If facilities were not initially disproportionately sited as to African Americans, and if the opening of a facility is not followed by disproportionate increases in the percentage of African Americans in the host areas, can the claim that areas hosting TSDFs currently are disproportionately African American be true? To test this claim, we again used comparison of means tests, logit estimations and comparative static exercises to evaluate differences between the current demographics of host tracts and non-host tracts.[82]

A. Comparing the Means

We compared the means of various demographic variables for the 544 tracts hosting active TSDFs in 1994 to those of the approximately 60,000 non-host tracts, as of the 1990 census. As detailed in Figure Nineteen, there is no statistically significant difference between the mean percentage of African Americans in host tracts and non-host tracts. The analysis does show a substantial and statistically significant difference between the mean percentage of Hispanics in host and non-host tracts, and a statistically significant difference between the mean percentage of all minorities (all races other than white, and all Hispanics, whether white or of another race).

The results reveal considerable differences along measures of wealth and social class: host tracts have median family incomes that are about ten percent less than those in non-host tracts, and have somewhat higher percentages of people living in poverty than non-host tracts. Host tracts have a much less educated population, higher

neighborhoods, and both mean family income and median housing values in host areas fell relative to non-host neighborhoods). The other found no evidence of market dynamics. John Michael Oakes et al., A Longitudinal Analysis of Environmental Equity in Communities with Hazardous Waste Facilities, 25 Soc. Sci. Research 125, 144-46 (1996) (nationwide study comparing changes in the demographics of areas hosting TSDFs to those of non-host areas with varying levels of industrial employment, and finding no significant differences in the changes).

82. Comparisons of distributions are reported in Been, *supra* note 31, at 29-36.

levels of unemployment, lower levels of employment in the professional occupations,[83] and higher levels of employment in manufacturing occupations. Median housing value is strikingly lower in host than in non-host tracts. Each of these differences is statistically significant.

The comparison of means, therefore, supports the environmental justice movement's claim that LULUs are located in areas that currently are disproportionately populated with Hispanics and lower-income families, but does not support the claim that host neighborhoods are disproportionately populated by African Americans.

B. Logit Estimations

The logit estimations are presented in Figure Twenty. In the logits, the dependent variable was the presence or absence of a facility in the tract, without regard to when the facility was sited. The independent variables were the demographic characteristics and density.

As the claims of the environmental justice movement suggest, the percentages of African Americans and Hispanics both are significant positive predictors of the presence of a facility. Contrary to the claim that host neighborhoods currently are disproportionately poor, the percentage of individuals with incomes below the poverty line is a significant but negative predictor: the higher the percentage of the poor, the lower the likelihood that the tract hosts a facility. Also contrary to expectations, median family income is positive and significant, and median housing value is positive, although not significant.

C. Comparative Static Exercises

An analysis of changes in the probability that a tract in 1990 hosts a facility, using comparative static exercises,[84] provides evidence of the magnitude of the correlation between race and ethnicity and the presence of a facility. The base probability that a tract hosts a facility as of 1990 is 0.0050. Increasing the percentage of African Americans in all tracts by ten percentage points changes the probability that a tract at the mean for all other variables hosts a facility to 0.0059, an increase of eighteen percent. Increasing the percentage of Hispanics in all tracts by ten percentage points changes the probability that a

83. For the purposes of this analysis, professional employment means those persons employed in executive, administrative and managerial occupations (Census Bureau occupational codes 3-37) and those employed in professional specialty occupations (codes 43-199). The percentage of workers employed in those categories was calculated by dividing the number of persons employed in those categories by the total number of males and females age sixteen or older employed in the civilian labor force.

84. *See supra* part II.C. for an explanation of comparative static exercises.

tract at the mean hosts a facility to 0.0071, an increase of forty-two percent.

D. Explanations for the Inconsistency

It seems odd that the logit estimations find a correlation between the presence of a facility and a tract's 1990 percentage of African Americans, when neither the 1970 nor 1980 analyses found that the percentage of African Americans was a significant predictor (at the ninety-five percent confidence level) of where facilities would be sited, and when the market dynamics analysis found no evidence that the presence of a facility affected a tract's racial demographics in subsequent years. Several factors may explain the inconsistency.

First, it appears that a large part of the disproportion reported in Figure Twenty results from facilities that were sited prior to 1970. In comparison of means tests, the mean percentage of African Americans, as of 1990, in the tracts sited before 1970 is 19.58%, compared with 14.39% in all host tracts and 13.46% in the non-host tracts. The difference between the pre-1970 host tracts and the non-host tracts is statistically significant at the ninety-five percent confidence level. Further, if the logit analysis reported in Figure Twenty is modified to include a variable distinguishing between those tracts sited before 1970 and those tracts sited after 1970, the coefficient for the percentage of African Americans in the pre-1970 tracts is almost three times as high as the coefficient for that variable in the post-1970 tracts. This indicates that the correlation between the percentage of African Americans and the presence of a facility is much stronger for the pre-1970 facilities. It would seem, therefore, that the current disproportion revealed in Figure Twenty is driven primarily by the pre-1970 facilities. Because of data limitations, it was not possible for us to study the demographics of tracts hosting facilities sited before 1970 at the time the facility opened, so we cannot say whether the current disproportion resulted from the siting process or from market dynamics.

Second, as discussed previously, it is likely that the requirement that the longitudinal analysis be limited to areas tracted in the census prior to the siting (which were predominantly metropolitan) results in some understatement of the gap between the demographics of host and non-host tracts in the 1970 and 1980 analyses. The analysis reported in Figure Twenty, which includes all areas within the continental United States, does not have that bias.[85]

85. This hypothesis is consistent with the findings of Anderton that neither race nor ethnicity is significantly correlated with the presence of a facility in 1990 when only metropolitan areas or rural counties with at least one TSDF are considered. *Evaluating TSDF Siting*, *supra* note 25, at 86, 92. In earlier work, we showed that Anderton's limitation

V.
CONCLUSION

The results of the cross-sectional analyses detailed above are summarized in the following chart:

Test	% African Americans	% Hispanics	Average Family Income
1970 comparison of means—1970 sites	Lower in hosts, insignificant	Higher in hosts, significant at 95%	Lower in hosts, significant at 99%
1970 comparison of distributions— 1970 sites	Minor excesses in Af. Am. tracts, significant at 90%	Minor excesses in Hispanic tracts, significant at 99%	
1970 logits—1970 sites	+ correlation, significant at 90%	+ correlation, significant at 99%	+ correlation, insignificant
1980 comparison of means—1980 sites	Lower in hosts, significant at 95%	Higher in hosts, insignificant	Lower in hosts, significant at 99%
1980 comparison of distributions—1980 sites	Minor shortages in Af. Am. tracts, significant at 95%	Minor excesses in Hispanic tracts, insignificant	
1980 logits—1980 sites	– correlation, insignificant	+ correlation, significant at 99%	+ correlation, significant at 95%
1990 comparison of means—1990 sites	Higher in hosts, insignificant	Higher in hosts, insignificant	Lower in hosts, significant at 95%
1990 comparison of means—All sites	Higher in hosts, insignificant	Higher in hosts, significant at 99%	Lower in hosts, significant at 99%
1990 logits—All sites	+ correlation, significant at 99%	+ correlation, significant at 99%	+ correlation, significant at 99%

A. African American Communities

The study shows that the percentage of African Americans in a tract in 1990 is a significant predictor of whether or not that tract hosts a facility. It provides no significant evidence, however, that the percentage of African Americans in a tract at the beginning of a decade affected the probability that the tract would be selected to host a facility sometime in that decade. Thus, the evidence provides little support for the claim that siting processes follow a PIBBY—Put It in Blacks' Backyards—strategy, at least as to sitings in the last twenty-five years.

