



Maryland Population Research Center

WORKING PAPER

Racial Disparities in Residential Mobility and Long-term Population Displacement from New Orleans after Hurricane Katrina

PWP-MPRC-2017-001

February 2017



Authors:

Michael S. Rendall
University of Maryland

Narayan Sastry
University of Michigan,
RAND Corporation

Lori Reeder
University of Maryland



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Michael S. Rendall^{1,2}, Narayan Sastry^{3,2}, and Lori Reeder¹

Abstract

Social theory of disasters asserts that both hazard exposure and recovery processes are strongly affected by pre-disaster processes of social stratification. We examine this theory’s application to differences in long-term mobility following Hurricane Katrina between White and Black City of New Orleans residents. We examine both movement within the New Orleans metropolitan area movement away from the metropolitan area. We develop estimates of involuntary displacement in a counterfactual, no-disaster scenario that combines pre-Katrina Census five-year mobility data with post-Katrina survey data on place of residence four years after Katrina, in a representative sample of pre-Katrina New Orleans residents. At the population level, we estimate that one in four Black adult New Orleanians was displaced, whereas White adult New Orleanians suffered no displacement at all. Greater housing damage and exclusion of Blacks from predominantly White suburban parishes were critical factors. Had White working-age City residents with equivalent socio-economic characteristics suffered equivalent housing damage, almost one third would have moved to suburban New Orleans parishes, whereas only 4% of Black working-age City residents actually did so. We interpret these findings as providing strong support for theory of entrenchment of pre-disaster patterns of racial stratification and segregation.

1. University of Maryland, College Park
2. RAND Corporation
3. University of Michigan

Acknowledgements: We thank Christine Peterson and Jonathan Jackson for programming and research assistance and Nicole DeLoatch for comments on an earlier version. This research was supported by grants R21 HD059087, R01 HD059106, and R24HD41041 from the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development. It has benefited also from comments received at presentations at the University of Maryland, Brown University, Australian National University, University of Paris I – INED, Yale University, University of Pennsylvania, and Pennsylvania State University.

INTRODUCTION

Hurricane Katrina struck New Orleans and neighboring Gulf Coast communities on August 29, 2005. The damage was catastrophic, leading to what Fussell and Elliot (2009, p.383) describe as "...the largest, most complete urban evacuation ever to occur on U.S. soil." Groen and Polivka (2010) estimate the number of adult evacuees alone as numbering 1.5 million. Finch, Emrich, and Cutter (2010, p.180) describe Hurricane Katrina as "...the largest residential disaster in U.S. history." Of the 1.33 million people living in the New Orleans metropolitan area before Katrina struck, almost half (589,000, or 44%) lived in areas that experienced moderate to catastrophic damage. The majority (354,000) of these were in the City of New Orleans (Orleans Parish, Logan 2006, p.6) whose pre-Katrina population numbered 494,000. Only 230,000 people were again living in the city by the middle of 2006 (U.S. Census Bureau, no date, a). The prospect of an unprecedented magnitude of long-term or permanent population displacement from a large urban area in a high-income country was evident.

Long-term or permanent displacement (that is, involuntary moves out of the area) is one of the mechanisms through which social and racial/ethnic inequalities may be exacerbated. Two terms are commonly used to describe the mass movement of people from their homes (Oliver-Smith 2006, p.3): *Evacuation* refers to the "removal of people from harm's way"; while *Displacement* refers to "the uprooting of people from a home ground." Unsurprisingly given its greater frequency, much more attention has been given to socio-economic differentials in *evacuation*, and the conclusion here is of large disadvantages in evacuation for lower socio-economic status and disadvantaged race/ethnic minority individuals (Fothergill et al 1999; Bolin 2007). Disasters frequently expose and exacerbate existing social inequalities (Cutter, Boruff, and Shirley 2003; Tierney 2006; Mutter 2010). Hurricane Katrina dramatically exposed

historically deep-rooted inequalities by race in New Orleans (Spain 1979; Campanella 2007; Falk, Hunt, and Hunt 2006). The present study focuses on how these racial inequalities manifested themselves in the form of long-term displacement from the New Orleans metropolitan area, and on the extent that racial inequalities in opportunities for residential mobility within the New Orleans metropolitan area acted as a mechanism generating racial inequalities in displacement.

Our study makes three main empirical contributions. First, we analyze data from a new survey of the pre-Katrina City of New Orleans population wherever they were located throughout the U.S. in 2009–2010, thereby extending the scope of analysis of post-Katrina displacement from a focus on the first year after the disaster (Frey, Singer, and Park 2007; Fussell, Sastry, and VanLandingham 2010; Groen and Polivka, 2010; Sastry and Gregory 2014) to 4 to 5 years out. Second, we use observed 1995–2000 mobility from the 2000 Census to embed post-Katrina mobility in its historical context of much more constrained mobility of Blacks than Whites, groups that together constituted 96% of the City’s population in 2000. This embedding allows us to construct estimates of involuntary ‘displacement,’ distinguished from population movement that would have occurred anyway in the absence of Katrina. We also use evidence of attenuation or reversal of the usual associations between demographic and socio-economic factors and mobility in the period following Katrina to infer the extent to which this mobility had a displacement character. The third empirical contribution is our distinguishing three types of mobility: mobility within the City (Orleans Parish); mobility to suburban New Orleans parishes; and migration out of the New Orleans metropolitan area.

To preview our main conclusions, not only did long-term displacement disproportionately affect Black New Orleanians; at the population level, displacement *only*

affected Black New Orleanians. White New Orleanians avoided long-term displacement from metropolitan New Orleans through suffering less housing damage and by their being able to move to suburban New Orleans parishes. Whites' highly elevated odds of moving to a suburban parish in the case that their pre-Katrina housing was rendered uninhabitable contrasted with Blacks' odds of moving to a suburban parish that were statistically no greater when they had experienced severe housing damage than when they had not. We use these findings to contribute both to the literature on whether and how natural disasters engender social change or instead entrench pre-existing social structures and processes (Quarantelli and Dynes 1977; Bolin 2007; Henry 2011), and to the more general literature on mobility processes related to racial stratification and residential segregation (Farley et al 1978; Massey, Gross, and Shibuya 1994).

BACKGROUND

Natural disasters were originally theorized to provide impetuses for social change, including to structures of socio-economic and racial stratification (Carr 1932). Socio-political mechanisms to preserve the existing social structure, however, are inevitably also mobilized. Bates and Peacock (1987) hypothesized that more developed countries, including the U.S., would be less susceptible to having even a major disaster induce substantial social change. Supporting this view, Morrow and Peacock (1997, p.242) summarize the 1992 Hurricane Andrew impact on Miami as follows: "while some changes reflect alterations in this complex multiethnic community, others reflect a reversion to or at least the maintenance of the status quo, perhaps even exacerbating preexisting stratification patterns." Reviews of the disaster literature have found exacerbation of racial/ethnic inequalities to be a typical outcome (Fothergill et al 1999; Bolin 2007).

The literature specifically on racial and ethnic differences in disaster-induced *population displacement*, however, is equivocal on differences by race. Much of the long-term impact of disasters on the exacerbation of inequality concerns housing, as analyses of recent U.S. disasters have shown (Girard and Peacock 1997; Bolin and Stanford 1998; Kamel and Loukaitou-Sideris 2004; Mitchell, Esnard, and Sapat 2012). Poorer recovery of the physical housing structures of a disadvantaged minority group does not always imply their greater displacement. It may instead be associated with their remaining in houses and neighborhoods under deteriorated physical and socio-economic conditions. They may be less able to relocate from disaster-impacted neighborhoods due to their disadvantaged economic circumstances, due to institutionally unfavorable treatment in the recovery process, or due to race-based exclusion from alternative neighborhoods. Girard and Peacock (1997) describe just such dynamics following Hurricane Andrew. They found lower rates of long-term relocation *and* weaker housing recovery among the largely African-American population of Florida City than among the immediately-adjacent, largely White population of Homestead. One factor they discuss was the insurance payouts to Black, Florida City owners that were much more likely to be below the levels needed for repairing the damaged house. Similarly, Mitchell et al (2012) cite two studies of the impact of 2008 Hurricane Ike on Galveston, Texas that, respectively, found that African-Americans were less likely to have moved from damaged houses and were more likely to live in neighborhoods experiencing slower initiation of housing repairs.

Studies of other natural disasters in the U.S., however, have found that disadvantaged minorities *are* more likely to be displaced. Historically, displacement of African-Americans following the devastating 1927 Mississippi floods contributed to the large-scale migration of Blacks in the South to the North (Barry 1997). More recently, Morrow-Jones and Morrow-Jones

(1991) analyzed national-level American Housing Survey data from 1974-81 and found that African-Americans were almost three times more likely to be found among “disaster movers” than among all movers, and speculated (p.129) that “All groups may be equally involved in disasters but the more powerful subpopulation is less likely to move because of access to resources to recoup its losses in place.” Kamel and Loukaitou-Sideris (2004) found that after the Northridge earthquake, in the neighborhoods of lower socio-economic groups, public funding for housing recovery was lower *and* population loss was higher. Rebuilding and new construction of low-income housing primarily for the Hispanic population was met with local homeowner opposition, in a continuation of conflicts over the building of affordable housing that preceded the earthquake (Bolin and Stanford 1998).

The experience of Hurricane Andrew offers additional insights into the factors that may influence longer-term displacement. Renters were more likely to be displaced than were owners (Girard and Peacock 1997). Family structure and location of initial displacement were additional factors. Extended family ties may allow for relocation nearer to the site of the disaster, but multi-generational families are a major challenge to keep intact (Morrow 1997; Morrow and Enarson 1996). Especially relevant to displacement from New Orleans following Hurricane Katrina, Hurricane Andrew victims who initially relocated no farther than to the neighboring county (Broward County to the north) were far more likely to return to their pre-hurricane residence than were those who initially relocated out of state (Smith and McCarty 1996).

Population movement under conditions that may be described as displacement or forced migration (Ruiz and Vargas-Silva 2013) is characterized by a mix of two alternative decision-making processes which we will refer to as ‘reverse selectivity’ and ‘diminished selectivity’. As Lee (1966, p.56) summarizes more generally, “Migrants responding primarily to minus factors at

origin tend to be negatively selected [‘reverse selectivity’]; or, where the minus factors are overwhelming to all population groups, they may not be selected at all [‘diminished selectivity’].” Under the ‘reverse selectivity’ mechanism, costs of migration are not associated with the move away, which is involuntary, but instead are associated with the move back. It is this move back, after evacuation or displacement, which will be chosen by those with the most resources (Groen and Polivka 2010). Access to resources may be conceptualized more broadly, moreover, to include advantaged access to public resources for neighborhood rebuilding (Kamel and Loukaitou-Sideris 2004). More distant relocations have previously been characterized by more negative selection and relocations closer to the disaster-affected place by less negative, or possibly positive, selection (Morrow-Jones and Morrow-Jones 1991).

Racial stratification and flood exposure in New Orleans city and suburbs

The first observation about Hurricane Katrina’s devastating impact on New Orleans is that only its timing was unforeseen. The devastation of the City of New Orleans by a powerful, ‘direct hit’ hurricane had long been predicted and feared (e.g., Fischetti 2001). Earlier in 2005, a “Hurricane Pam” simulation exercise predicted levels of damage and loss of life under a direct-hit scenario well in excess of those that actually occurred in New Orleans with the Hurricane Katrina impact (Tierney 2008). Neither this exercise nor previous warnings had resulted in the major efforts required to prepare for and mitigate such an impact. Freudenberg et al (2009) describe instead an ongoing process of building greater exposure through a combination of constructing manmade waterways that would carry storm surge into the city, weakening natural defenses by destroying protective wetlands, and failing to build and maintain levee and canal-wall protection adequate to withstand the storm surge that might be brought by a major hurricane.

