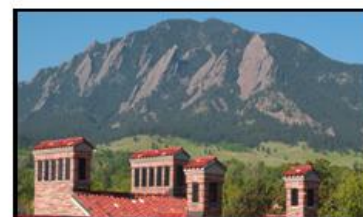


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WORKING PAPER

Inter-Neighborhood Migration, Race, and Environmental Hazards: Modeling Micro-level Processes of Environmental Inequality

Kyle Crowder
Liam C. Downey

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**INTER-NEIGHBORHOOD MIGRATION, RACE, AND ENVIRONMENTAL
HAZARDS:
MODELING MICRO-LEVEL PROCESSES OF ENVIRONMENTAL
INEQUALITY**

Kyle Crowder, Professor of Sociology, Department of Sociology, Western Washington University,
Bellingham WA
Liam C. Downey, University of Colorado

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Abstract

This study combines individual-level data from the Panel Study of Income Dynamics with neighborhood-level environmental hazard data derived from the Environmental Protection Agency's Toxics Release Inventory to provide the first empirical examination of racial and ethnic differences in migration between neighborhoods with varying levels of environmental pollution. Results indicate that profound racial and ethnic differences in exposure to industrial pollution are maintained more by differences in mobility destinations than by differential effects of pollution on the decision to move. Conditional upon moving, black and Latino householders enter neighborhoods that are significantly more polluted than those accessed by whites, while other-race householders enter neighborhoods with less pollution. These differences cannot be explained by group differences in socioeconomic resources or other micro-level characteristics but are shaped, in part, by group differences in the reaction to non-white populations that tend to be concentrated in highly polluted areas.

**INTER-NEIGHBORHOOD MIGRATION, RACE, AND ENVIRONMENTAL HAZARDS:
MODELING MICRO-LEVEL PROCESSES OF ENVIRONMENTAL INEQUALITY**

A burgeoning body of literature has revealed substantial racial and ethnic differences in exposure to environmental hazards. For example, a number of studies have demonstrated that African Americans and Hispanics tend to be overrepresented in urban neighborhoods with high levels of environmental pollution and industrial hazards (Ash and Fetter 2004; Brulle and Pellow 2005; Downey 2005; Pastor, Sadd, and Hipp 2001), and several studies suggest that racial inequality in exposure to environmental hazards likely contributes to significant racial disparities in a variety of outcomes, including physical and psychological health, educational success, and perceptions of social order (Downey and Van Willigen 2005; Evans and Kantrowitz 2002; Pastor, Sadd, and Morello-Frosch 2002, 2004; Ross, Reynolds, and Geis 2000; Sadd, Pastor, Boer, and Snyder 1999). Given these consequences, developing an understanding of the causes of environmental racial inequality is an important endeavor.

Yet, while there is a good deal of consensus that racial and ethnic disparities in exposure to industrial hazards exist in the aggregate (Ash and Fetter 2004; Derezinski, Lacy, and Stretesky 2003, Downey 2003; Morello-Frosch, Pastor, and Sadd 2001), we have very little information about the micro-level processes that shape and reinforce this environmental inequality. Even in the context of racial biases in the process through which industrial facilities are sited (Downey 2005; Pastor, Sadd, and Hipp 2001), much of the persistent concentration of minority families in hazardous neighborhoods likely reflects racially differentiated patterns of mobility and immobility between neighborhoods with varying levels of pollution (Hunter, White, Little, and Sutton 2003; Mitchell, Thomas, and Cutter 1999). Indeed, the most common theoretical explanations for environmental inequality implicate individual residential mobility patterns as the key mechanisms through which environmental inequality is maintained, focusing attention on

why minority households may be less likely than white households to leave highly polluted areas and/or more likely to move into such neighborhoods.

However, due to data limitations these theoretical arguments have been tested only indirectly using aggregate-level data (c.f., Been and Gupta 1997; Downey 2005; Hamilton 1995; Hunter et al. 2003; Oakes, Anderton, and Anderson 1996; Pastor, Sadd, and Hipp 2001; Shaikh and Loomis 1999), producing results that are fraught with contradictions and the potential for ecological fallacy. The dearth of appropriate multi-level data that links information on individual members of different racial and ethnic groups to information on the levels of pollution in their neighborhoods has prevented a more theoretically appropriate examination of the micro-level mobility patterns that likely produce and maintain sharp racial disparities in exposure to local environmental hazards.

The current study addresses these significant gaps in the existing literature on environmental racial inequality by merging individual-level data from the nationally representative Panel Study of Income Dynamics (PSID) with neighborhood-level environmental hazard data derived from the Environmental Protection Agency's (EPA) Toxics Release Inventory (TRI) and neighborhood sociodemographic data drawn from the U.S. census to examine racial and ethnic differences in household migration between neighborhoods with varying levels of environmental pollution. The study employs analytic techniques commonly found in the residential mobility literature but not the environmental inequality literature, tests hypotheses drawn from both bodies of literature, and utilizes an innovative Geographic Information Systems (GIS) technique that weights the potential impact of each environmental hazard inversely according to geographic distance from the hazard, allowing us to measure hazard proximity more precisely for each neighborhood than has been possible in prior research.

This combination of data, theory, and methods makes it possible to examine, for the first time, whether the effect of local industrial hazards on the decision to leave the neighborhood differs for members of different racial and ethnic groups, the extent to which hazard levels in the neighborhoods to which individuals relocate varies across racial and ethnic groups, and whether these racial and ethnic differences in mobility patterns and the exposure to environmental hazards that result can be explained by group differences in economic resources and other factors that shape mobility opportunities and behavior. While these data do not allow us to test hypotheses concerning hazardous facility siting patterns, this study makes an important contribution to our understanding of environmental racial inequality by providing the first analysis of household-level migration into and out of environmentally hazardous neighborhoods.

PAST RESEARCH

Academic interest in environmental inequality has grown dramatically over the past twenty years, with researchers in fields as diverse as economics, sociology, epidemiology, geography, and legal studies attempting to determine whether minority and low income neighborhoods are disproportionately burdened by environmental hazards (Anderton, Anderson, Oakes, and Fraser 1994; Anderton, Anderson, Rossi, Oakes, Fraser, Weber, and Calabrese 1994; Been 1994; Bowen, Salling, Haynes, and Cyran 1995; Chakraborty and Armstrong 1997; Hamilton 1995; Liu 2001; Pastor, Sadd, and Morello-Frosch 2002; Szasz and Meuser 1997). Environmental inequality researchers have studied the distribution of social groups around a variety of environmental hazards, including hazardous waste sites, manufacturing facilities, superfund sites, and chemical accidents (Bowen 2002; Derezinski, Lacy, and Stretesky 2003; Morello-Frosch, Pastor, and Sadd 2001; Szasz and Meuser 1997). Virtually all studies have relied on aggregate-level data (Bowen 2002) to assess the correspondence between *neighborhood*

sociodemographic composition (e.g., percentages made up of particular racial groups) and *neighborhood* hazard levels, and most studies support the hypothesis that neighborhoods containing relatively large shares of racial and ethnic minorities are disproportionately burdened by residential proximity to environmental hazards (Pastor, Sadd, and Hipp 2001).

Despite the plethora of environmental inequality research, only a handful of studies have attempted to isolate the determinants of environmental racial inequality (Been and Gupta 1997; Downey 2005; Hamilton 1995; Hunter et al. 2003; Oakes, Anderton, and Anderson 1996; Pastor, Sadd, and Hipp 2001; Shaikh and Loomis 1999). Some of these past studies have assessed the argument that environmental racial inequality emerges because environmental hazards are disproportionately sited in minority neighborhoods (Been and Gupta 1997; Hamilton 1995; Pastor, Sadd, and Hipp 2001; Shaikh and Loomis 1999). However, others have pointed out that, in the context of high levels of residential mobility, initial siting decisions may have relatively little impact on patterns of exposure to environmental hazards as individual householders may simply move away from these hazards. According to this argument, racial differences in exposure to environmental hazards may persist because minority households may be less likely than white households to move away from, and more likely to move into, areas containing environmental hazards (Boer, Pastor, Sadd, and Snyder 1997; Brooks and Sethi 1997; Downey 2005; Hamilton 1995; Hunter et al. 2003; Mohai and Bryant 1992; Oakes, Anderton, and Anderson 1996). As Hunter and her colleagues (2003:24) point out, “selective migration is often implied to be a key dynamic leading to differential exposure to proximate environmental hazards” (2003: 24).