B. Hispanic Communities

With regard to Hispanics, the study reveals that the percentage of Hispanics in a tract in 1990 affects the probability that the tract hosts a facility. It also shows that the percentage of Hispanics at the beginning of a decade increased the probability that the tract would be selected to host a facility in that decade. The study therefore supports

narrows the gap between the racial and ethnic demographics of host and non-host tracts in 1990. Been, *supra* note 31, at 12-13, 26.

the claims of the environmental justice movement that siting processes in the past few decades have had a disproportionate effect upon Hispanics.

C. *Poor Communities*

The results indicate that siting processes do not intentionally or unintentionally target neighborhoods with high percentages of people with incomes below the poverty level. Indeed, the study shows that high poverty rates are negatively correlated with the probability that a tract will be selected to host a facility. Again, contrary to the assertion that poor neighborhoods are targeted to host facilities, average or median family income is positively correlated with siting choices. Further, the distributional analyses show that working class and lower middle income neighborhoods, not poor neighborhoods, are at greatest risk of being disproportionately chosen to host facilities.

D. *The Market Dynamics Theory*

The analysis provides little support for the theory that market dynamics following the introduction of a TSDF into a neighborhood might lead it to become poorer and increasingly populated by racial and ethnic minorities.

E. *Contributions of the Study*

This study advances the research on environmental justice in seven significant ways. It is the first study to lend any support to the claims of the environmental justice movement that is carefully designed to separate the effects race or ethnicity might have on sitings from the effects sitings might have on race or ethnicity. Second, the study reveals that it is Hispanics, rather than African Americans, who are most at risk from the siting processes. Third, the analysis shows that the very poor are not hosting a disproportionate share of facilities, and indeed, that neighborhoods with high levels of poverty appear to repel, rather than attract, facilities. Instead, it is working class or lower middle class neighborhoods that bear a disproportionate share of facilities. Fourth, the study reveals the significance of density in the siting of facilities, and makes it clear that environmental justice studies must be constructed to control for differences in density. The SADRI study, which appeared to refute environmental justice claims, did not control for density. Fifth, the study illustrates the importance of multivariate techniques in isolating the importance of variables, such as race and class, that are highly correlated with one another. The logits revealed that African Americans currently are overrepresented in host neighborhoods. This result was not reached by

comparison of means tests, the primary test relied upon by the CRJ study and many other environmental justice studies. Sixth, the study attempts to quantify the effect of the variables through both distributional analyses and comparative static exercises that examine how changes in the probability that a tract is selected to host a facility are related to changes in the demographic characteristics of that tract. Finally, the study reveals, and shows the importance of taking into account, the U-shaped nature of the distribution of non-host tracts (in which tracts with both the lowest and the highest percentages of minorities escape sitings).

Claims that undesirable land uses are disproportionately sited in minority and poor neighborhoods have shaken land use and environmental regulators, precipitating considerable debate on how best to factor concerns about distributional equity into the decisionmaking process. The debate has been hindered, however, by serious concerns about the evidence upon which the environmental justice claims were based. This study addresses the major questions and criticisms of that evidence, in the hope of moving the debate beyond the nature of the problem and toward discussions of appropriate solutions.

FIGURE ONE

Comparison of Means
Demographics of Tracts Becoming Hosts
1970-1979, as of the 1970 Census

Variable	Tracts Becoming Hosts in the '70s	Non-Host Tracts as of 1969	Host to Non-Host Ratio	Significance
% African American	10.43	12.23	0.85	0.225
% Hispanic	7.26	5.13	1.42	0.033**
% Minority	N/A	N/A	N/A	N/A
% Poor	12.21	11.88	1.03	0.632
Average Family Income	$10,403	$11,573	0.90	0.000***
% With No High School Diploma	52.65	46.75	1.13	0.000***
Average House Value	N/A	N/A	N/A	N/A
% Housing Renter Occupied	30.57	37.07	0.82	0.000***
% Housing Built Prior Decade	30.47	24.85	1.23	0.000***
% Unemployed	4.85	4.53	1.07	0.165
% Employed in Manufacturing	39.60	31.76	1.25	0.000***

*** Statistically significant at 99% confidence level
** Statistically significant at 95% confidence level
* Statistically significant at 90% confidence level

FIGURE TWO

Comparison of Means
Demographics of Tracts Becoming Hosts
1980-1989, as of the 1980 Census

Variable	Tracts Becoming Hosts in the '80s	Non-Host Tracts as of 1979	Host to Non-Host Ratio	Significance
% African American	10.17	13.85	0.73	0.022**
% Hispanic	7.18	6.81	1.05	0.727
% Minority	18.36	22.51	0.82	0.027**
% Poor	11.82	12.49	0.95	0.392
Average Family Income	$21,122	$23,156	0.91	0.000***
% With No High School Diploma	38.92	34.19	1.14	0.000***
Average House Value	$33,051	$41,362	0.80	0.000***
% Housing Renter Occupied	29.19	34.79	0.84	0.000***
% Housing Built Prior Decade	24.47	19.73	1.24	0.001***
% Unemployed	7.76	7.06	1.10	0.080*
% Employed in Manufacturing	39.02	31.47	1.24	0.000***

*** Statistically significant at 99% confidence level
** Statistically significant at 95% confidence level
* Statistically significant at 90% confidence level

FIGURE THREE

Comparison of Means
Demographics of Tracts Becoming Hosts
1990-1994, as of the 1990 Census

Variable	Tracts Becoming Hosts in the '90s	Non-Host Tracts as of 1989	Host to Non-Host Ratio	Significance
% African American	14.98	13.46	1.11	0.749
% Hispanic	10.53	7.83	1.34	0.220
% Minority	29.07	24.18	1.20	0.373
% Poor	15.54	14.59	1.07	0.673
Average Household Income	$32,996	$37,227	0.89	0.034**
% With No High School Diploma	28.58	26.55	1.08	0.458
Average Housing Value	$90,366	$104,064	0.87	0.546
% Housing Renter Occupied	35.57	32.10	1.11	0.297
% Housing Built Prior Decade	28.58	17.90	1.60	0.023**
% Unemployed	7.31	7.19	1.02	0.819
% Employed in Manufacturing	28.34	27.52	1.03	0.752