Historically, differences in exposure to a hurricane-generated storm surge varied along both racial and class lines, but by no means unidirectionally. The majority of the population of the City of New Orleans was White throughout the period 1840 to 1960 (Spain 1979). Transportation and water-pump technology developed in the early 20th Century allowed both Black and White residents to move into drained former swampland on the periphery of the city, all of which lay below sea level. “White flight” to suburban parishes of the metropolitan area from the 1960s through the early 1990s, however, followed the passing of Civil Rights legislation, and altered considerably the racial map of hurricane exposure (Campanella 2007). Many lower-lying neighborhoods that had originally been settled by White New Orleanians, or by both White and Black New Orleanians, became predominantly or entirely Black neighborhoods. These included the Lower 9th Ward, initially populated by lower-income Whites and Blacks, and Gentilly and New Orleans East, which were initially populated mainly by middle-income Whites or Whites and Blacks. Another lower-lying neighborhood in Orleans Parish that had originally been settled exclusively by White New Orleanians, largely from middle- and upper-incomes, Lakeview, remained predominantly White.

White home owners in the Lower 9th Ward initially resisted the racial integration of public schools, but ultimately almost all White residents moved out, especially to neighboring St. Bernard Parish to the south (Landphair 2007). Housing there was affordable, and discriminatory housing practices kept St. Bernard Parish very largely White (Mack and Ortiz 2013). Middle-income Whites living in neighborhoods including Gentilly and New Orleans East moved out to suburban parishes including Jefferson Parish to the west and St. Tammany Parish to the north (Campanella 2007). By 2000, Orleans Parish constituted 37% of the total metropolitan area population, slightly larger than Jefferson Parish’s 35%, with St. Tammany next with 15%. Of

Jefferson and St. Tammany parishes, Jefferson Parish was the more racially diverse, with 65% non-Hispanic White and 22% Black in 2000, with Hispanics 7% and Asians 3%. St. Tammany Parish was 85% non-Hispanic White and 10% Black in 2000 (Mack and Ortiz 2013).

Hurricane and flood damage from Katrina was overall greater in predominantly Black neighborhoods of the City of New Orleans, but less than that implied by early accounts of the disaster from those charged with decision-making on the recovery (Green, Bates, and Smyth 2007). According to Campanella (2007), who calculated damage in the three parishes with the largest absolute population numbers living in damaged areas (Orleans, Jefferson, and St. Bernard), Blacks constituted 65% of the flood victims but only 44% of the population, whereas Whites constituted 31% of the flood victims but 51% of the population. In Orleans Parish, the ratios were more even, with Blacks constituting 67% of the population and 76% of the flood victims, whereas Whites constituted 20% of the flood victims but 28% of the population. Sharkey (2007) found that Blacks and Whites were represented in the most severely flooded tracts of Orleans Parish in about equal proportions to their population shares, with 30% of Whites in the most severely flooded tracts. He further notes that "...the most racially segregated tracts were not the tracts that experienced the most flooding" (p.494). Similarly, Campanella (2007) describes media reports immediately following Katrina as oversimplifying a complex racial geography, noting reports that "...erroneously implied a strong positive correlation between elevation and class (and by extension race)..." and "...revealed a misunderstanding of the role of historical economic and environmental geographies..." (p.715). For example, higher elevations close to the Mississippi river were disproportionately occupied by Blacks as a result of those neighborhoods being considered undesirable due to proximity to the historically very busy port area. By far the largest factor for Hurricane-Katrina flood damage in the New Orleans

metropolitan area was found in differences in flooding *between* parishes. Of the suburban parishes, only St. Bernard Parish experienced a similar level of destruction by the Hurricane to that of Orleans Parish, with respectively 73% of Orleans Parish and 79% of St. Bernard Parish residents living in damaged areas (Logan 2006). Jefferson and St. Tammany Parishes were much less affected. Jefferson Parish had 38% of its population living in damaged areas, whereas this was true for only 1% of St. Tammany Parish.

Racial stratification and differences in pre-Katrina mobility

Post-Civil Rights legislation ‘White flight’ was not unique to New Orleans (Farley et al 1978). Across central cities in U.S. metropolitan areas, many low-income Whites but few low-income Blacks were able to move into suburban jurisdictions within the metropolitan area (Massey, Gross, and Shibuya 1994). As a consequence, Black central-city residents nationwide were exposed to much higher levels of neighborhood concentrated poverty. New Orleans, however, was among the most extreme cases: The 43% of poor Black New Orleanians in 2000 who were living in neighborhoods with over 40% of households in poverty was the second highest among the 50 largest cities in the U.S. in that year (Berube and Katz 2005). The much higher levels of exposure to concentrated poverty of Black than White poor and low-income households follows from the highly racially segregated city and metropolitan area of New Orleans. The City of New Orleans was among the most segregated of large U.S. cities in both 1990 and 2000 (Iceland, Weinberg, and Steinmetz 2002). Moreover, while there were notable declines in segregation in many large cities between 1980 and 2000, New Orleans’ level of segregation changed little over this period. The most concentrated Black poverty was found among New Orleans’ public housing residents. The original public housing units of New Orleans were built to house,

separately, both low-income Whites and low-income Blacks. After the Housing Authority of New Orleans (HANO) was established, it oversaw the building between 1937 and 1941 of five entirely racially segregated complexes, three for Blacks and two for Whites (Spain 1979, Mahoney 1990). Following the federal civil rights legislation, White public-housing residents moved out and New Orleans' public housing became occupied almost entirely by Black residents (Pardee and Fox Gotham 2005).

[TABLE 1 ABOUT HERE]

In Table 1, we show differences in the pre-Katrina patterns and levels of mobility between White and Black adult residents of the City of New Orleans, and additionally in their sociodemographic characteristics. These statistics are estimated from the 1990 and 2000 U.S. Censuses. We define adults as those aged 23 and above and in the household population at Census date 1990 and 2000, and therefore age 18 and above at the beginning of the 5-year mobility interval in 1985 and 1995. Whites constituted 42.2% and 34.6%, and Blacks 55.2% and 60.9% respectively of the total 1990 and 2000 adult populations of the City of New Orleans. For maximum inclusiveness, we consider all White and Black race adults regardless of Hispanic ethnicity in these totals, and throughout our study. For reference, non-Hispanic Whites constituted 40.0% and 33.0% and non-Hispanic Blacks constituted 54.9% and 60.4% respectively of the 1990 and 2000 adult populations.

The recent historical contrasts in the mobility of the Black and White adult populations of the City of New Orleans are striking. We first describe five-year mobility of those who lived in the City of New Orleans in 1985 or 1995. Included in this description are those individuals who

were living elsewhere in the United States by 1990 or 2000. Approximately one in four White adults living in the City of New Orleans in 1985 had moved out of the metropolitan area by 1990, a pattern which was repeated between 1995 and 2000. Meanwhile, fewer than one in ten Black adults moved away from the metropolitan area in both of these five-year periods.

Residential mobility within the New Orleans metropolitan area also differed greatly between White and Black New Orleanians in the five years before 1990 and 2000. Blacks were much more likely than Whites to have moved house within the city; Whites were much more likely than Blacks to have moved from the city to a suburban parish within the New Orleans metropolitan area. Among White adults living in the City of New Orleans in 1985, just over twice as many (16.9%) moved within the city as moved to a suburban parish elsewhere in the metropolitan area (7.1%). In contrast, Black adults living in the city in 1985 were fourteen times more likely to have moved within the city (35.9%) as to have moved to a suburban parish elsewhere in the metropolitan area (2.5%). In the 1995 to 2000 period, when White flight was largely over (Campanella 2007), White adults were again twice as likely to move within the City as to a suburban parish (18.1% versus 9.5%). For Black adults, moves within the city were still seven times more likely than were moves to a suburban parish (28.9% versus 4.2%). In total, in both the 1985-1990 and 1995-2000 periods, one in three White adult residents of the City of New Orleans was no longer living in the City five years later (34.7% in 1990 and 34.1% in 2000). In contrast, only one in eight Black residents (11.9% and 12.7%) moved out of the City in those same five-year intervals.

Next, we look at the five-year mobility of those who in 1990 and 2000 were living in the City of New Orleans, thereby allowing us to consider moves into the City. Among Black adults, only 4.4% in 1990 and 5.6% in 2000 had been living outside the New Orleans metropolitan area

five years before, compared to 16.2% and 18.0% of White adults. The smaller representation of in-migrant Black adults in the City of New Orleans in the decades immediately before Katrina differed from those of some southern cities, such as Atlanta, which saw large influxes of African-Americans from Northern States as part of the reversal of the Great Migration of Blacks from the South to the North (Tolnay 2003). Other comparable-sized southern cities, such as Memphis, however, were also largely bypassed by this return or reverse migration of Blacks from the North to the South (Falk et al 2006). Together, these statistics on five-year mobility to and from suburban New Orleans and outside the metropolitan area describe a remarkably constrained sphere of mobility for Black compared to that of White New Orleanians in the two decades before Hurricane Katrina struck.

We also compare the socio-demographic characteristics of the White and Black adult populations in the City of New Orleans in 1990 and 2000. Consistent with the above five-year mobility statistics, only 15.8% and 14.9% of Black adults, but 40.4% and 46.1% of White adults, were born outside of the State of Louisiana in 1990 and 2000. The White population of the City was socio-economically advantaged compared to the Black population, having higher levels of education and home-ownership, and lower levels of poverty, in both 1990 and 2000. The Black proportion of the City's adult population increased from 55% in 1990 to 60% in 2000, while the White proportion declined from 40% to 33% over the same period. The characteristics of the Black adult population, meanwhile, exhibited some convergence to the characteristics of the White adult population. The median age for Black adults increased from 36 to 39, the proportion living in a rented dwelling fell from 55.6% to 51.1%, and the proportion whose household was poor in the previous year fell from 34.3% in 1990 to 27.9% in 2000. Because of this decline in

the Black poverty rate, the overall decline in the New Orleans poverty rate was the fifth largest among central cities nationally in this decade (Berube and Frey 2002).

Racial inequality in evacuation and in population displacement in the year following Katrina

Quarantelli (2006) describes Hurricane Katrina as being best understood as a “catastrophe,” one of whose characteristics is that the scale of physical destruction makes it impossible for displaced residents to obtain shelter with nearby relatives and friends (p.3). The extensive dispersal of the evacuated pre-Katrina population affected both its likelihood of return and the manner of its being re-housed elsewhere. Elliott and Pais (2006, p.302) report that within two weeks, temporary shelters for Hurricane Katrina evacuees had already been established in 24 states and the District of Columbia. Race and income differentiated strongly the locations of the evacuated Katrina population and their likelihood of return. Most White residents evacuated before Hurricane Katrina struck on August 29, and evacuated to locations of their choosing. The racial dimension of evacuation inadequacies has been argued forcefully elsewhere (e.g., Molotch 2006). Large numbers of Black residents were evacuated from New Orleans approximately a week after Katrina struck, and to locations largely out of their control (Weber and Peek 2012). Houston, Texas, accounted for a disproportionate share of African Americans due to Houston’s Reliant complex having been made available for a mass transfer of evacuees from New Orleans’ Superdome and Convention Center (Brodie et al. 2006). At peak occupancy, 27,100 New Orleans evacuees resided in the main Houston shelter sites (Brodie et al, p.1403), 93% of whom were Black. Among Houston shelter residents, those with lower incomes were found to be less likely to express an intention to return to New Orleans (Landry et al 2007). Frey et al (2007) estimated that a year later Houston’s main county, Harris County, accounted for 25% of all

Blacks but only 4% of Whites living outside Orleans Parish in 2006; another 29% of Whites but only 13% of Blacks were living in another Parish in the New Orleans metropolitan area in 2006.

Evacuation after, rather than before, Katrina struck was much more frequent among Black than White New Orleansians (Thiede and Brown 2013; Elder et al 2007). Experience of trauma was accordingly greater among those who, along with family members, experienced and endured the chaos and tragedy of the storm itself, the inundation, and the post-Katrina evacuation (Rhodes et al 2010). This experience and resulting trauma itself may have made it less likely that those former New Orleans residents would either be able to generate the economic and emotional resources to go back and rebuild their homes and lives in the city. Kim and Oh's (2013) analysis of a random sample of Red Cross-registered evacuees found that "emotional competence" was one of the two most important factors determining return visits to or resettling in New Orleans, with homeownership being the other major positive factor for likelihood of return.