However, to date, the absence of appropriate multi-level data related to the mobility behaviors of individual householders has prevented researchers from directly testing

environmental inequality hypotheses related to racially-differentiated patterns of residential mobility. Moreover, those aggregate-level studies that have attempted to identify the ways in which mobility patterns shape environmental inequality have produced contradictory results. For example, while most environmental inequality research shows that whites live further from environmental hazards than do members of minority groups, only one study (Shaikh and Loomis 1999) has found evidence of a disproportionate flow of white population out of hazardous neighborhoods and none have observed that environmentally hazardous neighborhoods receive disproportionately large in-flows of minority residents (Been and Gupta 1997; Hamilton 1995; Pastor, Sadd, and Hipp 2001; Shaikh and Loomis 1999). Similarly, Hunter et al's (2003) comprehensive study of inter-county migration flows found no evidence of racial differences in migration away from counties containing hazardous facilities. Thus, if racially-differentiated mobility processes are responsible for maintaining racial differences in exposure to environmental hazards, aggregate-level studies appear to be inadequate for uncovering these dynamics.

In addition to producing contradictory results, existing aggregate-level studies have been unable to adequately test many of the key theoretical arguments informing the environmental inequality literature because the mechanisms proposed in these theoretical arguments all operate at the individual or household levels. As a result, these studies are unable to resolve ongoing debates about the relative effects of race and household socioeconomic status in the determination of exposure to environmental hazards. While some authors have attempted to test these arguments with aggregate-level data (Been and Gupta 1997; Downey 2005; Hamilton 1995; Hunter et al. 2003; Oakes, Anderton, and Anderson 1996; Pastor, Sadd and Hipp 2001; Shaikh and Loomis 1999), it is impossible to know whether or not conclusions drawn from these

studies reflect ecological fallacy. Thus, as Hunter and her colleagues (2003) recently concluded, building our understanding of racial differences in exposure to environmental hazards requires that additional attention be paid to patterns of individual mobility between small geographic units.

THEORETICAL PERSPECTIVES

The disproportionate concentration of minorities in polluted neighborhoods has given rise to a number of competing theoretical arguments within the environmental inequality literature that highlight the importance of racially differentiated patterns of residential mobility. According to the *racial income inequality thesis* (Downey 2005; Oakes, Anderton, and Anderson 1996), racial differences in the likelihood of moving into and out of environmentally hazardous neighborhoods largely reflect group differences in socioeconomic resources. More specifically, the thesis holds that property values and rents tend to be relatively low in environmentally hazardous neighborhoods, making such neighborhoods more attractive to lower-income families, among which non-white families are overrepresented, and less attractive to higher income families, among which white families are overrepresented. This argument is consistent with the more general *spatial assimilation model* (Alba, Logan, Stults, Marzan, and Zhang 1999; Massey 1985) that informs much of the research on residential attainment (c.f., Crowder and South 2005; Crowder, South, and Chavez 2006; Quillian 1999; South, Crowder, and Chavez 2005) by emphasizing socioeconomic characteristics as the main predictors of mobility between lesser- and higher-quality neighborhoods. The key implication to be drawn from these studies is that racial and ethnic differences in mobility into and out of environmentally hazardous neighborhoods will largely disappear when differences in socioeconomic resources are taken into consideration.

In contrast to the racial income inequality thesis, the *residential discrimination thesis* (Bullard 1993; Godsil 1991; Mohai and Bryant 1992) suggests that racial and ethnic differences in mobility into and out of environmentally hazardous neighborhoods result from housing market discrimination which reduces the housing options available to minorities. Consistent with the broader *place stratification perspective* that informs research on residential attainment and mobility, the residential discrimination thesis assumes that discriminatory actions by real estate agents (Pearce 1979; Yinger 1995), local governments (Shlay and Rossi 1981), and mortgage lenders (Shlay 1988; Squires and Kim 1995), create barriers to residential attainment for African Americans and, perhaps, members of other racial and ethnic minority groups (Galster 1991; Galster and Keeney 1988; Massey and Denton 1993). These barriers are assumed to reduce the ability of minority families to move out of, or avoid moving into, hazardous neighborhoods, thereby creating or maintaining environmental racial inequality.

One implication of the residential discrimination thesis is that overall racial and ethnic differences in mobility between more- and less-polluted neighborhoods will persist even after controlling for differences in *levels* of socioeconomic resources such as income and education. Moreover, the place stratification perspective on which this thesis is based suggests that, because of discriminatory practices against minority homeseekers, the *effects* of socioeconomic characteristics on mobility outcomes might vary across racial and ethnic groups. Specifically, in what Logan and Alba (1993) refer to as the “strong version” of the stratification perspective, discrimination in housing markets limits the ability of minority householders to translate their socioeconomic resources into more desirable residential outcomes so that even resource-rich members of minority groups are likely to end up in relatively less advantageous neighborhoods. According to this argument, the effects of income and education on access to less polluted

neighborhoods may be stronger for white than for minority householders. In contrast, the “weak version” of the stratification perspective (Logan and Alba 1993) suggests that, while even relatively low-status white householders are able to gain access to fairly advantageous neighborhoods, only the highest-status minority householders are able to achieve similar residential outcomes. According to this weak version of the stratification perspective, the effects of income and education on residential mobility into low-hazard areas should be stronger for minority householders than for white householders.

A third theoretical explanation for existing racial and ethnic differences in exposure to neighborhood environment hazards focuses attention on group difference in the reaction to the racial composition of neighborhoods. Guided by the principles of the Chicago school's invasion-succession model (Hawley 1950; McKenzie 1968; Park 1936; Park, Burgess, and McKenzie 1925) an abundant body of research has documented the process through which the introduction of blacks and other minorities to a neighborhood leads to a loss of white population and the eventual turnover of the area's population from predominantly white to predominantly minority (c.f., Denton and Massey 1991; Duncan and Duncan 1957; Lee and Wood 1991). In combination with research showing relatively weak preferences among whites for residence near minority neighbors (Farley, Steeh, Krysan, Jackson, and Reeves 1994; Krysan 2002), this neighborhood change literature has informed an alternative perspective on racial environmental inequality, the *racial succession thesis* (Downey 2005), that stresses whites' disinclination to share neighborhoods with African Americans and other minorities as a primary determinant of residential decisions. According to this perspective, it may be the preexisting concentration of African Americans and other minorities in hazardous neighborhoods that increases the incentive among whites to avoid moving into such areas. In contrast to whites, minority householders may

be more likely to enter minority-dominated neighborhoods, either because of a lower aversion to minority neighbors or because discriminatory housing market practices limit their residential options. As a result, they may be more likely than whites to find themselves in areas with relatively high levels of environmental inequality. These arguments suggest that racial and ethnic differences in the choice of destinations might be explained, at least in part, by controlling for the racial composition of the residential destination.

These existing theoretical perspectives highlight several competing expectations about the relative roles that race, ethnicity, and socioeconomic status play in shaping residential mobility into and out of environmentally hazardous neighborhoods. At the same time, existing research suggests that these mobility patterns are likely to be complicated by the effects of a wide range of additional individual- and household-level factors that also play important roles in shaping mobility decisions. For example, past research indicates that inter-neighborhood migration is significantly shaped by the age, sex, and marital status of the householder, the number of children in the household, employment status, housing tenure, and the level of residential crowding in the household (Crowder and South 2005; Deane 1990; McHugh, Gober, and Reid 1990; South and Crowder 1997; South and Deane 1993). These factors must be taken into consideration if we are to isolate racial and ethnic differences in mobility between less- and more-polluted neighborhoods.

DATA AND METHODS

Sources: In order to test these theoretical arguments we rely on data from the Panel Study of Income Dynamics (PSID) linked to neighborhood-level data drawn from the U.S. Census and the Environmental Protection Agency's (EPA) Toxics Release Inventory (TRI). The PSID is a well-known longitudinal survey of U.S. residents and their families begun in 1968 with approximately

5,000 families (about 18,000 individuals). Members of panel families were interviewed annually between 1968 and 1995 and every two years thereafter. New families have been added to the panel as children and other members of original panel families form their own households.