*** Statistically significant at 99% confidence level
** Statistically significant at 95% confidence level
* Statistically significant at 90% confidence level

FIGURE FOUR

Distribution of Tracts in 1980 by Percentage of African Americans in Tract (1980 census)

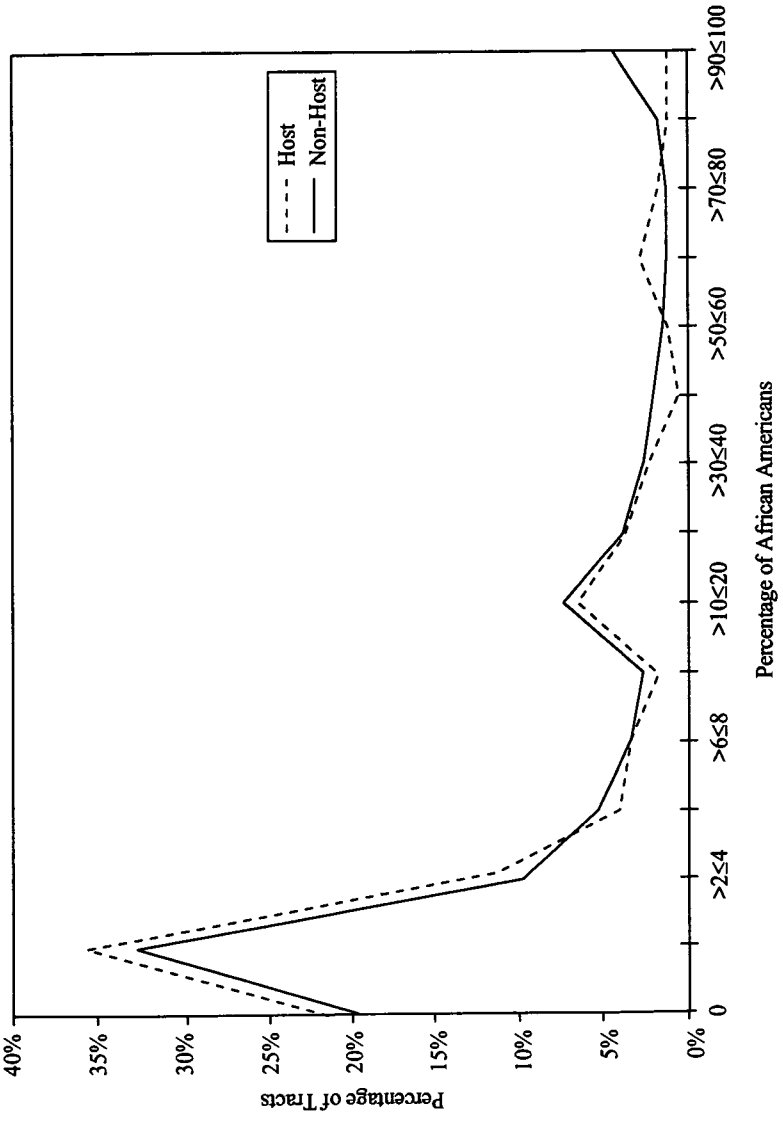


FIGURE FIVE

Actual and Proportionate Distribution of Tracts Becoming Hosts in the 1980s by Percentage of African Americans (1980 census)

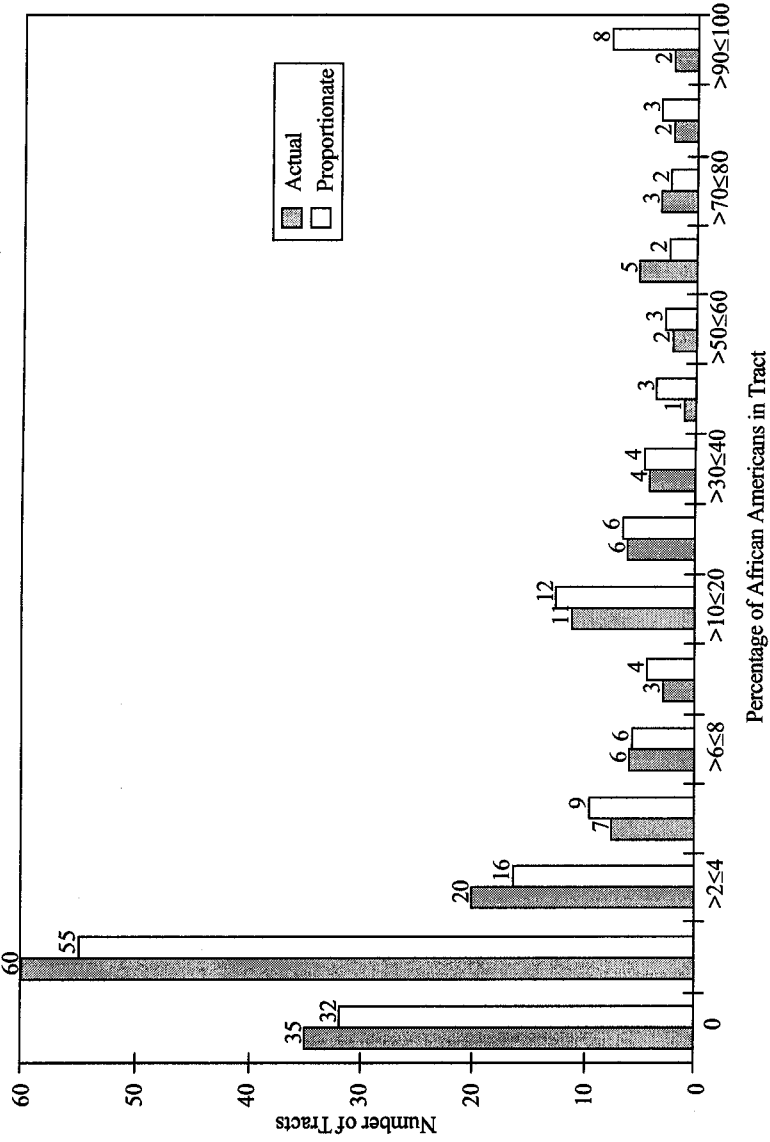


FIGURE SIX

Distribution of 1970 Tracts by Percentage of African Americans (1970 census)