Until now, almost all we know about displacement and return after Hurricane Katrina, as opposed to about net population change in the city, is from data on mobility in the year immediately after Katrina. All residents were displaced for at least a month while the city's basic public services and utilities were recovered. Over the year immediately following the Hurricane, displaced White New Orleansians returned at a considerably greater rate than did displaced Black New Orleansians. As a consequence, the Black share of the population fell from 67% to 58% between 2005 and 2006 and the White share increased from 26% to 34% (Frey, et al 2007). Frey et al (2007) and Sastry and Gregory (2014) both analyzed American Community Survey (ACS) data on those who lived in New Orleans in the year before Hurricane Katrina struck. The population composition of New Orleans in 2006 was substantially different from its 2005 character. Regarding economic inequalities in returning in the first year after Katrina, Sastry and

Gregory found that differences by race were more important than differences by education. Among Black residents, they found no association of education with returning. Among non-Black residents, however, there was a strong negative education gradient with having remained outside the New Orleans metropolitan area in 2006. These findings are consistent with the ‘reverse selection’ hypothesis applying to Whites and with the ‘diminished selection’ hypothesis applying to Blacks. Studies by Vigdor (2007), Zottarelli (2008), and Zissimopoulos and Karoly (2010) all used the special Current Population Survey (CPS) Hurricane Katrina Supplement to analyze return propensities among those who had been living in a wider area of Hurricane-affected counties throughout the three-state region (Alabama, Louisiana, and Mississippi). Also consistent with the ‘reverse selection’ hypothesis, but again not distinguishing the selectivity of White and Black populations, those who moved back in the year immediately after Hurricane Katrina had higher educational attainment and other positive labor force characteristics than did those who remained outside the affected area.

Other than the ACS, the only area probability sample that specifically identified pre-Katrina City of New Orleans residents and followed them to their post-Katrina location was the much smaller 2006 Displaced New Orleans Residents Pilot Study (Sastry 2009a). Analyses of these data similarly found that economically disadvantaged individuals were less likely to have returned to live in New Orleans just over one year after Katrina (Fussell, Sastry, and VanLandingham 2010; Groen and Polivka, 2010; Sastry 2009b), but that race and housing damage were crucial additional variables. Fussell et al (2010) found that individual characteristics including age and education could not explain the lesser likelihood of return among Black than non-Black New Orleanians, and that instead the greater likelihood of housing damage among Black New Orleanians was the critical factor.

Relocation to suburban parishes

As noted above, the greatest racial disparity in exposure to flood damage across the New Orleans metropolitan area was due to the concentration of the Black population inside the City of New Orleans (Orleans Parish). This meant that Black residents had a proportionately much greater need to find housing in other parishes in the metropolitan area if they were to be able to return to and remain in greater New Orleans in the medium and longer term. The predominantly White character of the suburban parishes, meanwhile, was the result of historical processes of residential segregation by race (Spain 1979; Campanella 2007) that were not about to be easily cast aside in the post-Katrina period.

In the year following Katrina, Whites were much more likely than Blacks to move to suburban parishes within the New Orleans metropolitan area (Frey et al 2007). There is substantial evidence also of ongoing barriers to the Black population's resettling in suburban parishes. Efforts to rebuild pre-existing rental housing and to build new rental housing were actively thwarted. Seicshnaydre (2010) describes the several legislative and administrative tools used by local governments in the New Orleans metropolitan area to prevent the provision of low-income housing in suburban parishes. A major tool was the issuing or withholding of permits for the rebuilding or new building of private rental units that might have rehoused former Orleans Parish residents. The most extreme case of intensified (compared to even the pre-Katrina period) processes of exclusion of low-income Blacks from neighboring parishes was found in St. Bernard Parish. An ordinance against renting to other than direct-descendent family members following Katrina was quickly passed and, after it was overturned in court based on its racially discriminatory intent, three subsequent contempt of court judgments were made over violations

of the initial court order (Seicshnaydre, pp.697-699). The important historical context of St. Bernard Parish in the racial segregation of the New Orleans metropolitan area is that it was a major destination for lower-middle class Whites leaving the neighboring what was a racially-integrated Lower 9th Ward (Campanella 2007).

Probably more important, given its size, were zoning restrictions and other actions taken by Jefferson Parish. Before Katrina, Jefferson Parish had almost as large a population as Orleans Parish and had the largest Black population of the suburban parishes. After Katrina it became New Orleans' most populous parish (Mack and Ortiz 2013). Among zoning or building-permit restrictions, the City of Kenner in Jefferson Parish passed a moratorium on the construction of developments with five or more apartments (Seicshnaydre 2010, p.694). The Jefferson Parish council additionally approved an ordinance prohibiting the use of Low Income Housing Tax Credits in building new housing units in two particular districts, Gretna and Terrytown. Gretna's unwelcoming actions were foreshadowed by the notorious Gretna Bridge incident when in the days following Hurricane Katrina, Black evacuees fleeing flooded Orleans Parish by crossing the Gretna Bridge were turned back at gunpoint by the Gretna Police (Hawkins and Maurer 2012, p.122). Discriminatory practices of private landlords and their agents in suburban parishes also played roles in preventing former city of New Orleans residents from relocating to those parishes. In a 2009 audit of 100 rental properties, "Landlords denied voucher holders the opportunity to rent units 82% of the time, either by outright refusal to accept vouchers or by the addition of insurmountable requirements for voucher holders making it impossible for voucher holders to rent units" (Greater New Orleans Fair Housing Action Center 2009, p.7).

Regarding differences between Black and White home owners' opportunities to relocate from a destroyed home or neighborhood without leaving the New Orleans metropolitan area, a

comparison in selecting Road Home Program (RHP) options to sell and relocate between predominantly-White St. Bernard Parish and the majority-Black Orleans Parish is suggestive of greater opportunities to relocate in other suburban New Orleans parishes for St. Bernards' White homeowners than for Orleans Parish's Black homeowners. These were virtually the only parishes in which options to sell one's house (to the state of Louisiana) rather than rebuild and re-occupy were chosen by any RHP participants (Green and Olshansky 2012). As many as 37% of St. Bernard RHP participants chose this option compared with 11% of Orleans Parish RHP participants. There were two relocation options in the RHP, one to relocate within the state of Louisiana (including elsewhere in the New Orleans metropolitan area), which provided higher compensation, and one to relocate outside Louisiana. Among RHP participants choosing a 'sell' option, relocation outside of Louisiana was chosen by less than a fifth of St. Bernard participants, but by more than a third of Orleans Parish participants. Two other elements of the RHP noted by Green and Olshansky to disadvantage the return of Blacks relative to Whites were its using pre-Katrina house values, which were higher in predominantly White neighborhoods, in assessing compensation amounts to be used for rebuilding, and the program's emphasis on home owners over renters.

The federal Department of Housing and Urban Development (HUD) also took actions which significantly worsened prospects for low-income Blacks to return to the City of New Orleans. HUD first decided in December 2005 to board up and bar residents from returning to the main four public housing projects in the city, and then in June 2006 announced they would all be demolished. This was in spite of expert testimony that they were structurally sound and repairable (Graham 2012). Browne-Dianis and Sinha (2008) describe plans by HUD to reduce physical public housing units by 70%, replacing them with mixed-use developments. In the

interim period, former tenants were provided with Section 8 vouchers. Theoretically these could have been used in other areas in New Orleans or outside the New Orleans area. Browne-Dianis and Sinha described these vouchers as “...not a viable option for public housing families seeking to return to the city” given the severe shortage of housing in post-Katrina New Orleans. Plyer et al (2009) similarly described Section 8 housing vouchers as failing to provide opportunities for desegregated and mixed-income housing in the New Orleans city or metropolitan area.

Population change in the five years following Katrina

Early predictions were that the short-term changes observed in the racial/ethnic composition of New Orleans would endure over the longer term (e.g., Falk et al 2006). Regarding net population change, these predictions were mostly borne out by 2010 data. Housing recovery remained far from complete five years on. Both the total number of housing units and their rate of occupancy were down considerably. The 2010 Census counted 47,738 vacant units out of 189,896 housing units in the City of New Orleans, whereas there were 26,840 vacant units out of a total of 215,091 housing units ten years earlier at the 2000 Census (Plyer 2011, p.4). The population count for the City of New Orleans was 343,829 people, down 29% from the 2000 Census count of 484,674 and down 30% from the revised, intercensal estimate of 494,294 in mid-year 2005 (U.S. Census Bureau, no date, a). The proportion Black recovered only marginally since 2006, to 60%. The non-Hispanic White population in 2010 was 33%, midway between its 2005 and 2006 proportions. The Hispanic population had increased both in absolute numbers and relative share, to 5% (U.S. Bureau of the Census, no date, b). Racial differences in net population change, however, are not equivalent to racial differences in population displacement, especially given the history of such great differences between the net change and flows of the much more mobile

White and much less mobile Black populations before Katrina. As we showed above, before Hurricane Katrina, White New Orleanians both moved out of and moved into the City of New Orleans at much greater rates than did Black New Orleanians. Looking only at net population change masks what we will show to be an enormous racial disparity in long-term displacement from the City of New Orleans.

DATA AND METHOD

Our study's analyses are in two parts, both comparing White and Black adults living in the City of New Orleans at the beginning of the mobility interval, meaning either 1995 or 2005. Whites and Blacks constituted 95.5% of the city's population as at the 2000 Census (see again Table 1). First, we compare patterns of mobility between 1995 and 2000 with those between 2005 and 2009/10, contrasting the changes experienced by Whites with those experienced by Blacks. These comparisons are the sources of our 'displacement' estimates. Second, we conduct more detailed analyses of differences in mobility between Whites and Blacks in the 2005 to 2009/10 interval. In these more detailed analyses, we examine housing damage and individual and household demographic and socio-economic characteristics as factors that may explain differences in post-Katrina mobility between Blacks and Whites. In the 1995-2000 to 2005-2009/10 comparisons, we define adults as those aged 18 and above in the year at the beginning of the mobility interval (respectively 1995 and 2005). The more detailed analyses of the 2005-2009/10 interval alone are restricted to working-age adults, defined as individuals aged 25 to 60 at the beginning of the mobility interval.

Data Sources

A major analytical problem in estimating disaster outcomes is finding a suitable comparison group or comparison period (Ruiz and Vargas-Silva 2013). Natural disasters such as Hurricane Katrina are localized events, and there are typically no ongoing panel data collections with large enough samples to conduct before-and-after comparisons of population mobility. We meet this data challenge in the present study by comparing 1995-2000 mobility from the 2000 Census for the pre-Katrina period with 2005-2009/10 mobility from a new survey, the Displaced New Orleans Residents Survey (DNORS, Sastry et al, no date), for the post-Katrina period.

Unfortunately, neither the 2010 Census nor the ACS included a question on place of residence five years before. The DNORS was fielded over a 10-month period between June 2009 and May 2010. The mid-point of the survey was October 2009, approximately three months after the fourth anniversary of Hurricane Katrina, which struck on August 29th 2005, and for brevity we describe the location at DNORS survey as being “in 2009” below. The goal of DNORS was to study residential mobility, living arrangements, health, and well-being among children and families who lived in the New Orleans just prior to Katrina. The survey design built on the 2006 pilot study, the DNORPS (Sastry 2009a), analyses from which were discussed above. Like the DNORPS, the DNORS sample frame covered Orleans Parish, Louisiana, whose boundaries are those of the City of New Orleans. With a total sample size of 1,558 households, however, the DNORS is approximately 10 times larger than the DNORPS.

The weighted and adjusted response rate of the DNORS was 39.3 percent, only modestly below the 51 percent of the pilot study DNORPS that was conducted three years previously—and just one year after Hurricane Katrina (Sastry 2009a). A set of household and Household Respondent sampling weights is provided with the DNORS files. The weights account for

sample design and were post-stratified on basic demographic variables against a special ACS validation sample constructed from the restricted ACS data files (accessed through the Census Bureau's Research Data Center) that included all New Orleans households who responded to the ACS between January 2004 and August 2005, and on additional variables including housing tenure and household size from data in the 2005 ACS PUMS (U.S. Census Bureau 2009). To account statistically for the within-household dependence of mobility, for example within married couples, our estimates adjust for clustering of individuals within households in the DNORS.