For several reasons, the PSID is uniquely suited to examining racial stratification in the effect of environmental hazard proximity on in- and out-mobility. First, the PSID data contain an oversample of African American householders and, starting in 1990, a supplemental sample of Latinos, as well as rich information on a variety of individual- and household-level characteristics that are central to the study of residential mobility. Second, the longitudinal nature of the PSID data makes it possible to assess, prospectively, the impact of micro-level and contextual conditions on residential mobility. Third, and most importantly, the PSID's supplemental Geocode Match Files allow us to link the addresses of individual respondents at each interview to their corresponding 1990 and 2000 census tract identifiers. These identifiers make it possible to trace the mobility of PSID respondents across neighborhoods between successive interviews. They also enable us to attach detailed census and environmental data about the neighborhoods occupied by PSID respondents at each interview. In this study, we use census tracts to represent neighborhoods, because they come the closest of any commonly available spatial entity in approximating the usual conception of a neighborhood (Hill 1992; Jargowsky 1997; White 1987).

For this study, the individual- and household-level data provided by the PSID are attached to information on neighborhood proximity to environmental hazards constructed from the EPA's TRI dataset. Although they do not allow researchers to examine the impacts of siting decisions,¹ TRI data remain the most comprehensive and detailed, publicly available, national record of

¹ The TRI data do not provide information on facility age or why facilities are added to or dropped from the list from year to year, so it is impossible to tell whether facilities that move onto or off of the TRI list do so because they have been newly sited or newly closed or because their emissions patterns have changed.

industrial facility activity available to researchers. The TRI records the number of pounds of specified toxic chemicals released into the environment each year by industrial facilities that fall into one of seven industrial categories (manufacturing, metal mining, coal mining, electric generating facilities that combust coal or oil, chemical wholesale distributors, petroleum terminals, and bulk storage), employ the equivalent of ten or more full-time workers, and manufacture, process, or otherwise use the specified chemicals in specified quantities. The TRI includes records beginning in 1987, but because there are some questions about the accuracy of the first few years of TRI data, our study utilizes only the 1990-2000 TRI data.² In order to improve the accuracy of our geographic estimates of local pollution, we also focus only on those facilities that the EPA estimates were located within 200 meters of the latitude and longitude coordinates provided in the TRI data. Thus, our data incorporate information from a total 30,309 facilities in the continental United States between 1990 and 2000, with yearly facility counts ranging from 14,506 to 17,581.

Additional tract-level variables are derived from U.S. Census data as compiled in the Neighborhood Change Database by GeoLytics Corporation and the Urban Institute (GeoLytics 2005). These data utilize a consistent set of tract boundaries across decennial censuses, making it possible to employ linear interpolation to estimate values for tract characteristics in non-census years.

Sample: Our effective sample consists of 12,882 heads of PSID households (2,636 Latino; 6,046 non-Latino white; 3,951 non-Latino black; and 249 members of other race/ethnicity) who

² One potential problem with the TRI is that the guidelines used to determine which facilities and emissions are included in the database have changed over time, with chemicals being added to and dropped from the list in various years, and new industries being included in its reporting requirements at various points in time. However, this is unlikely to affect our results since there is no reason to believe that these changes have impacted the neighborhoods occupied by some racial and ethnic groups more than the neighborhoods occupied by other racial and ethnic groups. Moreover, the impact of possible changes in the TRI measure are minimized by the fact that we use these data to compare hazard levels at one conceptual point in time rather than inferring changes from one point in time to another.

were interviewed between 1990 and 2003 and resided in a census-defined Metropolitan Statistical Area (MSA) at the time of the interview. Because many of the residential moves identified in the PSID will be by members of the same family, we include only respondents who were classified as heads of the household either at the beginning *or* at the end of an annual mobility interval (i.e., the period between annual interviews). Many moves, of course, are undertaken by families, and thus a decision to move made by the household head (or made jointly by the family) perforce means a move by other family members. If all respondents were included in the sample, a single move would be counted several times, one for each family member. Imposing this selection criterion avoids counting as unique and distinct those moves made by members of the same family (e.g., children and spouses) since only moves by the head of the household are included. At the same time, moves by family members who were not the household head at the beginning of the interval but become the head at the end of the interval—e.g., when a child leaves the parental home or when an ex-husband or ex-wife establishes a new residence—are included in our effective sample.

Dependent variables: We follow prior work by treating inter-neighborhood residential mobility as a two-stage process involving, first, the decision to move and, second, the choice of destination (Massey, Gross, and Shibuya 1994). Accordingly, the first dependent variable in our analysis is a dichotomous variable indicating whether the respondent *moved out of the census tract of origin* between PSID interviews (a value of “1” for those who moved during the mobility interval and “0” for those who remained in the same tract).

The second dependent variable, the *proximate industrial pollution* in the destination tracts of mobile PSID householders, is a continuous, tract-level measure of neighborhood proximity to pollution produced through industrial activity. Rather than simply relying on the number of

industrial facilities located within the census-defined boundaries of each tract, we employ a measure that incorporates both the level of toxic air emissions produced by each industrial facility³ and its proximity to the census tract to which the respondent moved. Specifically, the measurement strategy utilizes annually reported 1990 to 2000 TRI data and a distance decay technique that weights the potential impact of each TRI facility inversely according to geographic distance from the hazard.

The variable is calculated as follows. First, for each year of TRI data, we locate each TRI facility on a census tract map of the continental U.S., using latitude-longitude coordinates provided by the EPA to locate each facility. This map is then overlaid with a rectangular grid made up of 400-foot square grid cells. For each grid cell we calculate a distance-weighted sum of the pounds of air pollutants emitted that year by all the TRI facilities located within 1.5 miles of that grid cell.⁴ For example, if two TRI facilities, emitting 1,000 and 200 pounds of air pollutants per year respectively, are located within 1.5 miles of grid cell A, and the distance-based weights for these facilities are .8 and .15 respectively, then grid cell A receives a *proximate industrial pollution* value of $(.8 * 1000) + (.15 * 200)$, or 830. Finally, we use these grid cell values to calculate an average grid cell value for each census tract in the continental United States. The resulting tract-level, hazard-proximity score provides a more precise hazard proximity estimate than has been utilized in past research.

³ An alternative to measuring the level of emissions produced by industrial facilities would be to measure the physical size of the facilities. This would be especially appropriate if individual home seekers use facility size as their primary indicator of industrial pollution. Unfortunately, the TRI provides no direct measure of facility size and such measures are unavailable from other sources (Dun and Bradstreet provide square footage data for many industrial facilities, but for only a small subset of the facilities included in our database). Nevertheless, TRI facility air emissions are strongly correlated with facility size ($r = .71, p < .0001$) for a subset of facilities for which facility size data are available.

⁴ The distance-weights used to calculate the weighted-sum grid cell values decline from one to zero as distance from the grid cell increases (until distance reaches 1.5 miles, after which the weight remains constant at zero). Since researchers have not developed a commonly accepted distance decay weighting scheme, we experimented with alternative distance decay functions to estimate proximity to industrial hazards, but none of these produced substantively different results from those reported here.

It is important to keep in mind that the proximate industrial pollution measure cannot be interpreted in absolute terms. Because the measure incorporates distance-weighted information about pollution from industrial facilities located outside of the tract, the scores on this variable do not refer to the total pounds of air pollutants emitted in each census tract in each year or to the pounds of pollutants emitted in the average census tract grid cell each year. Instead, they are estimates of the relative, non-exposure-related impact of all nearby TRI facilities on each census tract and must be interpreted relative to one another. For example, a score of 1,000 on this variable indicates twice the estimated proximate industrial pollution as a score of 500 (see Downey 2006).