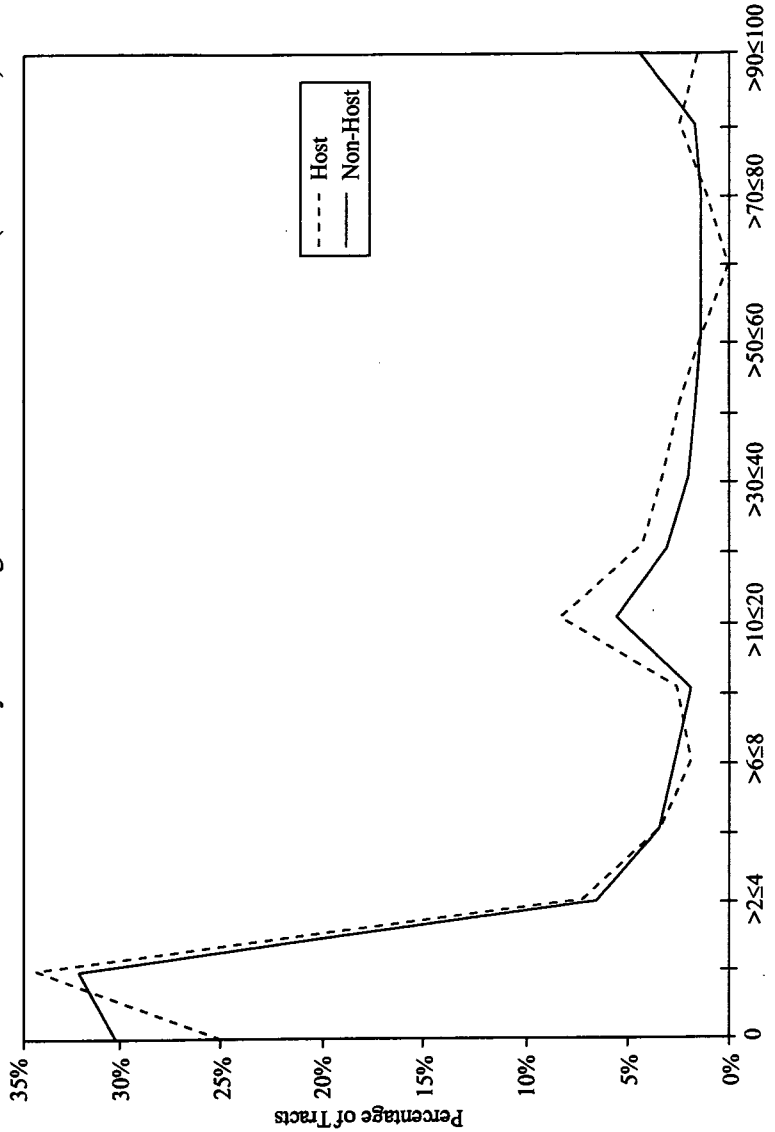


FIGURE SEVEN
Actual and Proportionate Distribution of Tracts Becoming Hosts in the 1970s by Percentage of African Americans (1970 census)

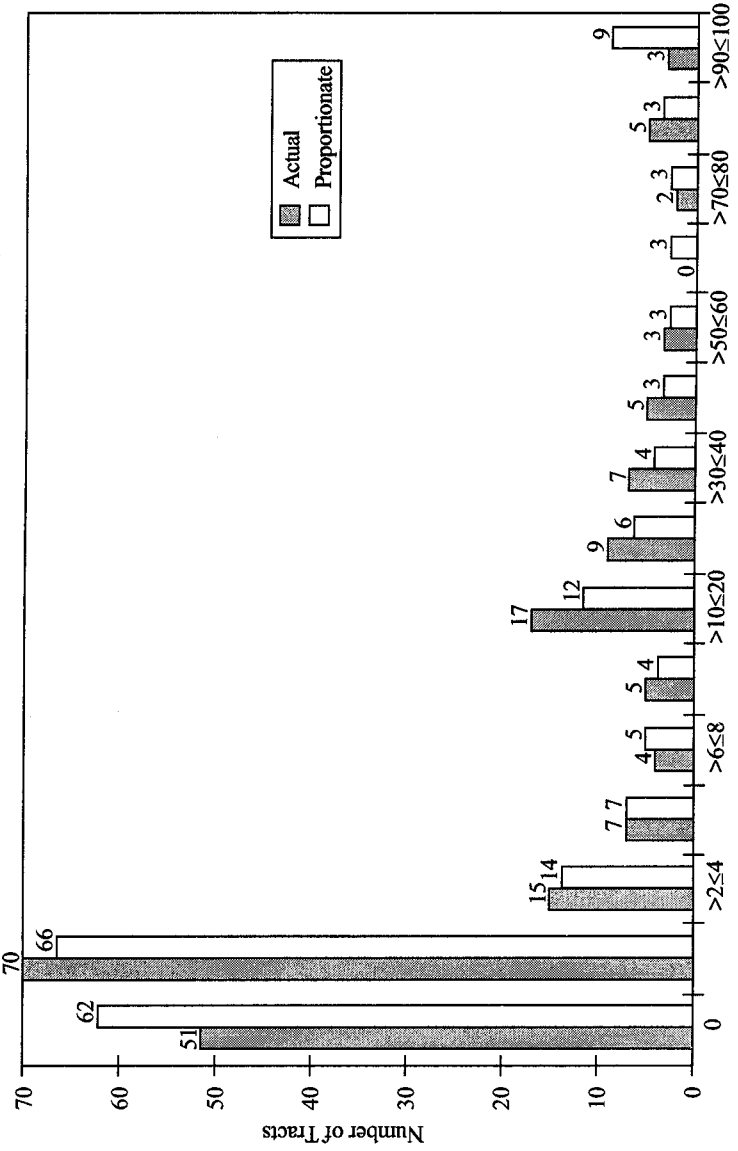


FIGURE EIGHT

Distribution of 1980 Tracts by Percentage of Hispanics (1980 census)