Analytical Methods

Our main research questions concern whether, how, and by how much displacement differed between White and Black adult New Orleans residents in the four years following Hurricane Katrina. Both a theoretical framework and an empirical strategy are needed to distinguish population displacement from population movement that would have occurred anyway. A fundamental characteristic of migration is that it is selective (Lee 1966). We define migration (or "outmigration") in the present study as movement to anywhere outside the metropolitan area, consistent with a standard definition as movement between communities or labor markets (Ritchey 1976; White and Mueser 1988). We also follow standard definitions of movement within the metropolitan area as "residential mobility." Migration is often motivated by labor market factors, and is therefore selective of both younger individuals (Plane 1993) and more educated and higher-earning individuals (Schwartz 1973; Greenwood 1997) because both groups have higher net gains to migrating. Positive selection on education is also associated with longer-distance moves (Wozniak 2010). Residential mobility exhibits strong positive selectivity under

normal conditions, though its selectivity is associated especially with age-dependent life-cycle events such as leaving home or starting a family and less on labor force characteristics.

Residential mobility tends to be selective of younger individuals, but is not necessarily selective on education or income (Geist and McManus 2008). Family status and place of birth (Plane 1993; Rogers and Belanger 1990) are further predictors of residential mobility and migration.

We aim to estimate the extent of racial differences in displacement, conceptualized as involuntary movement of pre-Katrina city of New Orleans residents to places outside the New Orleans metropolitan area. This conceptualization is chosen to be consistent with Oliver-Smith's (2006, p.3) definition of displacement as "the uprooting of people from a home ground." We further characterize displacement as migration out of the New Orleans metropolitan area that would not have occurred had Hurricane Katrina not struck. We operationalize this counterfactual by comparing differences in observed White and Black mobility patterns in the 2005 to 2009 period that followed Hurricane Katrina with predicted differences based on White and Black mobility patterns over the 1995 to 2000 period, adjusted to the length of the DNORS mobility interval. We use the 1995-2000 Census mobility patterns by race and socio-demographic characteristics, applied to the 2005 White and Black populations' socio-demographic characteristics, to predict what the mobility of New Orleans White and Black adults between 2005 and 2009 would have been in the absence of Hurricane Katrina.¹ We use the 2000 Census question on where each household member was living 5 years before Census date to first identify adult individuals who lived in the City of New Orleans in 1995, and then use their 2000 household location information to code the same four outcomes of mobility in the 1995-2000 interval as in Panel A of Table 1 above. For this prediction, we use a multinomial logit (MNL) model, estimated from the Census 2000 IPUMS (Ruggles et al 2010) samples of White and

Black adults ages 18 and above in 1995 and who were living in the City of New Orleans in that year. Estimation is conducted separately for the White and Black samples using the following specification:

$$Pr(Y|X) = MNL(X'\beta) \tag{1}$$

where $Y = \{\text{mobility outcome: same house; different house in the City of New Orleans; other ('suburban') Parish within the New Orleans metropolitan area; outside the New Orleans metropolitan area}\}$ and $X = \{\text{age, gender, education, state of birth}\}$. Our predictor variables are limited to those for which data are collected similarly between the Census and DNORS and whose values do not change, or would be expected to change little, over the five-year Census period 1995-2000. Education is a partial exception for its potential to increase over the younger adult ages, and to address this we also conduct analyses beginning at age 25 in the second part of our empirical study. We code state of birth as Louisiana versus elsewhere (including foreign country of birth). Our intention is for this to proxy for being born in New Orleans, and to represent stronger preferences for returning and staying (Rogers and Belanger 1990). We sometimes refer to it below as 'locally-born.'

We first estimated parameter values β in Equation (1) above from the 2000 Census 1995-2000 data and the DNORS 2005-2009 data, separately for Whites and Blacks ages 18 and above respectively in 1995 and 2005. We then applied the parameter values β estimated for 1995-2000 from the Census data to the 2005 DNORS observations of regressor variables X from equation (1), again for White and Black individuals ages 18 and above in 2005. Using the DNORS sample weights, we then derived predicted mobility outcome distributions of White and Black New Orleanians in 2010 in the absence of Hurricane Katrina (and in the absence of any period changes in mobility between 1995-2000 and 2005-2010, see again footnote 1). We then adjusted

the predicted probabilities of each of the three categories of movement (within city, to suburban New Orleans, out of the metropolitan area) for the shorter period from 2005 to 2009 than from 1995-2000.²

We conducted more detailed comparisons between White and Black pre-Katrina City of New Orleans residents for the 2005-2009 period only. For these comparisons, we included as predictor variables housing damage and a set of pre-Katrina characteristics in addition to the age, gender, education, and state-of-birth variables of mobility equation (1) above. We coded an indicator variable for whether the pre-Katrina residence was rendered uninhabitable by Hurricane Katrina, as reported by the DNORS Household Respondent. A residence was classified as “uninhabitable” if it was “Destroyed” or “Damaged so badly that someone couldn’t live in it,” and “habitable” if it was “Not damaged” or “Damaged but someone could still live in it.” We included a second housing variable shown in previous disasters to be important for displacement (e.g., Girard and Peacock 1997): whether the (pre-Katrina) residence was rented or owned by one or more of the occupants. We classify as ‘rented’ also the few residences for which the occupants were not the owner but did not pay rent. Other predictor variables defined at the beginning of the mobility interval included whether employed in 2005, relationship to household respondent, shown previously to have a strong impact on mobility (Rendall 2011), and household income in the year before 2005, adjusted for household size by dividing household income by the square root of household size (“equivalized household income”, e.g., Burkhauser, Smeeding, and Merz 1996) and then logged for our regression analysis. Household income in the DNORS comes transformed into a continuous variable by imputation within bracketed responses (Sastry et al, no date). As in the pre-Katrina versus post-Katrina mobility analyses, we make counterfactual predictions of the mobility outcome. We first run separate

multinomial logistic regressions on the DNORS data for Whites and Blacks, with the same outcome variable as in equation (1) above, but with the additional regressors just described. We then alternately use the parameter values estimated for the White population to predict the Black population's mobility and vice versa.

[TABLES 2A AND 2B ABOUT HERE]

RESULTS

The first place we look to for evidence of racial differences in the impact of Hurricane Katrina on mobility is in coefficients and odds ratios for Whites and Blacks in a mobility model with identical variables and specifications before and after Hurricane Katrina. The *pre*-Katrina Table 2a provides estimates of the effects of socio-demographic characteristics on mobility “under non-disaster conditions,” in 1995-2000, whereas the *post*-Katrina Table 2b provides estimates “under disaster conditions,” in 2005-2009. We interpret differences in single or grouped socio-demographic coefficients as indicating changes in selection into outmigration and into residential mobility. Regarding selection into outmigration, either a reversal of coefficient direction or a diminishing of coefficient magnitudes may be indicative of displacement, recalling that we define displacement as involuntarily moving out of the metropolitan area. Regarding residential mobility (either within Orleans Parish or to a suburban New Orleans parish), changes in the direction or magnitude of the coefficients may be indicative of mitigation of displacement pressures. To test for any change in selectivity in mobility by age, gender, place of birth, and education between 1995-2000 and 2005-2009, we pooled the Census and DNORS observations and compared AIC model fit statistics between a fully-interacted model (‘DNORS’ intercept

shifter and ‘DNORS’ interactions with all covariates) and models that remove the ‘DNORS’ interaction(s) with the particular covariate or covariate group. The results for changes in these individual and (age and education) grouped coefficients between 1990-95 and 2005-09 are denoted by the ^ symbol in Table 2(b).

We consider first the “Born in Louisiana” variable. As expected (Rogers and Belanger 1990), being born locally (in Louisiana) was highly predictive of lower outmigration in the 1995-2000 mobility interval, for both White (66% lower odds) and Black residents (78% lower odds, see Table 2a). For Whites, being born locally was associated with a 65% *higher* odds of moving to a suburban New Orleans parish, whereas for Blacks, being born locally was associated with a 54% *lower* odds. For both Whites and Blacks, mobility by whether born in Louisiana changed substantially between the pre-Katrina and post-Katrina periods (compare Table 2a and Table 2b). The large pre-Katrina associations of being born in Louisiana with *outmigration* disappeared for Blacks and reduced in magnitude for Whites, with the odds ratios changing respectively from 66% and 82% lower odds of outmigration for locally-born Whites and Blacks before Katrina to 29% and 3% lower odds respectively for Whites and Blacks after Katrina. The biggest change in Whites’ “locally-born” association, however, was in their *residential mobility*: locally-born Whites’ odds of moving to a suburban New Orleans parish increased from being 65% greater than if born outside Louisiana before Katrina to 312% greater (odds ratio of 4.12) after Katrina. For Blacks, consistent again with ‘diminished selection,’ this odds ratio instead became not statistically different between those born inside and outside Louisiana after Katrina. These racial contrasts in out-migration and residential mobility are consistent with locally-born Black New Orleanians having lost their ability to exercise a preference for remaining in the City of New Orleans (especially compared to moving out of the New Orleans metropolitan area), whereas

locally-born Whites, in contrast, were able to exercise their preference for remaining in the New Orleans metropolitan area by greatly increasing their likelihood of moving to a suburban New Orleans parish after Hurricane Katrina. That is, locally-born White New Orleanians, but not locally-born Black New Orleanians, were able to move to suburban parishes as a post-Katrina adaptation that enabled them to avoid being displaced from the New Orleans metropolitan area.

Shallower age gradients for mobility are seen after Katrina for both Whites and Blacks. Before Katrina, Whites aged 18-24 had a 99% higher odds than the reference age 25-35 group had of moving to a suburban parish, and Whites aged 60 and over had an 80% lower odds. After Katrina, these between-parish residential mobility odds for Whites no longer exhibited statistically-significant differences from the reference 25-34 age group, although the coefficients do still show the expected declines in mobility by age. This diminishing of the age gradient after Katrina may again be interpreted as an adaptation of Whites to the Hurricane damage in Orleans Parish by moving into suburban New Orleans when, absent the hurricane, many would not have done so. Among Blacks, there was also a diminishing of selection on age between 1995-2000 and 2005-2009. This is seen for both residential mobility to other parishes and outmigration, but the magnitudes of change are not especially large.

Before Katrina, education gradients of mobility were not large. They were in the direction of allowing White New Orleanians with more education to exercise a preference for moving within the City of New Orleans, whereas for Black New Orleanians having more education was associated with the expected higher likelihood of outmigration. After Katrina, there is an indication of a diminishing strength of these educational associations, but for neither Whites nor Blacks was there an overall statistically-significant change in patterns of mobility between the pre-Katrina and post-Katrina period. Finally, a disappearance of a gender effect on

mobility after Katrina is seen for Blacks, whereas there were no gender associations with mobility for Whites either before or after Katrina. Black men's odds of outmigration were 83% higher than Black women's before Katrina, possibly due to the lower probability of mobility associated with women having their own dependent children in single-mother households. This Black gender difference in outmigration disappeared in the post-Katrina period, again consistent with diminished selectivity for Black adults after Katrina.

[TABLE 3 ABOUT HERE]

Results are shown in Table 3 comparing observed 2009 locations of the 2005 adult White and Black populations of Orleans Parish with their predicted 2009 locations. Recall that the predicted locations were derived by applying Census 1995-2000 mobility model regression parameters, separately estimated for Whites and Blacks (see Appendix Tables A2a and A2b), to the 2005 DNORS observed distribution of the model's predictor variables, and then adjusting the predictions to the slightly shorter mobility interval observed in the DNORS. Statistically, the appropriate comparison is between the observed 2009 point estimates and the predicted 2009 confidence interval (see the rightmost two columns of Table 3). The latter accounts for sampling error in the Census microdata used to estimate the mobility prediction coefficients, whereas both observed and predicted estimates implicitly or explicitly begin from the same 2005 DNORS distributions of socio-demographic characteristics.