It is also important to note that these are proximity estimates, not pollution concentration or exposure estimates. While many researchers consider proximity estimates to be inferior to concentration and exposure estimates (see Downey 2006), a proximity measure is most appropriate for the purpose of this study because it likely approximates more closely than concentration and exposure estimates the sensory cues (e.g., visibility of factories and smell of emissions) that individuals and families consider when making decisions to move to or from specific neighborhoods.⁵

Explanatory variables: Our focal independent variable in the prediction of out-mobility (stage 1) indicates the level of proximate industrial pollution, as measured above, in and around the tract of residence at the beginning of the mobility interval (i.e., the tract of origin). Other

⁵ The claim that many individuals are concerned about residing near environmental hazards is supported by the drastic growth in recent years in the number of community-based environmental organizations dedicated to removing or banning industrial hazards from their neighborhoods (Downey and Van Willigen 2005: 291). It is also supported by recent research that suggests that residential proximity to industrial activity, industrial pollution, and other environmental hazards (a) increases psychological distress, feelings of personal powerlessness, perceptions of neighborhood disorder and beliefs about local health risks and (b) reduces property values and local economic activity (Downey 2006; Downey and Van Willigen 2005; Liu 2001; Sadd et al. 1999). This research and the growing environmental justice movement suggest that residential proximity to environmental hazards is likely to be both an important indicator of individual, family, and neighborhood well-being and an important cue used by individuals and families to rank neighborhood desirability.

independent variables, which follow closely from those examined in past studies (c.f., Crowder and South 2005), allow us to control for established life-cycle, demographic, and socioeconomic determinants of residential migration. The race/ethnicity of the respondents is indicated with a set of dummy variables differentiating between those reporting a Latino ethnicity, non-Latino respondents reporting white race (hereafter “whites”), non-Latino respondents reporting black or African-American race (hereafter “blacks”), and non-Latino respondents reporting some other race (hereafter “other race”)⁶.

The primary indicators of socioeconomic status are *education*, measured by years of school completed, and total family (husband and wife) taxable *income*, measured in thousands of constant 2000 dollars. Key demographic and life-cycle predictors of residential mobility include *age* and, to capture the non-monotonic dependence of migration on age (Long 1988), age-squared. The *sex* of the household head is captured by a dummy variable scored 1 for females and 0 for males. *Marital status* is a dummy variable taking a value of 1 for respondents who were married or permanently cohabiting at the beginning of the migration interval. The generally negative effect of *children* on migration propensity is tapped with a variable indicating the total number of people under age 18 in the family unit at the beginning of the migration interval. *Home ownership* is measured with a dummy variable scored 1 for those living in an owner-occupied housing unit at the beginning of the interval and 0 for non-owners. Household *crowding* is measured by the number of persons per room and *length of residence* is indicated with a dummy variable taking a value of 1 for those respondents who had lived in their current home for at least three years at the beginning of the mobility interval. All of these variables,

⁶ Asians and members of other groups are underrepresented in the PSID data because the original panel was selected in 1968, just prior to the rapid increase in the populations of these groups. The PSID has not implemented any panel supplements to redress this under-representation as they did for Latinos in 1990.

except gender and race/ethnicity, are considered time-varying and refer to conditions at the beginning of the mobility interval.

Finally, in testing the racial succession thesis we control for the *concentration of minority residents* in the destination tract, measured as the percentage of the population in the tract at the end of the mobility interval that is not non-Latino white. This variable is based on data from 1990 and 2000 census STF files, using linear interpolation for values in non-census years, and is attached to the individual PSID records based on the respondents' addresses at the end of the mobility interval.

Analytic strategy: We take full advantage of the longitudinal nature of the PSID by segmenting each respondent's data record into a series of person-period observations, with each observation referring to two-year period between PSID interviews.⁷ On average, the individuals in the sample contribute just under four person-period observations for a total sample size of 46,778 observations.

Our two-stage modeling strategy reflects the assumption of a sequential decision-making process (Frey 1979; Massey et al. 1994). In the first stage of the analysis we include the entire sample of PSID household heads and use logistic regression to examine the additive and interactive effects of proximate industrial pollution, respondent race/ethnicity, and other individual- and tract-level characteristics on the odds of moving to a different census tract between successive interviews. Here our central focus is on whether there are significant racial/ethnic differences in the effects of local industrial pollution on the likelihood of leaving the neighborhood.

⁷ The use of a two-year interval is necessitated by the adoption of a biennial interview schedule in the PSID after 1995.

For the second stage of the analysis, we select those household heads that left their census tract of origin during the mobility interval and we estimate linear regression models in which the dependent variable is the ratio-level measure of proximate industrial pollution in the census tract of destination. Because this variable is unobserved for non-movers, we estimate these models using a maximum-likelihood Heckman procedure (Heckman 1979). In our application of the Heckman procedure, the “selection” equation includes all of the regressors described above, while the “substantive” equation (proximate industrial pollution in the destination tract) omits the sociodemographic predictors (age, sex, marital status, children, duration of residence, and household crowding) because their influence is restricted largely to the likelihood of moving out of the origin tract. In this second stage of the analysis our primary goal is to assess racial/ethnic differences in the level of industrial pollution in the destination tracts of mobile householders, and to investigate whether these differences can be explained by group differences in socioeconomic resources, neighborhood racial composition, and other theoretically implicated mechanisms.

Because the same PSID respondent can contribute more than one person-period to the analysis, and because inter-neighborhood mobility is a repeatable event, the usual assumption of the stochastic independence of error terms underlying tests of statistical significance is violated (Bye and Riley 1989). We correct for this non-independence of observations using the cluster procedure available in Stata to compute robust standard errors (StataCorp 2005).⁸

⁸ The multi-level structure of our data would ordinarily call for the use of multilevel modeling strategies to relax the assumption that individual- and tract-level regression residuals are independent and to examine variation in the effects of lower-level (individual- and household-level) characteristics across tracts (Bryk and Raudenbush 1992; DiPrete and Forristal 1994; Teachman and Crowder 2002). However, the low level of clustering of individual PSID respondents within census tracts (many tracts have just one respondent and the average is less than two per tract) undermines the utility of such models.

RESULTS

Figure 1 provides a baseline description of racial and ethnic differences in the level of proximate industrial pollution to which individual householders in the sample are exposed. Specifically, the figure shows the average hazard level in and around tracts occupied by all members of each of the four broad racial/ethnic groups represented in our data at both the beginning (time t) and the end (time $t+2$) of the mobility interval. Here it is important to reiterate that these figures are based on distance- and emissions-weighted estimates of TRI facility activity within 1.5 miles of census tracts occupied by respondents.

Figure 1 about here

Consistent with the results of past aggregate-level studies, the descriptive statistics in Figure 1 point to pronounced racial and ethnic differences in exposure to industrial pollution. Specifically, at the beginning of the average observation period, the average level of proximate industrial pollution in and around tracts occupied by the Latino respondents (92,082) was almost twice the level experienced by non-Latino whites (46,120), and the level for non-Latino black respondents (97,698) was over 2.1 times the level experienced by non-Latino whites. Not surprisingly, these differences are statistically significant. On the other hand, members of the small but amorphous other-race category experienced, on average, slightly less industrial pollution in their tract of origin (34,366) than did non-Latino whites, but this difference is not statistically significant. Also noteworthy is the fact that the four groups differed in terms of the change in the hazard level experienced between the beginning and end of the average two-year mobility interval. White, other-race, and especially Latino householders experienced, on average, slightly lower levels of industrial pollution in their tracts at the end of the mobility interval than at the beginning, although only the change for Latinos was statistically significant.

In contrast, the average level of industrial pollution experienced by black householders actually increased from time t to time $t+2$.

These group differences in hazard trajectories likely reflect, at least in part, the impact of group-differentiated mobility patterns on broader patterns of environmental inequality. However, the precise nature of these mobility differences is currently unknown. Group differences in exposure to neighborhood-level hazards, and changes in this exposure over time, could reflect group differences in the likelihood of leaving hazardous neighborhoods or differences in the industrial pollution levels in the neighborhoods to which movers relocate. In addition, such racial and ethnic differences in mobility patterns are likely influenced by group differences in sociodemographic conditions and other factors that shape migration behaviors more generally.

Table 1 provides descriptive statistics for all variables included in the analysis of group differences in mobility patterns, disaggregated by race/ethnicity. These statistics show that, in addition to sharp group differences in exposure to industrial pollution, there are fairly large differences in the level of residential mobility. Over one-third of both black and other-race householders moved to a different tract during the two-year mobility interval while only just over one-quarter of Latino and white householders experienced this type of inter-neighborhood migration.