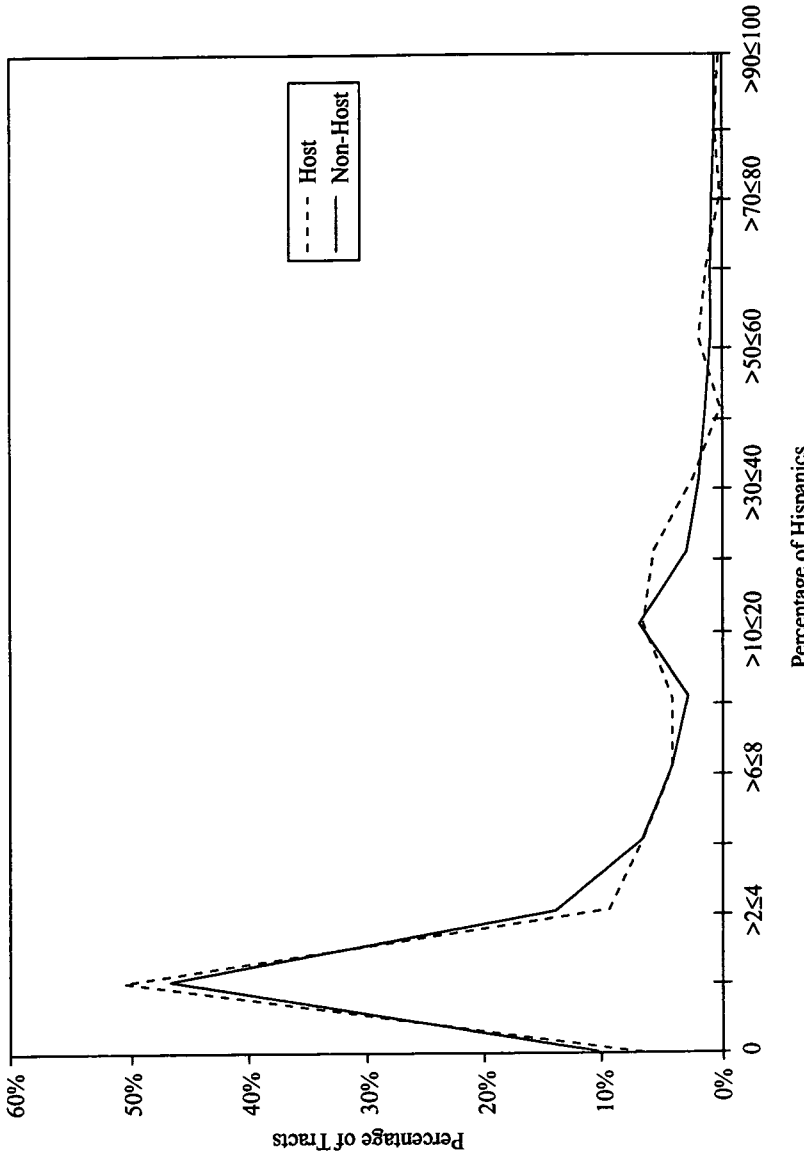


FIGURE NINE

Actual and Proportionate Distribution of Tracts Becoming Hosts in the 1980s by Percentage of Hispanics (1980 census)

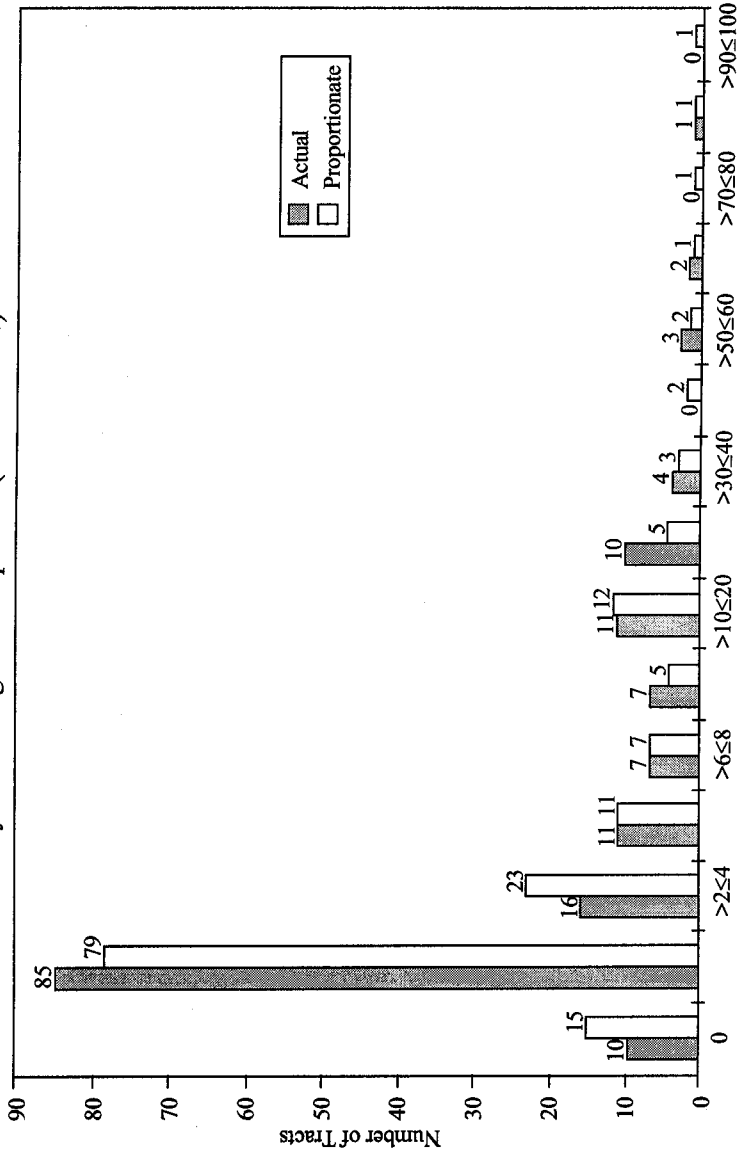


FIGURE TEN

Distribution of 1970 Tracts by Percentage of Hispanics (1970 census)