The percentage of White adults observed living in the same (Orleans Parish) residence in 2009 as in 2005 (56.1%) was just below the lower bound of the predicted confidence interval (57.9%), and the percentage observed to change residence within the city (14.6%) was within the

predicted confidence interval. The 10.4% of Whites observed to move to a suburban parish, however, was 2.9 percentage points above the upper limit of the predicted confidence interval (6.1% to 7.5%). Most strikingly, the percentage of White adult residents of the city of New Orleans in 2005 who were observed to leave the metropolitan area in the four years after Hurricane Katrina (18.9%) was within the confidence interval predicted from a continuation of the 1995-2000 mobility patterns (between 17.7% and 19.6%). We conclude that Hurricane Katrina caused no net displacement to locations outside of the New Orleans metropolitan area among White adult residents of the city of New Orleans between 2005 and 2009. Displacement pressures were instead mitigated by moving to suburban parishes.

The contrast with the Black population's predicted versus observed locational distributions could hardly be more stark. A similar fraction of Black adults to that predicted moved within the city (22.2%, within the predicted confidence interval). Very tellingly, only slightly more Black adults than would have been predicted under non-disaster conditions were observed to have moved to a suburban parish (4.5% versus a predicted confidence interval of 2.6% to 3.4%), despite the large rates of housing damage they experienced. More dramatically, the proportion of Black adults observed to be back in their pre-Katrina home in 2009 (44.5%) was 24 percentage points lower than the midpoint of the predicted confidence interval (68.2%). The observed proportion leaving the metropolitan area (28.8%) was correspondingly 23 percentage points higher than the midpoint of the predicted confidence interval (6.1%). We interpret this very large difference between the observed and predicted proportion of 2005 City of New Orleans Black adult residents no longer living in the New Orleans metropolitan area in 2009 as evidence of massive long-term displacement. Four-fifths of Black outmigrants (22.7% of all pre-Katrina Black adults, calculated as 28.8% observed minus 6.1% predicted) are therefore

estimated to be displaced residents, with only one-fifth of them (the 6.1%) being individuals who would anyway have migrated out of the metropolitan area in the absence of Hurricane Katrina. Applying this estimate of 22.7% displaced to the 233,860 Black residents aged 18 and over in 2005 (U.S. Census Bureau, no date, a³), we estimate that 53,086 Black adult residents of the city of New Orleans were displaced long-term by Hurricane Katrina.

We present also in Columns 1 – 2 in Table 3 the observed locational distributions of the 1985 and 1995 White and Black adult populations of Orleans Parish five years later in 1990 and 2000, and in Column 3 the predicted locations of the 2005 White and Black adult populations of Orleans Parish five years later in 2010 in the absence of Hurricane Katrina and of secular changes in mobility between 1995-2000 and 2005-2010. These show consistently very large racial differences. Among Blacks, the percentage who were in the City of New Orleans five years later hardly changed at all between 1985-90 and 1995-2000, despite a decline in the fraction changing residences within the City: between 1985-90 and 1995-2000, respectively, 88% and 87% of Black adults were again living in the city five years later, with 2.5% and 4.2% only moving to a suburban parish in the New Orleans metropolitan area and 9.4% and 8.5% only moving outside the New Orleans metropolitan area. Among Whites, however, fully one third moved out of the city in each pre-Katrina period. For a White adult, moving to suburban parishes in the metropolitan area was twice as likely as for a Black adult, and moving outside the New Orleans metropolitan area was three times as likely.

The differences between the ‘Observed Census 1995-2000’ mobility outcome distribution and the ‘2005-2010 Predicted from Census 1995-2000’ distribution are, by construction, due entirely to observed differences between the 1995 and 2005 distributions of socio-demographic characteristics of the City of New Orleans population. These distributions are presented in

Appendix Table A1, and represent a continuation of changes in the city of New Orleans population already described earlier for the 1990 to 2000 populations (see again Table 1). The changes towards an older and more educated population of Whites and Blacks are predicted to be offsetting in terms of their effects on five-year mobility. We see that for neither race are the differences between 1995-2000 observed mobility and 2005-2010 predicted mobility substantial.

[TABLE 4 ABOUT HERE]

Residential Mobility and Outmigration of pre-Katrina New Orleanians

In our analyses comparing White and Black mobility outcomes in the DNORS only, we are able to include more predictors, in particular a variable for housing damage. We limited our analyses to individuals aged 29 to 64 at survey (approximately age 25 to 60 in 2005, when Hurricane Katrina struck), referring to them as “working age.” Restricting the ages this way allows us to add pre-Katrina labor force status and to argue that our educational-attainment variable is plausibly unchanging over the mobility interval.⁴ Comparing White and Black working-age adults (see Table 4), we see that the household income and educational attainment of Blacks were both much lower than those of Whites, and that Blacks’ proportion employed was somewhat lower. In particular, the median household income adjusted for household size was three times greater for Whites than Blacks. Many more Blacks than Whites had deep local roots, with only 12.1% of Blacks born outside Louisiana compared to 51.2% of Whites. Blacks were nevertheless more likely to have lived in a rented home (51.6% versus 35.7%). Crucially, 77.9% of Blacks had their pre-Katrina home rendered uninhabitable by Hurricane Katrina versus 42.2% of Whites.

[FIGURE 1 ABOUT HERE]

In Figure 1, we graph the differences in mobility outcome in 2009 between those whose residence was rendered uninhabitable and those whose residence remained habitable following Katrina, separately for Whites and Blacks. Both Whites' and Blacks' chances of again being in their pre-Katrina residence was under 50 percent for those whose residence was rendered uninhabitable (respectively 44.7% and 41.4% for Whites and Blacks), more than 20 percentage points lower than for those whose residences remained habitable. White-Black differences in the mobility of those whose residences were rendered uninhabitable, however, are striking. Having lived in a residence rendered uninhabitable resulted in 15.7% of Whites moving to a suburban New Orleans parish whereas this happened for only 3.8% of Blacks whose residence was rendered uninhabitable. Blacks whose residences were rendered uninhabitable were instead about ten percentage points more likely than Whites to have moved within the City (23.0%, versus 13.1% for Whites) and about five percentage points more likely to have migrated away from New Orleans (31.9%, versus 26.5% for Whites). Thus in the context of having one's residence rendered uninhabitable, moves to suburban parishes were especially frequent for Whites, whereas moving within the City appeared to be the only way to avoid migration out of the New Orleans metropolitan area for the large majority of Blacks facing these circumstances.

[TABLE 5 ABOUT HERE]

The ratio of observed proportions moving to a suburban New Orleans parish between

Whites whose pre-Katrina residence was rendered uninhabitable and Whites whose pre-Katrina residence was still habitable was 3.1 (15.7% to 5.0%, see again Figure 1). This translates to an odds ratio (the proportion p divided by $1-p$) of 3.5. Controlling for socio-demographic variables, the odds ratio is elevated to 20.1 times greater (see Table 5). In contrast, after controlling for socio-demographic variables, for Blacks the odds ratio for moving to a suburban New Orleans parish whose pre-Katrina residence was rendered uninhabitable versus for Blacks whose pre-Katrina residence was still habitable is a statistically non-significant 1.42 times greater among those whose residence was rendered uninhabitable compared to those whose residence remained habitable. Whites and Blacks' mobility associations with having their residence rendered uninhabitable were much more similar with respect to the outcome of living in another Orleans Parish residence in 2009 (respectively 3.32 and 4.35 times greater odds if their pre-Katrina residence had been rendered uninhabitable), and for the outcome of living outside the New Orleans metropolitan area when their house was rendered uninhabitable (3.49 and 3.79 times greater odds respectively). Overall, then, residential mobility within the New Orleans metropolitan area was a much more viable option for Whites whose residences in Orleans Parish were made uninhabitable, and this was very largely due to their being able to move to a suburban parish.

Having lived in a rented residence increased the odds of moving very much for Blacks, 9.82 times greater for moving within Orleans Parish, 5.61 for moving to a suburban parish, and 8.34 for moving out of the metropolitan area. Having lived in a rented residence before Katrina mattered less for Whites, with only the odds of moving out of the New Orleans metropolitan area exceeding 3 and attaining statistical significance at the .05 level. That is, living in a rented residence when Katrina struck was especially consequential for Black New Orleanians' chances

of returning to their pre-Katrina residence in the long-term.

For Whites, the odds of moving both within the City and to other New Orleans parishes were reduced with higher household income (adjusted for household size), with respective odds ratios of 0.55 ($p < .10$) and 0.40 ($p < .05$). These results are consistent with ‘reverse selectivity,’ indicating that those Whites with higher incomes were more able to recover their pre-Katrina homes. Income had no statistically-significant effect, however, on the mobility of Black adults age 29-64 holding constant other variables. This result is consistent with the ‘diminished selectivity’ hypothesis of large-scale displacement, as we saw was experienced by Black but not White adults. Note, however, that we are unable to compare these post-Katrina income associations with mobility with equivalent pre-Katrina associations, since we do not have a pre-Katrina data source in which income was similarly measured at the beginning of the mobility interval. Finally, we note from Table 5 that individual socio-demographic coefficients were less different between Whites and Blacks than were the coefficients for housing and household variables.

[FIGURE 2 ABOUT HERE]

To obtain an overall indication of whether the racial difference in the mobility outcome was due to Blacks’ more disadvantaged socio-demographic characteristics and their greater level of housing damage, we counterfactually applied the White mobility coefficients to the Black distributions of socio-demographic characteristics and housing damage (see Figure 2). The Black mobility changes between pre-Katrina and post-Katrina were, as we saw above, far more dramatic than were the White mobility changes. If Black New Orleanians, given their observed

socio-demographic characteristics and housing damage, had experienced the same mobility behavior as did White New Orleanians with the same socio-demographic characteristics and housing damage, the changes would have been greater still. Most strikingly, instead of the 4.0% of Blacks aged 25 to 60 in 2005 who actually moved to a suburban New Orleans parish (see “Observed Black”), as many as 28.9% of Blacks, or seven times as many, would have done so had they experienced the mobility rates of Whites with those same socio-demographic characteristics and level of housing damage (see “Blacks Using White Mobility Coefficients”). Another way of putting this is to say that if Whites had the same need to move (especially with respect to housing damage, but also with respect to other conditions including having lived in rented housing), and if Whites had the same socio-demographic characteristics associated with for staying in New Orleans (notably the high proportion born locally) as did Blacks, they would have decamped *en masse* to suburban New Orleans.

Given their lack of opportunities to move into suburban parishes, what did Black New Orleanians do instead to remain in the metropolitan area? Mostly, they found a way to move back into their pre-Katrina residences. Compared with the 32.1% that would have done so “had they been White,” as many as 46.1% Black New Orleanians actually moved back to their pre-Katrina residence. Additionally, 20.9% of Black New Orleanians found a way to move to another residence inside Orleans Parish, whereas only 13.8% would have done so “had they been White.” Therefore, whereas 67.0% of Blacks were back in Orleans Parish, only 46.0% would have been back in Orleans Parish had they exhibited the mobility of Whites given the same socio-demographic characteristics and housing damage. Finally, 29.0% of Black New Orleanians moved out of the metropolitan area, whereas 25.2% would have done so “had they been White.”

We conducted an analogous application of Blacks’ mobility coefficients to White City of

New Orleans residents (compare “Whites Using Black Mobility Coefficients” with “Observed White” in Figure 2). Because of their lower level of housing damage and higher level of home ownership, White New Orleanians had less need to move from their pre-Katrina residence than did Black New Orleanians. However, because of Whites’ greater ability to move into suburban New Orleans parishes, 10.0% (see “Observed White”) did so whereas only 6.3% would have done so “had they been Black” (see “Whites Using Black Mobility Coefficients”).

DISCUSSION

Our study addressed a major theoretical question of whether, four years on from the disaster that struck New Orleans in August 2005, the patterns of long-term population displacement from the City of New Orleans support the view that natural disasters engender social change (Carr 1932; Bates and Peacock 1987) or continue and entrench existing social structures and processes (Quarantelli and Dynes 1977; Henry 2011)? Our findings support a view of continuity and entrenchment, and do so very strongly.