Table 1 about here

Group differences in other characteristics also reinforce well-known patterns. For example, the number of years of completed schooling is lowest among Latino householders, with an average just slightly below that among black householders, and highest among non-Latino white householders and householders of other races. The family incomes of these racial and ethnic

groups follow a similar ranking, although the average family income for blacks is slightly lower than for Latinos in the sample. Non-Latino black households are also more likely than other groups to be headed by unmarried women. Only about 40% of non-Latino blacks own their own homes, compared to 48% of Latinos, 56% of other-race householders, and 71% of whites. Latino and black households tend to contain more children and have more people per room than those of other racial and ethnic groups. Not surprisingly, the concentration of minority residents is lowest in tracts occupied by white respondents at the end of the mobility interval and highest in tracts occupied by black and Latino respondents.

The logistic regression models presented in Table 2 examine how these characteristics influence the likelihood that the PSID householders in our sample moved out of their census tract of origin between successive annual interviews. These models are intended to shed light on the extent to which group differences in hazard exposure represent differential propensities to move away from hazardous neighborhoods. The first model shows the gross effect of the level of proximate industrial pollution in the tract of origin for a pooled sample of respondents. The positive logit coefficient indicates that the likelihood of moving from the tract increases with the level of industrial pollution in the area. However, the coefficient is very small and does not approach statistical significance ($p = .354$).

Table 2 about here

While the overall effect of local industrial pollution on the likelihood of leaving the neighborhood appears to be weak, any racial and ethnic differences in this effect could help to produce the large observed group differences in exposure to neighborhood industrial pollution (see Figure 1). To investigate this possibility, the second model adds dummy variables indicating the race/ethnicity of the respondent (with non-Latino whites as the reference category)

along with a set of product terms representing the interactions between race/ethnicity and proximate industrial pollution in the tract of origin. The results point to a number of important differences in the mobility patterns for the four racial and ethnic groups. First, mirroring the group differences shown in Table 1, the coefficients for the group dummies indicate that, controlling for proximate industrial pollution, the likelihood of changing tracts is significantly higher for non-Latino blacks and other-race householders than for whites. Second, there are important differences in the effects of local industrial pollution on this mobility. In this interactive model, the coefficient for proximate industrial pollution in the tract of origin ($b=.0002$) indicates that for white respondents, the odds of leaving the tract increase modestly but significantly as levels of local industrial pollution increase. This positive effect of local hazard levels on out-mobility may be slightly stronger for non-Latino other-race householders, as indicated by the positive interaction coefficient ($b=.0020$), but this difference just fails to achieve statistical significance ($p=.055$). In contrast, the statistically significant negative coefficient for the interaction between black race and proximate industrial pollution ($b=-.0002$) indicates that the effect of local industrial pollution on out-migration is weaker for black householders. In fact, the combination of the baseline effect of proximate industrial pollution and the interaction between black race and proximate industrial pollution indicates that local hazard levels have no effect on the probability of out-mobility for black respondents [$.0002+(-.0002)=0$]. Overall, the fact that black householders are less likely than white householders to leave environmentally hazardous neighborhoods likely contributes modestly to their relatively high and persistent level of exposure to environmental hazards.⁹

⁹ The difference between black and other-race respondents in the effect of proximate industrial pollution is also statistically significant, but the difference between black and Latino householders is not.

The remainder of the models in Table 2 attempt to explain the source of these group-specific effects of proximate industrial pollution on out-mobility. Model 3 in Table 2 tests the racial income inequality perspective hypothesis that these modest differences in the ability to move away from hazardous areas are due to group differences in socioeconomic resources. This argument is tested by adding controls for family income and the education of the householder. The results indicate that education significantly increases, and income significantly decreases, the likelihood of inter-tract mobility. However, controlling for these resource characteristics does little to attenuate either the effect of local industrial pollution on out-mobility or racial differences in this effect. Specifically, the results are consistent with the Model 2 finding that the likelihood of inter-tract mobility among whites increases with neighborhood hazard levels, and that this effect is not significantly different for Latino householders but may be slightly stronger for other-race householders. Most importantly, Model 3 provides evidence that the weaker effect of proximate industrial pollution on black householder out-migration is *not* due to a deficit in the economic resources necessary to escape polluted areas.

In order to test whether the effect of local industrial pollution on out-mobility, and group differences therein, are attributable to, or suppressed by, the effects of other mobility predictors, Model 4 in Table 2 adds measures of other basic respondent sociodemographic characteristics. Most of the effects of these characteristics are consistent with theory and prior research. Net of other effects, educational attainment and family income are both significantly and positively associated with the likelihood of moving out of the origin tract. The likelihood of moving decreases significantly with age but this decline tapers off at older ages. Married respondents are less likely than the unmarried to change tracts, and the number of children in the household is inversely associated with inter-tract migration. The likelihood of moving to a different tract

increases significantly with household crowding and is significantly lower for those who own their own home and those who have been in their home for at least three years.

Most importantly, the positive effect of proximate industrial pollution on the log-odds of out-mobility among white householders becomes statistically non-significant after controlling for these significant micro-level predictors of mobility, as does the interaction coefficient indicating the difference in the effect between black and white householders. Supplemental models (not shown) indicate that controlling for the age of the respondents is primarily responsible for these changes. Specifically, adding controls for age and its polynomial without the controls for other sociodemographic characteristics drops the coefficient for proximate industrial pollution and the interaction involving black race to non-significance. This is due to the fact that while age is not significantly correlated with the hazard level in the neighborhood of origin among most groups, the correlation is actually negative ($r=-.05$) and statistically significant among white householders, indicating that younger white householders tend to originate in neighborhoods with somewhat higher hazard levels than those in which older white householders originate. Combined with the generally negative influence of age on residential mobility observed in our research and most other studies, this higher concentration of younger, more mobile whites in more polluted areas and older, less mobile whites in lower-pollution areas produces the relatively higher risk of out-mobility from polluted neighborhoods among white householders observed in Model 3 of Table 2. Thus, controlling for this age effect brings the effect of pollution among whites closer to zero, more in line with the non-effect among black householders.

In sharp contrast, controlling for age and other factors significantly bolsters the apparent contrast between the effects of proximate industrial pollution on white respondents and the effect on other-race respondents. The statistically significant positive coefficient between pollution and

membership in the other-race group ($b=.0025$) indicates that other-race respondents are especially responsive to the level of pollution in and around the neighborhood. For this group, a difference of 100,000 points (about one standard deviation) on the hazard indicator increases the odds of out-mobility by almost 30% ($e^{100(.0001+.0025)}-1=.296$). In fact, group-specific models (not shown) indicate that only among this group is the positive net effect of local industrial pollution on the odds of out-mobility statistically significant. This greater mobility response to local pollution likely helps to explain the relatively low exposure of other-race householders to neighborhood hazards (see Figure 1).

Overall, the results presented in Table 2 provide modest support for the argument that dramatic racial and ethnic differences in proximity to industrial hazards are due to differential propensities to leave hazardous neighborhoods, with the likelihood of leaving hazardous areas slightly higher among white householders than among black householders (due to the concentration of younger white residents in more polluted neighborhoods), and slightly higher among other-race householders than among whites. The remainder of the analysis assesses the extent to which environmental inequality is attributable to group differences in the level of proximate industrial pollution in the neighborhoods to which members of these groups move.

Table 3 presents the results a series of Heckman-corrected linear regression models designed to examine the effects of race, ethnicity, and the other explanatory variables on hazard levels in and around the destination tracts of mobile PSID householders. These models regress the level of proximate industrial pollution in the destination tract on dummy variables for the racial/ethnic groups and other theoretically relevant independent variables while adjusting for the selection of respondents into the mover category. Here it is important to note that many of the mobility predictors included in the preceding analysis (e.g., age, marital status, etc.) are included

only in the selection model since they are presumed to affect the likelihood of moving, but not necessarily the choice of destinations.