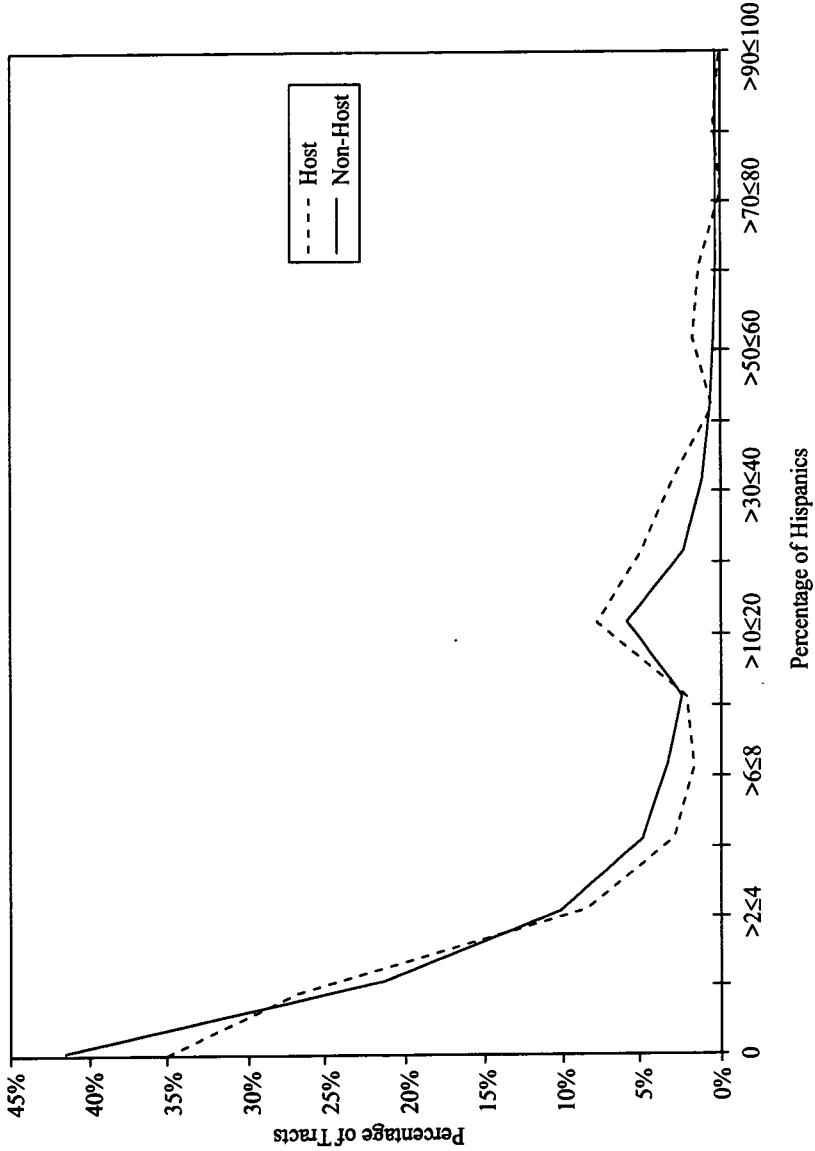


FIGURE ELEVEN

Actual and Proportionate Distribution of Tracts Becoming Hosts in the 1970s by Percentage of Hispanics (1970 census)

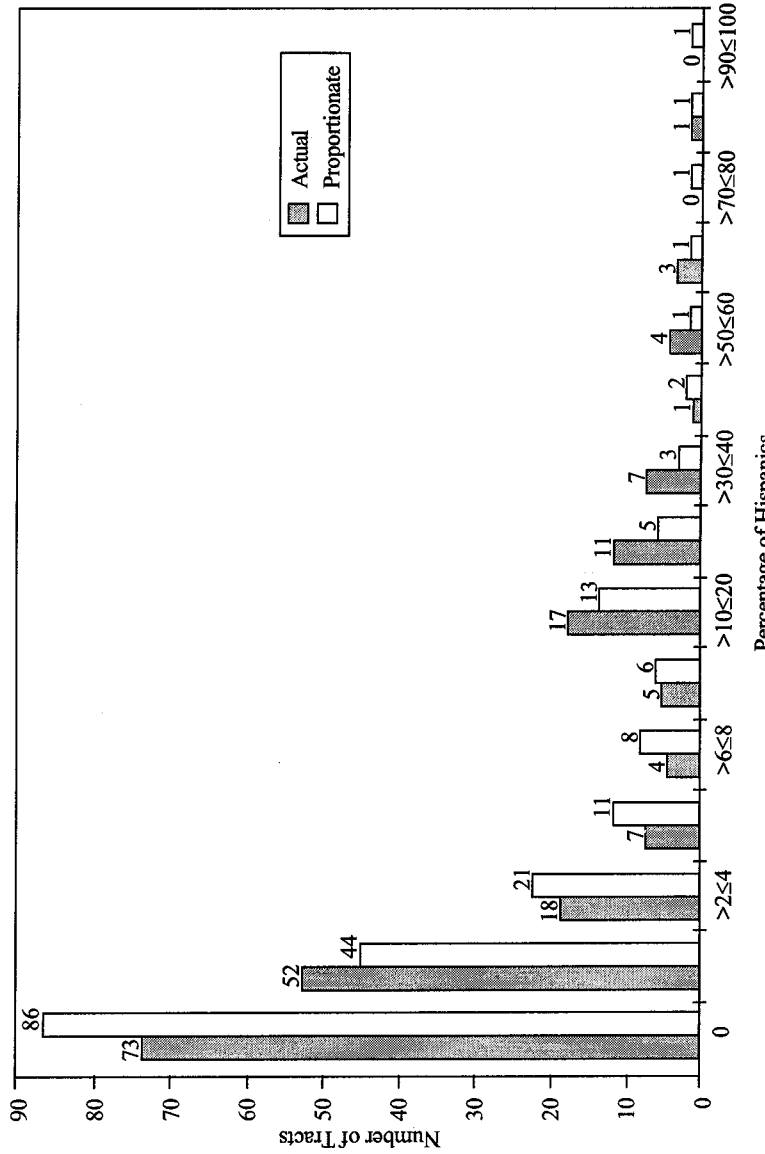


FIGURE TWELVE

Logit Estimations—1970 Census Data Tracts that Became Hosts 1970-79 and Sample of All Tracts

Variable	Coefficient	Standard Error	T Score	Significance
% African American	0.0237	0.0135	1.758	0.079*
% Hispanic	0.0431	0.0166	2.605	0.009***
% Poor	0.0116	0.0348	0.333	0.739
% With No High School Diploma	–0.0561	0.3392	–1.654	0.098*
Average Family Income	0.0001	0.0001	1.151	0.250
House Value $0-10,000 ('70 $)	–0.0087	0.0062	–1.396	0.163
House Value $10-25,000 ('70 $)	–0.0027	0.0052	–0.525	0.600
House Value $25-50,000 ('70 $)	–0.0006	0.0088	–0.069	0.945
% Unemployed	0.0857	0.0587	1.459	0.145
% Employed in Manufacturing	0.2405	0.5447	4.415	0.000***
Density	–0.0267	0.0075	–3.557	0.000***
% African American^2	–0.0002	0.0002	–1.171	0.242
% Hispanic^2	–0.0005	0.0003	–1.703	0.089*
% Poor^2	–0.0005	0.0005	–0.920	0.358
% With No High School Diploma^2	0.0007	0.0003	2.125	0.034
% Unemployed^2	–0.0033	0.0031	–1.079	0.281
Average Family Income^2	0.0000	0.0000	–1.106	0.269
% Employed in Manufacturing^2	–0.0028	0.0007	–4.195	0.000***
Density^2	0.0000	0.0001	0.000	1.000
Constant	–7.4384	2.1625	–3.440	0.000***

Log likelihood: –520.226
χ^2 (19 degrees of freedom): 232.08

Number of Observations: 1854
$P > \chi^2 = 0.000$

*** Statistically significant at 99% confidence level
** Statistically significant at 95% confidence level
* Statistically significant at 90% confidence level

FIGURE THIRTEEN

Logit Estimations—1980 Census Data Tracts that Became Hosts 1980-89 and Sample of All Tracts