Exploiting the insights of the social theory of disasters (Lindell 2013) that both hazard exposure and subsequent recovery are strongly affected by pre-disaster processes of social stratification, we first estimated baseline differences in residential mobility and in- and out-migration between New Orleans’ White and Black populations in 1985-1990 and 1995-2000. These described a highly mobile and an economically mostly well-off White adult population, only half of whom were born in the State of Louisiana, a fifth of whom had arrived in the metropolitan area in the last 5 years, and with a quarter leaving the metropolitan area again in a given 5-year period; and a deeply-rooted Black population whose mobility was very largely confined to moves within the City of New Orleans (Orleans Parish). Among Black adults living

in the City of New Orleans in 1990 and 2000, 85% were born locally. Only one in eight Black residents moved out of the City, including both residential mobility and outmigration, in the same five-year intervals that saw one third of White residents move out of the City. Over a quarter of Black adult New Orleanians in 2000 lived in poor households and their poverty was among the most spatially concentrated anywhere in the United States. Prior to Hurricane Katrina, one might argue that New Orleans was a tale of two cities in one. New Orleans was less accurately described as a city in general decline, as argued by Vigdor (2008), as it was a highly racially-segregated and racially-stratified city. The Vigdor narrative (p.140) that "...population declines of New Orleans have transcended racial groups," moreover, stands in contrast with the Census Bureau's revised population estimates for 2005 that put the city's population almost exactly at its 1990 size.

We defined population displacement conceptually as a change of residence from the City of New Orleans to locations anywhere outside the New Orleans metropolitan area between 2005 and 2009/10 that would not have occurred had Hurricane Katrina not struck New Orleans. We additionally considered residential mobility, both within the city and to suburban parishes within the New Orleans metropolitan area, as a major adaptive mechanism to mitigate displacement pressures. Our findings were that Hurricane Katrina drastically upset the racially-stratified pre-Katrina mobility equilibrium, but that it did so by a heightening of the pre-Katrina racially-stratified mobility processes within the City and metropolitan area of New Orleans. Hurricane Katrina's primary effect was then to displace Black New Orleanians from the metropolitan area, while its secondary effect was to move White New Orleanians to suburban parishes within the metropolitan area. We found that the combination of a lower incidence of major housing damage and increased movement to suburban parishes meant that White New Orleanians suffered no

displacement at all at the population level. That is, the proportion of White New Orleanians moving from the City of New Orleans to locations outside the New Orleans metropolitan area was no greater than it would have been had Hurricane Katrina not struck. The housing damage experienced by Black New Orleanians was substantially greater, and yet movement to suburban parishes was proportionately much less, than for White pre-Katrina residents of the city. We estimate that the consequence was that 53,000 individuals out of the 234,000 Black residents of the City of New Orleans aged 18 and over in 2005 were displaced long-term to locations outside the metropolitan area.

Additional indicators that much of the outmigration of Black New Orleanians in the 2005-2009 period was of an involuntary, 'displacement' character were found in a substantial diminishing of the strength of, or reversal in the direction of, the usual factors that would have predicted who moved out of the metropolitan area had Hurricane Katrina not struck. This is consistent with theory of forced migration (Lee 1966). Especially notable was the elimination of previously-large differences in propensities to leave the New Orleans metropolitan area between Blacks that were or were not born locally, whereas the 'locally-born' variable became much more highly predictive of moving to a suburban parish for White residents after Katrina than it had been before Katrina.

We also investigated the sources of this dramatic contrast in population displacement, specifically for working-age White and Black 2005 residents of the City of New Orleans. We first noted that much greater housing damage was experienced by Black than White working-age New Orleanians. Blacks were 36 percentage points more likely than Whites to have had their pre-Katrina residence rendered uninhabitable by Hurricane Katrina and the extensive flooding that followed (78% versus 42%). We found a striking racial difference, however, in the

association of having one's pre-Katrina residence rendered uninhabitable with moving to a suburban parish. For Whites, having one's pre-Katrina residence rendered uninhabitable increased the odds of moving to a suburban New Orleans parish by a factor of 20; for Blacks it had no discernable impact on such moves.

We conducted a counterfactual analysis to quantify further this impact of racial stratification in post-Katrina mobility for working-age adults, applying White working-age adults' mobility coefficients to the Black working-age adults' distributions of socio-demographic characteristics and housing damage. Our conclusion from this analysis was that, if Whites with equivalent socio-demographics had experienced the same housing damage as Blacks, they would have decamped *en masse* to suburban New Orleans. Put another way, whereas only 4% of working-age Blacks actually moved to a suburban New Orleans parish, we estimated that about 30% would have done so had they experienced the mobility rates as working-age Whites with equivalent socio-demographic characteristics and levels of housing damage. The confining of residential mobility by Black New Orleanians to be very largely within Orleans Parish continued to apply after Katrina. We also found that working-age Blacks were more likely than working-age Whites to move back to their pre-Katrina residence, after controlling for damage and socio-demographic characteristics. From research into racial disparities in housing recovery following previous hurricanes in the U.S. (Girard and Peacock 1997; Mitchell et al 2012), and given evidence reviewed above of their poorer housing recovery, we may speculate that many accomplished this by moving back into incompletely-repaired housing and neighborhoods. The main alternative for many Blacks after Katrina appears to have been to remain displaced long-term from the metropolitan area.

To explain these stark racial disparities in both displacement and its mitigation by

residential mobility, processes producing and maintaining segregation in New Orleans, one of the United States' most racially-segregated cities and metropolitan areas before Hurricane Katrina, rise to the forefront. Local authorities in the contiguous suburban parishes of Jefferson and St. Bernard, with support from predominantly White constituents, were quick to enact zoning restrictions on the building or rebuilding of multi-family residential housing complexes, and to impose restrictions on renting to Black former residents of Orleans Parish (Seichsnaydre 2010). Black homeowners, who were already proportionately fewer than White homeowners, faced slower restoration of public services to their neighborhoods (Green et al 2007) and a 'Road Home Program' that determined repair-cost caps based on the lower house values in predominantly Black neighborhoods (Green and Olshansky 2012). For Black renters of public-housing units, HUD contributed to the process of long-term displacement first by locking out public housing residents, almost all of whom were Black, and then by demolishing the main public housing complexes in Orleans Parish, notwithstanding their moderate and repairable level of damage from the storm and subsequent flooding (Graham 2012). Hurricane Katrina was seen not only as a threat to the existing racial-residential order but also as an opportunity to "clean up" the city by moving low-income Black residents out and making their return difficult. This sentiment to change the socio-demographic composition of New Orleans to exclude low-income Black residents of the City was expressed by multiple key individuals charged with the recovery effort from the earliest days after Hurricane Katrina hit the City (Brown-Dianis and Sinha 2008).

Broader questions concerning the historical sources of entrenched racial disparities in the United States are also spotlighted by the catastrophic event of Hurricane Katrina. Previous work has implicated racial residential segregation in decreasing the prospects for upward economic mobility of the Black population in the post-civil rights era (Massey 1990). Our study takes this

documentation of the processes of ongoing racial exclusion from neighborhoods with greater opportunities for upward economic mobility (e.g., Massey et al 1994) to a level of greatly-accelerated exclusion processes occasioned by the disaster context. The post-Katrina New Orleans experience demonstrated that, even under the enormous pressure for desegregating a major U.S. metropolitan area occasioned by the large-scale displacement of a mostly low-income Black population from central-city New Orleans neighborhoods, the processes of racial exclusion largely held strong. That is, the weight of residential segregation from the pre-civil rights era, and of more recent segregation processes implemented in the post-civil rights era of 'White flight,' was by no means shaken off in the post-Katrina processes of evacuation, short-term displacement and, as we have shown in the present study, long-term displacement. We view this as analogous to the wealth transmission that has linked White Americans' economic fortunes today to those of earlier, pre-civil rights generations and thereby buttressed and buffered their current economic well-being relative to that of Blacks (Oliver and Shapiro 1995; Avery and Rendall 2002). Both the legacy of racial residential segregation and the legacy of highly unequal racial wealth have proved to be strong barriers to the achievement of racial economic equality in the United States. The experience of Hurricane Katrina illustrates an additional exposure of the Black population to major losses of well-being relative to the White population under conditions of extreme environmental crisis, losses that are strongly linked to processes of both racial residential segregation and racial economic inequality.

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Notes

¹ The period following Hurricane Katrina included atypical macro-economic conditions occasioned by the 2008 “Great Recession” (Grusky, Western, and Wimer 2011). These conditions may have anyway (that is, in the absence of Hurricane Katrina) produced different volumes of migration and patterns of migration selection than in other periods. We conducted separate comparisons using the U.S. Panel Study of Income Dynamics (PSID, Institute for Survey Research, no date, a, b), to compare outmigration from all U.S. metropolitan areas—except those in the Hurricane Katrina (and Hurricane Rita)-affected area—over the four years 1997-2001 (similar to the 1995-2000 Census interval) with outmigration in the four years 2005-2009 (similar to the 2005-2009/10 DNORS interval). Outmigration in 1997-2001 was 8.8% and outmigration in 2005-2009 was 9.7%, a difference that was not statistically significant.

² We adjusted the predicted probabilities of each of the three categories of movement (within city, to suburban New Orleans, out of the metropolitan area) for the shorter, average of 4.25-year, period from 2005 to 2009/10 than from 1995-2000 using an assumption of uniformly distributed moves over the five years before the Census. The assumption of uniformly-distributed moves is made for computational convenience, and implies a rising hazard of moving across the 5 years. If the hazard was instead constant, then our downward adjustment will have been too large.

³ Estimates are given in five-year age groups and for non-Hispanic White only, non-Hispanic Black only, and non-Hispanic “two races” reported (these were small in number in Orleans Parish). We assumed that 18 and 19 year olds constituted two fifths of the 15 to 19 year old group, and that those who reported two races would be allocated to White and Black races in the same proportion as were single-reported races in that age group if only one race were chosen.

⁴ As a sensitivity analysis, we alternately collapsed the bachelor’s degree and post-graduate categories and found little difference in results.

Table 1. Socio-Demographic Characteristics and Five-year Mobility of White and Black Residents of the City of New Orleans in 1990 and 2000, Ages 18 or Older at Start of Mobility Interval

	1990		2000	
	White	Black	White	Black
<i>A. Residential Mobility and In- and Out-migration, 1985-1990 and 1995-2000</i>				
<i>1985 or 1995 City of New Orleans Population by Place of Residence in 1990 or 2000</i>				
Lived In Same House Again	48.4	52.1	47.9	58.3
Changed House in City	16.9	35.9	18.1	28.9
Moved Elsewhere in New Orleans metropolitan area	7.1	2.5	9.5	4.2
Moved Outside New Orleans metropolitan area	27.6	9.4	24.6	8.5
All residents of City of New Orleans aged 18+ in 1985 or 1995	100.0	100.0	100.0	100.0
<i>1990 or 2000 City of New Orleans Population by Place of Residence in 1985 or 1990</i>				
Lived In Same House as in 1990 or 2000	59.4	55.9	55.2	61.6
Changed house within New Orleans City	20.8	38.5	20.9	30.6
Lived Elsewhere in New Orleans metropolitan area	3.7	1.2	5.9	2.3
Lived Outside New Orleans metropolitan area	16.2	4.4	18.0	5.6
All residents of City of New Orleans in 1990 or 2000, age 18+ in 1985 or 1995	100.0	100.0	100.0	100.0
<i>B. Sociodemographic characteristics of the 1990 or 2000 City of New Orleans Population age 18+ in 1985 or 1995</i>				
Born in the State of Louisiana	59.6	84.2	53.9	85.1
<i>Educational Attainment in 1990 or 2000</i>				
Less than high school	15.4	33.9	8.5	25.1
High school degree	25.2	32.3	24.3	40.9
Some college	23.0	22.7	19.8	20.8
Bachelor's degree	21.1	7.2	27.3	8.9
Post-Bachelor's	15.3	3.9	20.2	4.3
Living in Rented Unit in 1990 or 2000	37.8	55.6	36.5	51.1
Living in Poor Household in 1990 or 2000 ^a	10.4	34.3	10.2	27.9
Median age in 1985 or 1995 (among those age 18+ in 1985 or 1995)	42	36	42	39
Male	46.7	42.6	49.1	42.3
Percentage of City Population (denominator includes other race/ethnicities)	42.2	55.2	34.6	60.9
Total Population (age 18+ in 1985 or 1995 and in the household population resident in the City of New Orleans in 1990 or 2000)	134,472	175,836	108,271	190,275