Table 3 about here

The first model in Table 3 presents the gross differences in proximate industrial pollution in the destination tract among the four racial/ethnic groups (non-Latino whites define the reference category). The results indicate that, conditional upon moving, Latino householders enter neighborhoods characterized by a level of proximate industrial pollution that is almost 37,000 points greater than those neighborhoods entered by non-Latino white movers. This hazard proximity disadvantage is even more pronounced for black householders who, on average, enter neighborhoods in which the level of local industrial pollution is over 75,000 points higher than in neighborhoods entered by non-Latino white movers.¹⁰ In sharp contrast, other-race householders tend to move to tracts with slightly lower levels of proximate industrial pollution than do non-Latino whites, complementing their somewhat stronger reaction to local hazard levels in the first stage of the analysis. All of these group contrasts in destination hazard levels are statistically significant, providing support for the argument that environmental inequality is shaped substantially by differences in the types of neighborhoods to which members of different racial/ethnic groups move.¹¹

It is important to note that the gross racial/ethnic differences in destination hazard levels found in Model 1 may reflect the distance dependence of residential mobility – the fact that most residential moves cover relatively short distances (Lee 1966). To the extent that neighborhoods

¹⁰ The difference in destination hazard levels between Latino and non-Latino black householders is statistically significant.

¹¹ The statistically significant, negative lambda coefficients in this and other models of Table 2 indicate that those respondents who move during the mobility interval (i.e., are selected into this second stage of the analysis) tend to experience significantly lower levels of proximate industrial pollution at the end of the mobility interval than do those respondents who do not move.

with similar hazard levels tend to cluster geographically, the observed group differences in mobility destinations may simply reflect group differences in the level of industrial pollution experienced in the origin neighborhood. Specifically, black and Latino householders may move to more environmentally hazardous areas simply because they are moving from nearby neighborhoods with similarly high hazard levels, and other-race households may move to less environmentally hazardous areas because they originate in similar low-hazard neighborhoods nearby.

This possibility is tested in Model 2 of Table 3 by adding a control variable for the level of proximate industrial pollution in the neighborhood of origin (time t). The positive and statistically significant effect of local industrial pollution in the origin tract ($b=.1770$) is consistent with the distance-dependence argument. Furthermore, changes in the race/ethnicity coefficients between Models 1 and 2 indicate that this distance effect partially explains the group differences in hazard levels experienced in the destinations of mobile householders found in Model 1. Nevertheless, even after controlling for origin neighborhood hazard levels, Latino and black householders still end up in neighborhoods with significantly higher levels of proximate industrial pollution than do white householders. For example, the origin-adjusted mean level of proximate industrial pollution experienced by white movers (65.7086) is about half that experienced by mobile black householders ($65.7086+68.2672=133.9758$) and about 29% lower than that experienced by Latino movers ($65.7086+26.8947=92.6033$). In contrast, even after controlling for the hazard level in the origin tract, other-race householders tend to enter neighborhoods with significantly lower hazard levels than do white householders.

According to the racial succession thesis, group differences in hazard levels in destination tracts likely reflect racial and ethnic differentials in the willingness to enter neighborhoods with

large concentrations of minority residents – neighborhoods where environmental hazards also tend to be concentrated. To test this explanation, Model 3 of Table 3 adds a control for the minority percentage of the population in the tract of destination.

The positive and statistically insignificant coefficient for the tract percent minority ($b=.3833$) is consistent with the idea that entering areas with larger concentrations of racial and ethnic minorities tends to increase the level of environmental hazard experienced in the destination tract. Moreover, controlling for this effect helps to explain a substantial proportion of the racial/ethnic differences in destination outcomes found in Models 1 and 2. Most notably, when the racial composition of the destination tract is controlled, the positive coefficient for Latino ethnicity declines by almost half (from 26.8947 in Model 2 to 13.5592 in Model 3) and becomes statistically non-significant. Thus, it appears that the higher level of hazard proximity in the tracts to which Latino householders move is largely a result of their greater tendency, relative to whites, to move to areas with large concentrations of minority residents. A similar dynamic operates for black householder, with the coefficient for black race declining by almost 22% from Model 2 ($b=68.2672$) to Model 3 ($b=53.5057$). However, the difference in destination hazard levels between black and white householders remains large and statistically significant even after controlling for the racial composition of the destination tract. Thus, even among those entering neighborhoods with similar concentrations of minorities, black householders are still at a disadvantage relative to whites in terms of the level of industrial pollution experienced. In contrast, the magnitude of the negative coefficient for other-race respondents actually increases after controlling for neighborhood racial composition, indicating that part of the relative advantage of lower destination pollution for other-race householders is actually suppressed by

their greater tendency (relative to white householders) to enter neighborhoods with higher concentrations of minority residents.

Key to the racial income differential thesis is the assumption that racial/ethnic differences in mobility outcomes are primarily due to group differences in socioeconomic resources. Accordingly, the residual effects of race/ethnicity on destination hazard levels should be largely attenuated when the resource characteristics of respondents are controlled. In contrast, the residential discrimination thesis suggests that even after controlling for socioeconomic resources, significant group differences in destinations will persist as minority-group members are blocked from accessing the best quality neighborhoods. Model 4 of Table 3 tests these competing theoretical arguments by incorporating two primary measures of socioeconomic resources, the education of the householder and total taxable family income. Not surprisingly, the coefficients for both of these characteristics are negative, although only the net effect of income is statistically significant. Thus, higher-income movers are apparently better able than lower-income movers to gain access to less hazardous neighborhoods: after controlling for other influences on destination decisions and conditional on mobility, a \$1,000 increment in income is associated with a modest reduction of just over 170 points in the dependent variable ($-.1711 * 1000 = -171.1$).

However, in a finding that supports the basic assumptions of the residential discrimination thesis, controls for socioeconomic resources do little to attenuate racial differences in the level of proximate industrial pollution in the destination tract. Even among those with similar socioeconomic resources, non-Latino black movers enter neighborhoods that are substantially more hazardous than those accessed by non-Latino white movers. Similarly, differences in socioeconomic resources explain only a small part of the difference in destination hazard

between non-Latino whites and householders of other races. Other-race movers enter neighborhoods that are substantially less hazardous than those accessed by non-Latino white movers with similar socioeconomic resources.

Model 5 of Table 3 provides additional support for one aspect of the stratification perspective on which the discrimination thesis is based, pointing to one apparent group difference in the effect of socioeconomic resources on hazard levels in destination tracts. Here group differences are assessed using a set of interaction terms involving the dummy variables for race/ethnicity and the indicators of both education and income. While the coefficients for the interactions involving education are all far from statistically significant,¹² there is some evidence that the negative effect of income on destination hazard levels may be somewhat stronger for members of some minority groups than for white householders. Specifically, the coefficients for the interactions between both Latino ethnicity and income and between black race and income are negative, although only the latter is large and statistically significant. The fact that the negative effect of income is especially strong among black respondents is consistent with the argument presented in Logan and Alba's (1993) weak version of the stratification perspective which assumes that white respondents of virtually all socioeconomic strata are able to avoid disadvantageous residential areas, but only the highest-status African Americans are able to do so.

This dynamic is further illustrated in Figure 2 which presents predicted levels of proximate industrial pollution in destination tracts for movers of different racial and ethnic groups at different income levels. These predicted values are based on the coefficients in Model 5 of

¹² These coefficients for interactions involving individual education are also statistically non-significant when entered in models without interactions involving family income.

Table 3 and assume mean values from the pooled sample of movers for all variables except income which is altered to represent low-income (\$11,000, about the 25th percentile), middle-income (\$28,000, about the 50th percentile), and high-income (\$52,000, about the 75th percentile) movers. Again, consistent with the weak version of the stratification perspective, the difference in destinations between low-, middle-, and high-income black respondents is more pronounced than the stratification across income categories for whites (and other groups). However, high-income black respondents still tend to enter neighborhoods with higher levels of proximate industrial pollution than do even low-income white movers.