Variable	Coefficient	Standard Error	T Score	Significance
% African American	–0.0091	0.0148	–0.645	0.519
% Hispanic	0.0500	0.0161	3.110	0.002***
% Poor	–0.0934	0.0353	–2.649	0.008***
% With No High School Diploma	–0.0344	0.0312	–1.105	0.269
Average Family Income	0.2121	0.0987	2.149	0.032**
Average Housing Value	–0.0077	0.0051	–1.503	0.133
% Unemployed	–0.0216	0.0564	–0.384	0.701
% Employed in Manufacturing	0.0495	0.0439	1.127	0.260
Density	–0.3182	0.0441	–7.208	0.000***
% African American^2	0.0002	0.0002	0.961	0.336
% Hispanic^2	–0.0005	0.0002	–1.988	0.047**
% Poor^2	0.0018	0.0006	2.775	0.006***
% With No High School Diploma^2	0.0004	0.0003	1.129	0.259
% Unemployed^2	0.0027	0.0022	1.224	0.221
Average Family Income^2	–0.0031	0.0013	–2.402	0.016**
% Employed in Manufacturing^2	–0.0003	0.0005	–0.463	0.643
Density^2	0.0014	0.0004	3.599	0.000***
Constant	–4.9079	1.9839	–2.474	0.013**

Log likelihood: –507.02594 Number of Observations: 2240

χ^2 (17 degrees of freedom): 204.31 $P > \chi^2 = 0.000$

*** Statistically significant at 99% confidence level

** Statistically significant at 95% confidence level

* Statistically significant at 90% confidence level

FIGURE FOURTEEN

Probability Analysis Changes in the Odds that a Tract with Demographic Characteristics at the Mean for All Tracts Would Have Been Selected as a Host

	Probability of Hosting a Facility Sited 1970-79	Probability of Hosting a Facility Sited 1980-89
Base Probability	0.0252	0.0176
– 10 % points, % African American	0.0234	Not Statistically Significant
+ 10 % points, % African American	0.0289	Not Statistically Significant
– 10 % points, % Hispanic	0.0232	0.0156
+ 10 % points, % Hispanic	0.0349	0.0257

FIGURE FIFTEEN

Changes in Demographic Means of Host and Sampled Tracts Between the 1980 and 1990 Censuses for Facilities Sited During the 1980s

Variable	Host 1980 (N=178)†	Host 1990 (N=178)	Sample 1980 (N=2098)	Sample 1990 (N=2098)	Change in Host (90-80/80)	Change in Sample (90-80/80)
% African American	9.88**	11.47**	13.91	15.83	16.09%	13.80%
% Hispanic	8.00	10.59	7.09	9.18	32.38%	29.48%
% Minority	18.91	22.91	22.91	28.14	21.15%	22.83%
% Poor	11.64	13.96	12.37	14.55	19.93%	17.62%
Average Family Income ('90 $)	33,889***	37,270	37,446***	44,507	9.98%***	18.86%
% With No High School Diploma	38.27***	33.48	28.18	25.75	-12.52%	-8.62%
Average Housing Value ('90 $)	52,326***	67,628	78,166***	113,920	29.24%***	45.74%
% Vacant Housing	7.99***	7.64	6.56	8.04	-4.38%	22.56%
% Housing Renter Occupied	29.00	30.65***	34.84	35.49	5.69%	1.87%
% Housing Built Previous Decade	24.09	22.53***	19.47	15.29	-6.48%	-21.47%
% in Same House Five Years Before	55.72	53.68	56.19	55.01	-3.66%	-2.10%
% Rural	21.92**	20.22**	16.16	14.65	-7.76%	-9.34%
% Unemployed	7.86**	7.43	7.07	7.28	-5.47%	2.97%
% Employed in Manufacturing	38.82***	31.54***	30.95	25.60	-18.75%	-17.29%
Density	1392***	1434	6353	6386	3.02%	0.52%

*** Statistically significant difference between host and sample tracts at the 99% confidence level

** Statistically significant difference between host and sample tracts at the 95% confidence level

* Statistically significant difference between host and sample tracts at the 90% confidence level

† N for hosts ranges from 174 to 178, and for the sample ranges from 1986 to 2098 because data for some variables is not reported for some tracts

FIGURE SIXTEEN

Changes in Demographic Means of Host and Sample Tracts Between the 1970 and 1990 Censuses for Facilities Sited During the 1970s

Variable	Host 1970 (N=201)†	Host 1990 (N=201)	Sample 1970 (N=1655)	Sample 1990 (N=1655)	Change in Host (90-70/70)	Change in Sample (90-70/70)
% African American	10.53	14.03*	12.31	17.82	33.26%*	44.70%
% Hispanic	7.065*	12.26	5.27	10.51	73.53%	99.43%
% Poor	12.35	15.03	11.87	15.37	21.70%	29.49%
Average Family Income ('90 $)	34,819***	38,615***	38,350	43,360	10.90%	13.06%
% With No High School Diploma	52.84***	29.48	47.48	27.68	-44.21%***	-41.70%
% Unemployed	4.92*	7.74	4.51	7.67	57.32%	70.07%
Average Housing Value ('90 $)	N/A	91,651***	N/A	115,950	N/A	N/A
% Housing $0-10,000 ('70 $)	17.71***	N/A	12.80	N/A	N/A	N/A
% Housing $10-25,000 ('70 $)	46.34	N/A	43.93	N/A	N/A	N/A
% Housing $25-50,000 ('70 $)	12.39***	N/A	16.18	N/A	N/A	N/A
% Vacant Housing	5.39	7.29	4.95	7.69	35.25%	55.25%
% Housing Renter Occupied	31.33***	34.72**	37.54	38.41	10.82%	2.32%
% Housing Built Previous Decade	28.65***	18.04***	24.35	12.21	-37.03%	-49.86%
% Rural	20.37***	13.47	14.14	10.25	-33.87%	-27.51%
Density	1865***	1918***	8843	8175	2.84%**	-7.55%

*** Statistically significant difference between host and sample tracts at the 99% confidence level

** Statistically significant difference between host and sample tracts at the 95% confidence level

* Statistically significant difference between host and sample tracts at the 90% confidence level

† N for hosts ranges from 191 to 201, and for the sample ranges from 1555 to 1655 because data for some variables was not reported for some tracts

FIGURE SEVENTEEN

Changes in Demographic Means of Host and Sample Tracts Between the 1970 and 1990 Censuses for Facilities Sited Before 1970