Notes:

^aAt or below 100% poverty threshold

All characteristics are statistically significant at $p < .001$ between Blacks and Whites according to the following tests: chi-square test for educational attainment, 5-year mobility history, and 1985 or 1995 population by place of residence; t-test for male, born in Louisiana, living in poor household, and living in a rented unit; Wilcoxon test for median age

Source: Authors' calculations from 1990 and 2000 Census PUMS

Table 2(a). Multinomial Logistic Regression Estimates of 1995-2000 Mobility, Whites and Blacks Ages 18 or Older in 1995

	Moved in City				Moved in Metro Area				Moved Out of Metro Area			
	Coeff.	S.E.	OR	Sig.	Coeff.	S.E.	OR	Sig.	Coeff.	S.E.	OR	Sig.
White												
Intercept	-0.381	0.121		**	-0.913	0.152		***	0.634	0.110		***
Demographics												
Born in Louisiana	-0.056	0.079	0.95		0.502	0.108	1.65	***	-1.065	0.076	0.34	***
Male	0.037	0.078	1.04		0.036	0.099	1.04		0.022	0.074	1.02	
Age in 1995 (ref: age 25-35)												
18-24	0.334	0.142	1.40	*	0.689	0.167	1.99	***	0.986	0.129	2.68	***
36-45	-1.041	0.112	0.35	***	-0.944	0.148	0.39	***	-1.080	0.106	0.34	***
46-59	-1.549	0.118	0.21	***	-1.252	0.149	0.29	***	-1.603	0.111	0.20	***
60+	-1.548	0.117	0.21	***	-1.593	0.150	0.20	***	-2.097	0.125	0.12	***
Education (ref: ≤ High School)												
Some College	0.376	0.114	1.46	***	-0.150	0.130	0.86		-0.033	0.108	0.97	
College Graduate	0.465	0.106	1.59	***	-0.499	0.133	0.61	***	0.018	0.100	1.02	
Graduate/Professional	0.523	0.112	1.69	***	-0.708	0.158	0.49	***	0.130	0.104	1.14	
n	5,655											
Black												
Intercept	-0.245	0.091		**	-1.543	0.170		***	-0.782	0.123		***
Demographics												
Born in Louisiana	-0.010	0.078	0.99		-0.782	0.142	0.46	***	-1.495	0.095	0.22	***
Male	-0.055	0.052	0.95		0.119	0.113	1.13		0.606	0.085	1.83	***
Age in 1995 (ref: age 25-35)												
18-24	0.427	0.077	1.53	***	0.577	0.144	1.78	***	0.672	0.111	1.96	***
36-45	-0.546	0.070	0.58	***	-0.706	0.153	0.49	***	-0.795	0.118	0.45	***
46-59	-0.927	0.077	0.40	***	-1.426	0.192	0.24	***	-1.532	0.146	0.22	***
60+	-1.146	0.092	0.32	***	-2.099	0.293	0.12	***	-1.618	0.179	0.20	***
Education (ref: ≤ High School)												
Some College	-0.036	0.065	0.96		-0.023	0.140	0.98		0.283	0.105	1.33	**
College Graduate	-0.305	0.094	0.74	**	-0.047	0.189	0.95		0.747	0.121	2.11	***
Graduate/Professional	-0.057	0.132	0.94		0.524	0.243	1.69	*	0.697	0.190	2.01	***
n	8,473											

Notes:

Regressions are weighted; Reference outcome category is living again in same residence as in 1995

S.E. = standard error; OR = odds ratio; Sig. = statistical significance of difference from reference predictor category,

* p < .05, ** p < .01, *** p < .001

Source: Authors' calculations from 2000 Census microdata

Table 2(b). Multinomial Logistic Regression Estimates of 2005-2009 Mobility, Whites and Blacks Ages 18 or Older in 2005

	Moved in City				Moved in Metro Area				Moved Out of Metro Area			
	Coeff.	S.E.	OR	Sig.	Coeff.	S.E.	OR	Sig.	Coeff.	S.E.	OR	Sig.
White												
Intercept	-0.714	0.567			-1.786	0.563		**	0.004	0.566		
Demographics												
Born in Louisiana^	0.031	0.291	1.03		1.416	0.403	4.12	***	-0.336	0.282	0.71	
Male	0.375	0.284	1.45		0.196	0.284	1.22		0.067	0.236	1.07	
Age in 2005^ (ref: age 25-35)												
18-24	0.993	0.611	2.70		0.354	0.832	1.42		0.498	0.648	1.64	
36-45	-0.836	0.483	0.43	+	-0.668	0.712	0.51		-1.001	0.494	0.37	*
46-59	-1.103	0.415	0.33	**	-0.482	0.616	0.62		-1.174	0.419	0.31	**
60+	-1.384	0.473	0.25	**	-0.609	0.627	0.54		-2.095	0.457	0.12	***
Education (ref: ≤ High School)												
Some College	0.356	0.519	1.43		-0.486	0.445	0.61		0.203	0.477	1.22	
College Graduate	-0.158	0.469	0.85		-0.398	0.443	0.67		0.185	0.440	1.20	
Graduate/Professional	-0.562	0.503	0.57		-1.308	0.487	0.27	**	-0.532	0.435	0.59	
n	780											
Black												
Intercept	-0.531	0.422			-1.648	0.561		**	0.273	0.321		
Demographics												
Born in Louisiana^	0.545	0.307	1.72	+	-0.142	0.467	0.87		-0.217	0.217	0.81	
Male^	-0.027	0.164	0.97		0.095	0.296	1.10		-0.034	0.152	0.97	
Age in 2005^ (ref: age 25-35)												
18-24	0.445	0.324	1.56		0.801	0.515	2.23		0.365	0.291	1.44	
36-45	-0.716	0.328	0.49	*	-1.076	0.555	0.34	+	-0.764	0.284	0.47	**
46-59	-0.831	0.278	0.44	**	-1.067	0.482	0.34	*	-1.004	0.254	0.37	***
60+	-1.409	0.338	0.24	***	-1.558	0.624	0.21	*	-1.361	0.269	0.26	***
Education (ref: ≤ High School)												
Some College	-0.083	0.223	0.92		0.189	0.320	1.21		0.445	0.195	1.56	*
College Graduate	0.156	0.316	1.17		0.325	0.487	1.38		0.285	0.251	1.33	
Graduate/Professional	-0.209	0.340	0.81		0.503	0.715	1.65		0.427	0.302	1.53	
n	1,644											

Notes:

Regressions are weighted, standard errors are adjusted with clustering by household; Reference outcome category is living in same residence as in 2005

S.E. = standard error; OR = odds ratio; Sig. = statistical significance of difference from reference predictor category,

† p < .10, * p < .05, ** p < .01, *** p < .001

^ Pattern of mobility differences by this variable is changed from 1995-2000 pattern (from AIC model fit statistic comparisons)

Source: Authors' calculations from Displaced New Orleans Residents Survey

Table 3. Observed 2005-2009 Mobility after Hurricane Katrina Compared to Mobility Predicted from Census 1995-2000 Mobility Patterns, White and Black residents of city of New Orleans, Age 18+ at Start of Mobility Interval (Confidence Intervals in parentheses)

	Observed Census 1985-1990	Observed Census 1995-2000	Predicted 2005-10 from Census 1995-2000 ^a	Predicted Mobility Adjusted to 2005-2009 ^b	Observed Mobility 2005-2009 ^c
White					
Mobility Outcome:					
Lived in Same House	48.4	47.9	51.9 (50.5, 53.3)	59.1 (57.9, 60.3)	56.1 (50.6, 61.6)
Changed House within New Orleans City	16.9	18.1	18.1 (16.9, 19.3)	15.4 (14.4, 16.4)	14.6 (10.8, 18.5)
Lived Elsewhere in New Orleans Metro Area	7.1	9.5	8.1 (7.2, 8.8)	6.8 (6.1, 7.5)	10.4 (6.8, 13.9)
Lived Outside New Orleans Metro Area	27.6	24.6	22.0 (20.9, 23.1)	18.7 (17.7, 19.6)	18.9 (14.6, 23.2)
Total	100.0	100.0	100.0	100.0	100.0
Black					
Mobility Outcome:					
Lived in Same House	52.1	58.3	62.6 (61.5, 63.8)	68.2 (67.3, 69.2)	44.5 (40.8, 48.2)
Changed House within New Orleans City	35.9	28.9	26.7 (25.6, 27.7)	22.7 (21.8, 23.5)	22.2 (19.1, 25.3)
Lived Elsewhere in New Orleans Metro Area	2.5	4.2	3.5 (3.1, 4)	3.0 (2.6, 3.4)	4.5 (3, 6)
Lived Outside New Orleans Metro Area	9.4	8.5	7.2 (6.6, 7.8)	6.1 (5.6, 6.6)	28.8 (25.3, 32.2)
Total	100.0	100.0	100.0	100.0	100.0

Notes:

^a Calculated by applying regression parameters from the Census (see Table 2(a)) to the Displaced New Orleans Residents Survey socio-demographic distributions in 2005 (see text for details)

^b Assumes a uniform distribution of moves over the 2005-2010 interval (see text for details)

^c Estimated from the Displaced New Orleans Residents Survey

Table 4. Predictor Variables for Non-Hispanic White and Black City of New Orleans Residents, Ages 25 to 60 in 2005, Percentages of Racial Groups Unless Otherwise Stated

	White	Black	p-value & sig. ^a
Age 29-39	28.1	24.6	0.552
Age 40-49	27.2	27.2	
Age 50-64	44.6	48.2	
Male	52.4	42.1	0.002 ***
Born in Louisiana	48.8	87.9	<.001 ***
High School or Less	15.8	52.3	<.001 ***
Some College	16.9	27.4	
Bachelor's Degree	35.0	13.4	
Graduate or Professional	32.3	7.0	
Employed	82.2	73.4	0.003 **
Residence Rendered Uninhabitable by Katrina	42.2	77.9	<.001 ***
Rented Home	35.7	51.6	<.001 ***
Relationship to Household Respondent:			
Self	68.4	62.5	<.001 ***
Spouse or Partner	22.1	17.1	
Child or Other	9.5	20.4	
Median Equivalized Household Income ^b	53,000	16,971	<.001 ***
n	505	1,071	

Notes:

a. Chi-Square tests of differences in proportions, Wilcoxon test of difference in medians, by race, * p < .05, ** p < .01, *** p < .001

b. Total household income divided by the square root of the number of household members.