CONCLUSION AND DISCUSSION

To date, most research on the magnitude and causes of racial environmental inequality has relied on aggregate-level data linking neighborhood racial characteristics to area pollution levels, often focusing on neighborhoods within a single or a small number of metropolitan areas. While highlighting persistent racial and ethnic differences in the exposure to environmental hazards, this reliance on aggregate-level data in past research has undermined efforts to effectively test theoretical explanations for environmental inequality, as has reliance on proximity indicators that do not take physical distance from the neighborhood to the hazard into account. Reliance on aggregate data has also prevented environmental inequality researchers from taking full advantage of the analytic techniques and theoretical insights that neighborhood attainment researchers have developed to understand racial and ethnic differences in residential mobility patterns. Thus, in linking micro-level data from the nationally-representative sample of PSID householders to a unique, neighborhood-level measure of proximate industrial pollution, and in employing theoretical insights and analytic techniques drawn from both the environmental inequality and residential mobility literatures, we have shed considerable new light on the

individual-level processes shaping racial differences in exposure to industrial pollution while simultaneously confirming the existence of environmental racial inequality at the national level.

Our analysis confirms sharp differences in proximate industrial pollution levels in the neighborhoods occupied by individual members of different racial and ethnic groups: non-Latino black and, to a lesser extent, Latino householders tend to originate in neighborhoods with significantly higher levels of industrial pollution than do whites, while non-Latino members of other racial groups tend to reside in areas with proximate industrial pollution levels slightly below that of whites. Moreover, while most groups tend to experience temporal improvements in the level of industrial pollution in their neighborhoods, non-Latino black householders, on average, experience slight increases in industrial hazard exposure over the two-year observation periods.

The two-stage mobility analysis employed in this study indicates that these racial and ethnic disparities in hazard levels and trajectories are shaped more by group differences in the destinations of mobile householders than by group differentials in the decision to move away from hazardous neighborhoods. In comparison to black householders, white householders' decision to leave the neighborhood of residence appears to be slightly more responsive to neighborhood hazard levels, but this difference appears to be due mainly to the relative concentration of younger, more mobile white householders in more hazardous neighborhoods. More pronounced is the stronger effect of pollution on other-race householders. For this group, local industrial hazard levels appear to be an especially strong motivator of out-mobility.

Still, these differences in out-mobility are modest in comparison to group differences in mobility destinations. Even after controlling for substantial group differences in origin neighborhood hazard levels, mobile black householders tend to move to neighborhoods in which

the level of proximate industrial pollution is about twice that experienced by non-Latino white movers, and Latino movers tend to move to neighborhoods with hazard levels that are over one-third higher than those experienced by white movers (see Table 3, Model 2). Once again, non-Latino movers of other races stand out by experiencing destination hazard levels that are slightly lower than those experienced by white movers.

Our results also have important implications for the most common theoretical arguments offered to explain racial environmental inequality. The *racial income inequality* and related *spatial assimilation theses* receive some support from the finding that family income and householder education significantly decrease the level of proximate industrial pollution experienced by residential movers (Table 3, Model 5), a finding that highlights the potentially important role income and education play in affecting mobility into environmentally hazardous neighborhoods. However, sharp racial and ethnic differences in destination hazard levels remain even after controlling for socioeconomic resources. Moreover, while family income appears to have a stronger impact on mobility outcomes for non-Latino black householders than for white householders, high-income blacks tend to move into neighborhoods with industrial hazard levels that are higher than those experienced by even low-income white movers. These results are highly consistent with the *racial discrimination* and *place stratification theses* and suggest that black householders in particular face unusual barriers in the effort to avoid environmentally hazardous residential areas.

The results also suggest that variations in the willingness to enter minority-populated areas, or variations in the ability to avoid such areas, play an important role in shaping overall patterns of environmental inequality. Specifically, consistent with the *racial succession thesis*, a portion of the pronounced group differences in destination outcomes appears to be rooted in the greater

tendency for black and Latino householders, relative to white householders, to move into neighborhoods with large concentrations of minority residents. Most notably, over half of the destination disadvantage experienced by Latino movers is attributable to their mobility into minority-dominated neighborhoods where industrial pollution tends to be highest, while about one-fifth of blacks' destination disadvantage is attributable to their mobility into such neighborhoods. Unlike Latinos, however, blacks' destination disadvantage remains large and significant even after controlling for the racial composition of destination neighborhoods, while the gap in destination hazard levels between white and other-race respondents actually increases.

These persistent racial gaps in destination-neighborhood hazard levels, and the important role that neighborhood racial composition plays in mediating the association between respondent race and destination hazard levels, suggest that racial discrimination and/or racially differentiated housing preferences play an important role, along with family income and education, in shaping broad patterns of environmental inequality. This is an important finding that casts doubt on theoretical explanations and policy solutions that focus solely on pure market mechanisms or individual and household socioeconomic assets (see Been 1994; Downey 1998; Hamilton 1995).

Before concluding, it is important to note that although this research provides some important clues about the individual-level processes that shape broader patterns of racial environmental inequality, it only represents a first step in developing a full understanding these processes. Thus, this study leaves open a number of important issues for future research. For example, our study utilizes a single measure of proximate industrial pollution based on the distance to industrial facilities and the amount of air pollution emitted by those facilities. While this measure represents an improvement over other hazard proximity measures currently found in the literature, future research would do well to employ alternative environmental hazard estimates,

including hazard proximity estimates that incorporate actual data on facility size or facility visibility, toxicity-weighted pollutant concentration estimates that more closely approximate the relative physical health risks of residing in different neighborhoods, and estimates that utilize data on other types of environmental hazard. Furthermore, additional analyses should be dedicated to understanding the extent to which the racial disparities in mobility between more- and less-hazardous neighborhoods are conditioned by the effects of broader metropolitan structures. For example, the propensity for other-race individuals to move to neighborhoods with relatively low levels of pollution, and the higher level of pollution in the neighborhoods entered by black movers, might reflect differences in housing options – including differences in the concentration of housing and housing vacancies in less polluted neighborhoods – in the metropolitan areas occupied by these groups. Finally, future research on the individual-level processes that shape environmental racial inequality should incorporate data on hazardous facility siting patterns. This would allow researchers to compare the relative importance of facility siting versus racially differentiated mobility patterns in shaping environmental inequality. Such analyses will substantially bolster our understanding of the structural forces shaping the broad, pronounced and persistent racial and ethnic differences in the exposure to environmental hazards.

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Figure 1. Observed Proximate Industrial Pollution by Race/Ethnicity

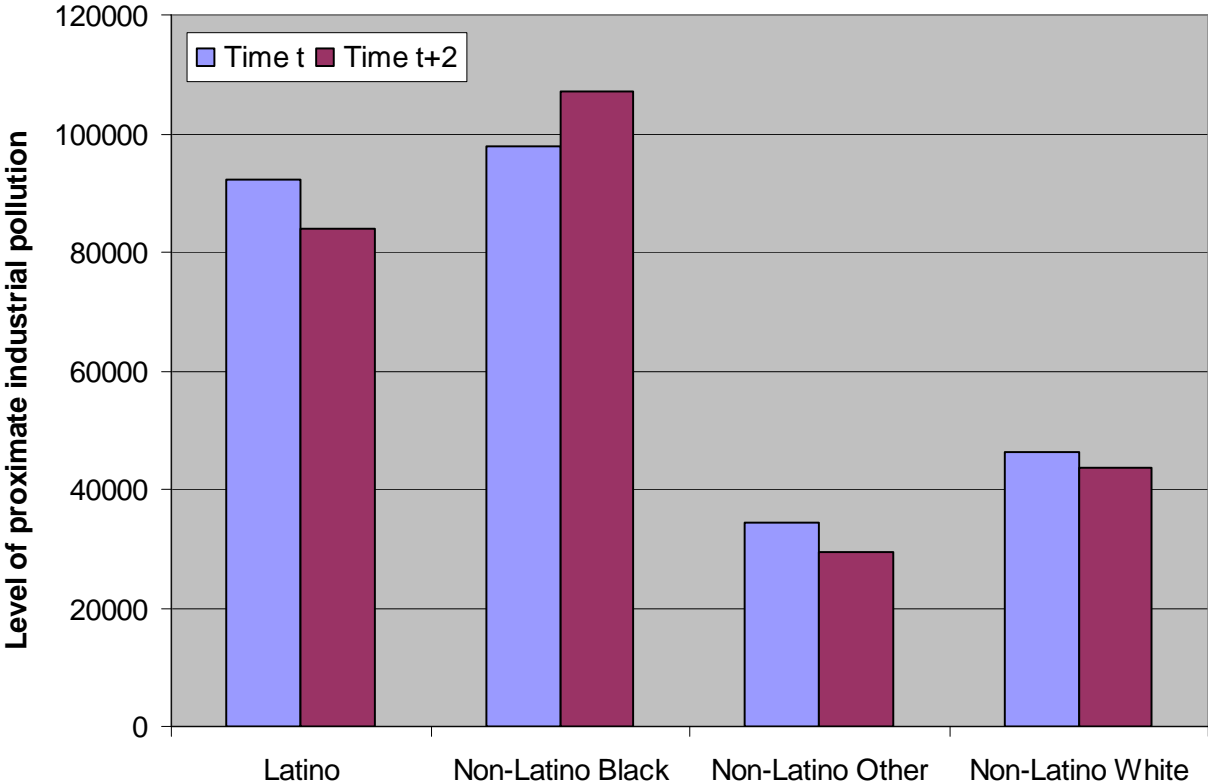


Figure 2. Predicted Level of Proximate Industrial Pollution in Destination Tract by Race/Ethnicity and Income for Mobile Householders