Variable	Host 1970 (N=97)†	Host 1990 (N=97)	Sample 1970 (N=1655)	Sample 1990 (N=1655)	Change in Host (90-70/70)	Change in Sample (90-70/70)
% African American	12.40	20.34	12.32	17.82	64.03%	44.64%
% Hispanic	6.54	13.78	5.27	10.51	110.70%	99.43%
% Poor	12.04	16.50	11.87	15.37	37.04%	29.49%
Average Family Income ('90 $)	34,514***	36,254***	38,350	43,360	5.04%	13.06%
% With No High School Diploma	56.62***	34.90***	47.48	27.68	-38.36%	-41.70%
% Unemployed	4.83	9.37***	4.51	7.67	94.00%	70.07%
% Employed in Manufacturing	41.15***	33.94***	32.02	26.21	-17.52%**	-18.14%
Average Housing Value ('90 $)	N/A	83,942***	N/A	115,950.00	N/A	N/A
% Housing $0-10,000 ('70 $)	16.74**	N/A	12.80	N/A	N/A	N/A
% Housing $10-25,000 ('70 $)	47.71	N/A	43.93	N/A	N/A	N/A
% Housing $25-50,000 ('70 $)	9.79***	N/A	16.18	N/A	N/A	N/A
% Vacant Housing	4.26	7.75	4.95	7.68	82.08%	55.15%
% Housing Renter	33.75	35.94	37.54	38.41	6.49%	2.32%
% Housing Built	23.52	14.38	24.35	12.21	-38.86%	-49.86%
% Rural	15.70	7.69	14.15	10.25	-50.99%	-27.56%
Density	3414***	2998***	8843	8175	-12.19%	-7.55%

*** Statistically significant difference between host and sample tracts at the 99% confidence level

** Statistically significant difference between host and sample tracts at the 95% confidence level

* Statistically significant difference between host and sample tracts at the 90% confidence level

† N for hosts ranges from 88 to 97, and for the sample ranges from 1555 to 1655, because data for some variables was not reported for some tracts

FIGURE EIGHTEEN

Regression Coefficients of Siting (Dummy) Variable When the Post-Siting Demographic Variable of Interest Is Regressed Against Pre-Siting Demographic Variables and the Siting (Dummy) Variable

Facilities sited 1980-1989, 1990 variable listed regressed against all 1980 demographic variables and a siting (dummy) variable

1990 Variable	Coefficient of Siting Variable	Standard Error	T-Score	Significance (P>\t\)
Percentage of African Americans	–0.2870	0.5230	–0.549	0.583
Percentage of Hispanics	0.6192	0.4060	1.525	0.127
Average Family Income	–0.0043	0.0155	–0.276	0.782

Facilities sited 1970-1979, 1990 variable listed regressed against all 1970 demographic variables and a siting (dummy) variable

1990 Variable	Coefficient of Siting Variable	Standard Error	T-Score	Significance (P>\t\)
Percentage of African Americans	–0.4462	1.1173	–0.399	0.690
Percentage of Hispanics	0.1849	0.7945	0.233	0.816
Average Family Income	0.0081	0.0188	0.447	0.655

Facilities sited before 1970, 1990 variable listed regressed against all 1970 demographic variables and a siting (dummy) variable

1990 Variable	Coefficient of Siting Variable	Standard Error	T-Score	Significance (P>\t\)
Percentage of African Americans	3.084	1.6222	1.901	0.057*
Percentage of Hispanics	1.5836	1.1454	1.383	0.167
Average Family Income	–0.0178	0.0256	–0.697	0.486

* Statistically significant at 90% confidence level

FIGURE NINETEEN
Comparison of Means
Demographics of All Host Tracts
as of 1990 Census

Variable	Host Tracts	Non-Host Tracts	Host to Non-Host Ratio	Significance
% African American	14.39	13.46	1.07	0.355
% Hispanic	10.34	7.83	1.32	0.002***
% Minority (all nonwhite races, and Hispanic whites)	27.21	24.17	1.13	0.016**
% Poor	15.69	14.59	1.08	0.049**
Median Family Income	$31,602	$34,586	0.91	0.000***
% With No High School Diploma	31.23	26.55	1.18	0.000***
Median Housing Value	$76,125	$96,808	0.79	0.000***
% Unemployed	8.12	7.19	1.13	0.000***
% Employed in Manufacturing	33.46	27.52	1.22	0.000***
Average Population Density	1749	5076	0.34	0.000***

*** Statistically significant at 99% confidence level
** Statistically significant at 95% confidence level
* Statistically significant at 90% confidence level

FIGURE TWENTY
Logit Analysis
1990 Census/All Host Tracts

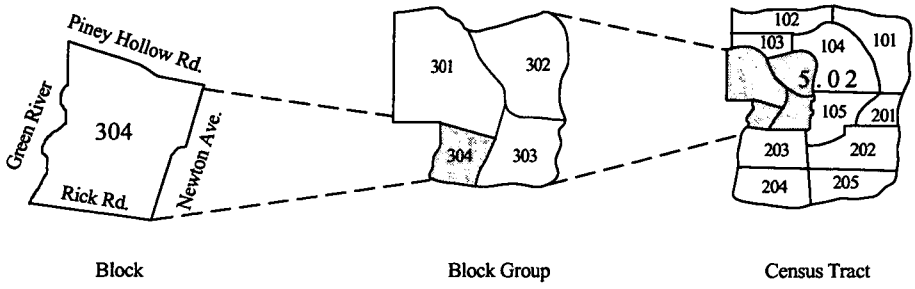
Variable	Coefficient	Standard Error	T Score	Significance (P>\t\)
% African American	0.0242	0.0062	3.87	0.000***
% Hispanic	0.0458	0.0076	6.01	0.000***
% Poor	–0.0265	0.1580	–1.677	0.094*
% With No High School Diploma	–0.0062	0.0159	–0.39	0.697
Median Family Income	1.3186	0.2965	4.448	0.000***
Median Housing Value	0.0133	0.1247	1.071	0.284
% Unemployed	0.0578	0.2234	2.549	0.010***
% Employed in Manufacturing	0.1108	0.2401	4.616	0.000***
Population Density	–1.7636	0.1842	–9.574	0.000***
% African American^2	–0.0002	0.0001	–2.383	0.017**
% Hispanic^2	–0.0004	0.0001	–4.038	0.000***
% Poor^2	0.0006	0.0002	2.574	0.010***
% With No High School Diploma^2	0.0002	0.0002	0.985	0.325
Median Family Income^2	–0.1435	0.0354	–4.052	0.000***
% Unemployed^2	–0.0006	0.0005	–1.122	0.262
% Employed in Manufacturing^2	–0.0011	0.0003	–3.459	0.000***
Population Density^2	0.0244	0.0039	6.235	0.000***
Constant	–9.7730	0.7858	–12.437	0.000***

Log likelihood: –2866.6658
Number of Observations: 57889

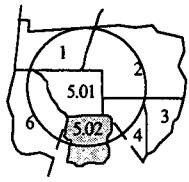
χ^2 (17 degrees of freedom): 371.64
$P > \chi^2 = 0.000$

*** Statistically significant at the 99% confidence level
** Statistically significant at the 95% confidence level
* Statistically significant at the 90% confidence level

FIGURE TWENTY-ONE



The drawings above illustrate the relationship between blocks, block groups and census tracts. Census tracts, in turn make up towns or cities. Zip codes can be as large as an entire town, and bear no relationship to census units. Concentric circles can intersect several census tracts, as illustrated by the following diagram.



These diagrams are adapted from Bureau of the Census, Census Catalog & Guide 1995, at 10.