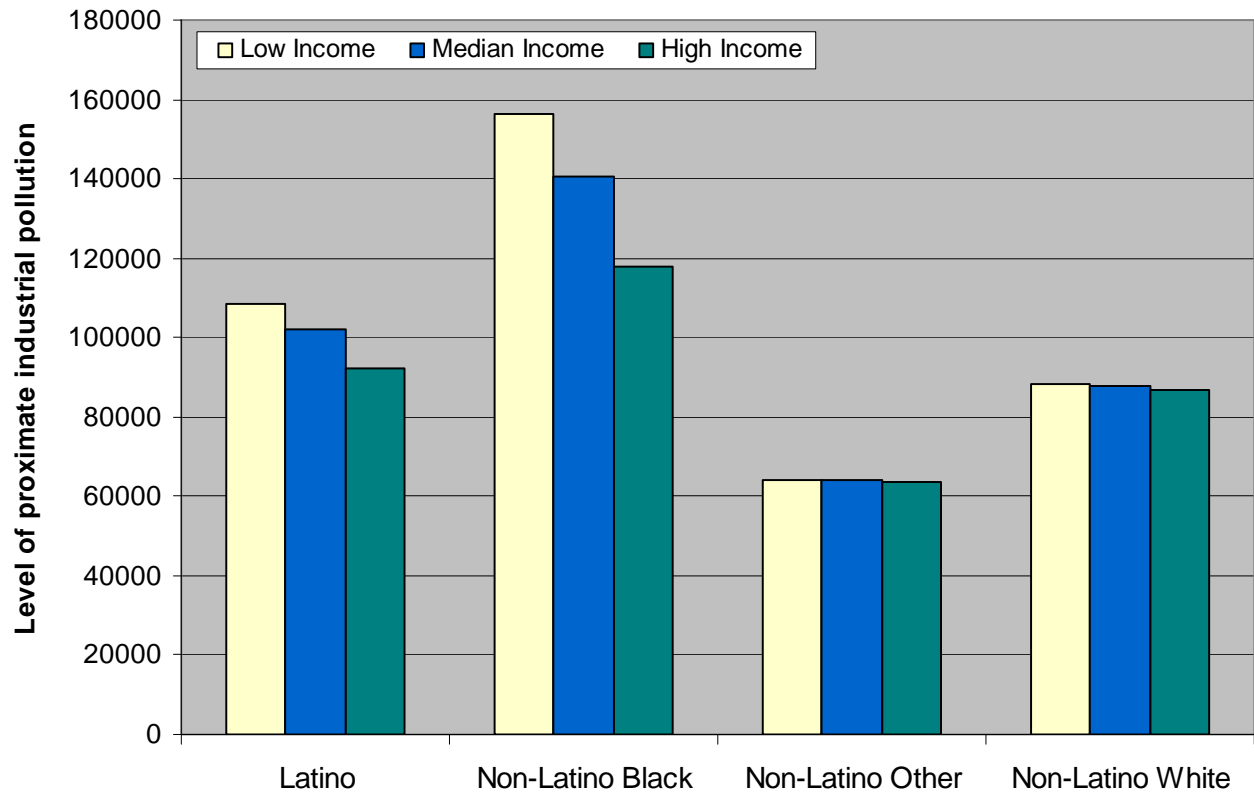


Table 1. Descriptive Statistics for Variables in Models of Residential Mobility between Census Tracts by Race/Ethnicity: PSID Householders, 1990-2003.

	Latino		Non-Latino Black		Non-Latino Other		Non-Latino White	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<u>Dependent Variables</u>								
Changed Tracts, time t to t+2 (1=yes)	.274	.446	.336	.472	.346	.476	.259	.438
Proximate Industrial Pollution in tract, time t+2	84.013	425.576	106.945	1100.760	29.452	61.095	43.556	198.058
<u>Independent Variables</u>								
Proximate Industrial Pollution in tract, time t	92.082	499.615	97.698	786.039	34.366	101.543	46.120	224.425
Education	10.755	4.013	11.973	2.584	14.042	3.343	13.602	2.877
Family Income (in \$1000's)	33.018	38.275	27.127	30.048	61.892	70.143	56.761	73.058
Age	41.977	15.487	40.705	14.459	41.315	14.225	44.776	16.443
Female (1=yes)	.288	.453	.503	.500	.257	.437	.238	.426
Married (1=yes)	.617	.486	.380	.485	.654	.476	.651	.477
Number of Children	1.272	1.381	1.271	1.353	.916	1.135	.767	1.073
Homeowner (1=yes)	.477	.499	.396	.489	.564	.496	.711	.453
Persons per Room	.792	.501	.639	.381	.576	.363	.468	.249
In Same House 3+ Years (1=yes)	.375	.485	.455	.498	.479	.500	.558	.497
Tract % Minority, time t+2	61.777	31.019	68.702	30.031	34.654	28.360	14.425	16.015
N of person-years	5,561		14,817		653		25,747	
N of persons	2,636		3,951		249		6,046	

Table 3. Coefficients for Linear Regression of Proximate Industrial Pollution in Census Tract of Destination: PSID Householders, 1990-20

Independent Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	<u>b</u>	<u>se</u>	<u>b</u>	<u>se</u>	<u>b</u>	<u>se</u>	<u>b</u>	<u>se</u>	<u>b</u>	<u>se</u>
Latino	36.7800 **	12.9701	26.8947 *	12.3138	13.5592	15.5925	7.9944	17.3872	30.4520	27.5625
Non-Latino Black	75.1980 **	25.3956	68.2672 **	25.3307	53.5057 *	22.4518	48.7294 *	21.7751	69.2785	92.6589
Non-Latino Other	-18.7278 **	6.2154	-16.6856 **	5.7119	-25.4197 **	9.0770	-22.1762 **	8.1991	-38.2984	27.3198
Non-Latino White	<i>reference</i>		<i>reference</i>		<i>reference</i>		<i>reference</i>		<i>reference</i>	
Proximate Industrial Pollution in tract, time t			.1770 **	.0596	.1787 **	.0617	.1780 **	.0618	.1773 **	.0617
Tract % Minority, time t+2					.3833	.3222	.3262	.3026	.2666	.2795
Education							-2.3848	1.7522	-1.9590 *	.8982
Family Income (in \$1000's)							-.1711 **	.0492	-.0449	.0316
Interactions										
Education x Latino									-.4983	2.0767
Education x NL Black									.6747	6.3121
Education x NL Other									1.0803	1.7283
Income x Latino									-.3509	.3113
Income x NL Black									-.8982 *	.4367
Income x NL Other									.0230	.0510
Constant	79.3450 **	13.4567	65.7086 **	13.6501	60.7541 **	12.3294	101.5608 **	33.0539	89.8088 **	19.6681
Lambda	-31.8422 **	12.4148	-28.2754 **	12.2119	-29.2700 **	13.0782	-28.2162 *	13.1359	-27.5174 *	13.1065
Wald chi-square	23.35		32.01		33.28		35.31		101.74	

Notes: Models estimated with maximum-likelihood Heckman selection using regressors shown in Table 2 in selection equation.

*p<.05; **p<.01; ***p<.001

N of uncensored observations = 13,404; N of censored observations = 33,374; N of observations total = 46,778; N of persons = 12,882