Source: Displaced New Orleans Residents Survey

Table 5. Multinomial Logit Regression Odds Ratios for Residential Mobility and Outmigration from New Orleans, versus the Reference Outcome of Living again in the Same House as before Hurricane Katrina, White and Black Adults, Age 25 to 60 in 2005 (p-values in Parentheses)

	White			Black		
	Different House, City of New Orleans	Other New Orleans Metro Area Parish	Outside of New Orleans	Different House, City of New Orleans	Other New Orleans Metro Area Parish	Outside of New Orleans
Condition of Residence (ref: habitable)						
Uninhabitable	3.32 ** (0.007)	20.13 *** (<.001)	3.49 ** (0.002)	4.35 *** (<.001)	1.42 (0.510)	3.79 *** (<.001)
Residence Owned or Rented (ref: owned)						
Rented	2.80 † (0.077)	1.84 (0.350)	3.55 ** (0.009)	9.82 *** (<.001)	5.61 *** (0.001)	8.34 *** (<.001)
State of Birth (ref: born in other state)						
Born in Louisiana	1.39 (0.391)	2.94 * (0.022)	0.74 (0.317)	1.65 (0.241)	0.76 (0.577)	0.98 (0.943)
Relation to Household Respondent (ref: self)						
Spouse or Parther	0.94 (0.827)	0.73 (0.266)	1.08 (0.715)	0.88 (0.652)	0.66 (0.381)	1.30 (0.236)
Child or Other	4.63 ** (0.002)	1.36 (0.599)	2.50 † (0.051)	5.59 *** (<.001)	2.40 (0.123)	3.27 *** (<.001)
Gender (ref: non-female)						
Male	0.94 (0.830)	0.97 (0.911)	0.79 (0.306)	0.95 (0.836)	1.18 (0.680)	0.88 (0.510)
Age (ref: age 29-39)						
Age 40-49	0.28 * (0.020)	0.64 (0.502)	0.28 ** (0.009)	0.74 (0.410)	0.44 (0.174)	0.67 (0.203)
Age 50-64	0.42 † (0.073)	0.86 (0.778)	0.39 * (0.029)	0.72 (0.305)	0.46 (0.135)	0.61 † (0.083)

Labor Force Status in 2005 (ref: employed)						
Unemployed or Not in LF	0.60 (0.315)	0.38 (0.244)	1.03 (0.942)	0.65 (0.117)	0.54 (0.249)	0.89 (0.644)
Education in 2009 (ref: ≤ high school graduate)						
Some College	2.89 (0.159)	0.98 (0.979)	0.58 (0.291)	1.24 (0.477)	1.04 (0.929)	2.40 *** (0.001)
Bachelor's Degree	3.58 † (0.055)	1.01 (0.994)	1.05 (0.920)	1.72 (0.160)	1.11 (0.889)	1.77 † (0.088)
Graduate or Professional	3.30 † (0.098)	1.27 (0.730)	0.88 (0.823)	1.49 (0.360)	2.52 (0.205)	2.96 ** (0.005)
Log of Equivalized Household Income‡	0.55 † (0.086)	0.40 * (0.024)	0.62 (0.141)	1.14 (0.263)	1.37 (0.211)	1.04 (0.736)
sample n	503			1,075		

Notes:

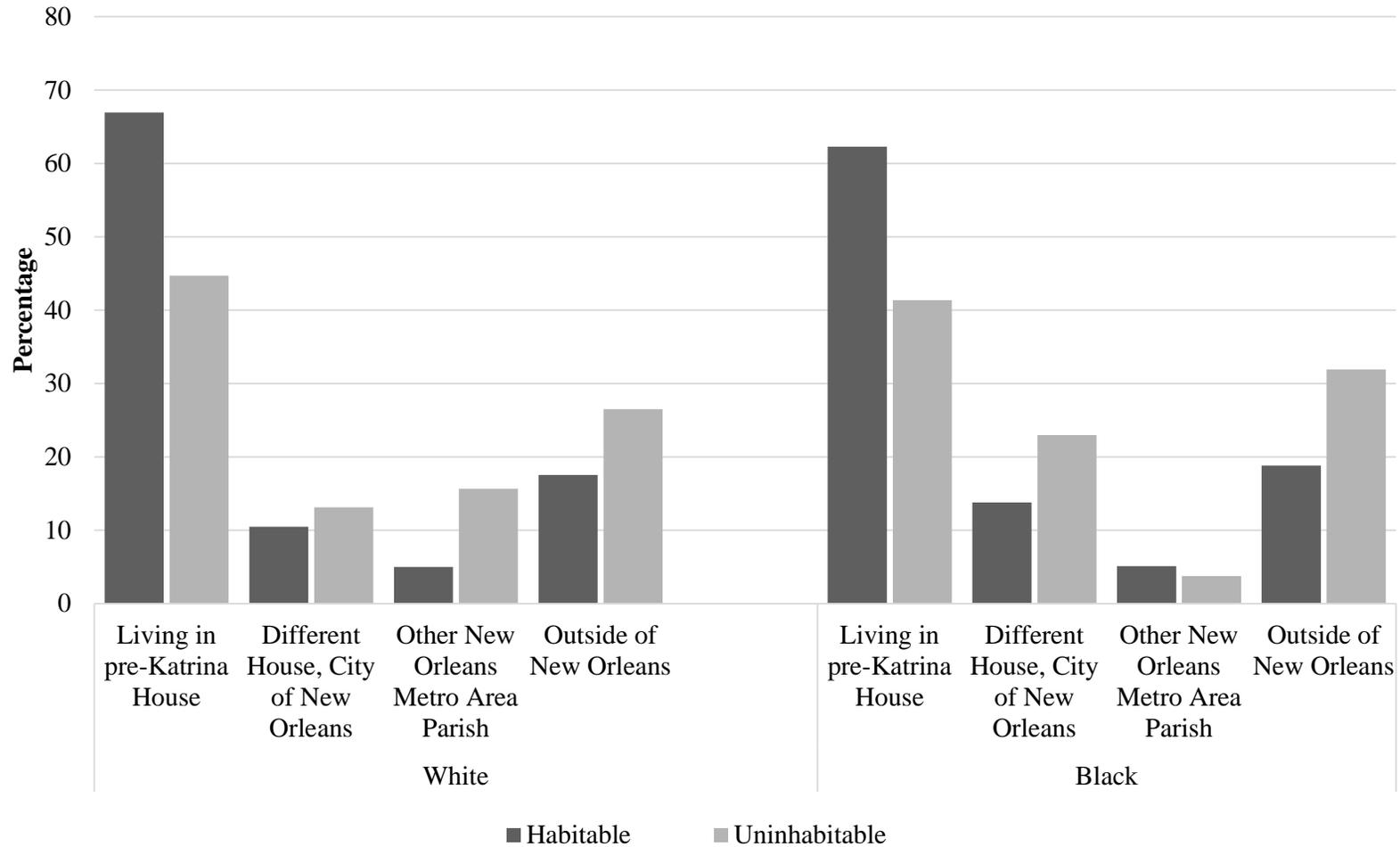
† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Regressions are weighted; standard errors are adjusted for clustering by household.

‡ Total household income divided by the square root of the number of household members.

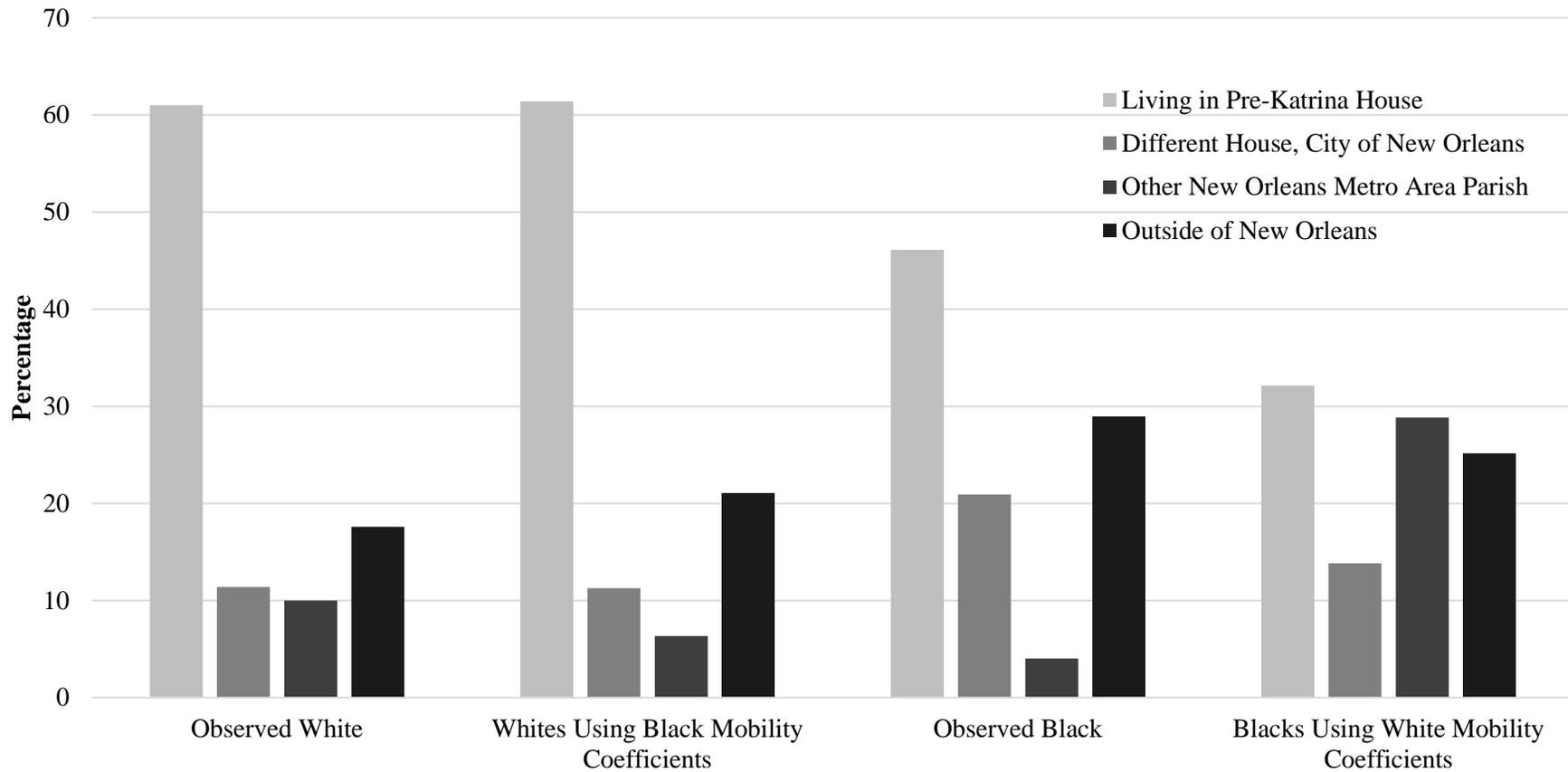
Source: Authors' calculations from the Displaced New Orleans Residents Survey

Figure 1. Location in 2009 by Hurricane Katrina Housing Damage, White and Black Residents of City of New Orleans, Ages 18 and Older in 2005



Note: Distribution of location in 2009 is statistically-significantly different ($p < .05$, chi-square test) between residents of habitable and uninhabitable residences for both Whites and Blacks. Source: Displaced New Orleans Residents Survey

Figure 2. Location Four Years After Hurricane Katrina, White and Black Residents of City of New Orleans, Ages 25 to 60 in 2005, Observed versus Predicted Counterfactually from Other Race's Mobility Behavior^a



^aApplies other race's coefficients to this race's pre-Katrina housing damage and socio-demographic characteristics
 Source: Displaced New Orleans Residents Survey

Appendix Table A1. Characteristics of the 1995 and 2005 City of New Orleans White and Black Population, Age 18+ (Weighted Percentages)

	1995 ^b			2005 ^c		
	White	Black	p-value ^d	White	Black	p-value ^d
Age ^a			<.001 ***			0.130
18-24	13.5	16.7		8.8	14.3	
25-35	24.1	26.2		18.8	16.3	
36-45	19.4	23.9		18.1	18.3	
46-55	20.0	19.9		29.6	32.1	
56+	23.0	13.3		24.7	19.0	
Sex			<.001 ***			<.001 ***
Female	50.3	57.5		48.9	58.8	
Male	49.7	42.5		51.1	41.2	
Education			<.001 ***			<.001 ***
Less than High School	9.5	24.1		2.7	23.9	
High School Graduate	24.9	41.4		16.7	32.1	
Some College	19.5	20.4		19.1	26.3	
College Graduate	25.6	9.8		32.5	11.4	
Postgraduate Degree	20.6	4.4		28.9	6.3	
State of Birth			<.001 ***			<.001 ***
Not Louisiana	46.2	15.2		47.2	12.9	
Louisiana	53.8	84.8		52.8	87.1	
N	5,655	8,473		816	1,652	

Notes:

^a Age in 1995 or 2005

^b 2000 Census microdata

^c Displaced New Orleans Residents Survey

^d Chi-Square tests for Age and Education, t-tests for Sex and State of Birth, * p < .05, ** p < .01, *** p < .001

Appendix Table A2a. Regression Parameters and Standard Errors from 1995-2000 Model to Predict Mobility of White Adults in 2005-2010

	Moved in City		Moved in Metro		Moved out of Metro	
	Coeff.	sig. S.E.	Coeff.	sig. S.E.	Coeff.	sig. S.E.
<i>Intercept</i>	-0.438	** 0.148	-1.157	*** 0.182	0.631	*** 0.130
<i>Demographics</i>						
Born in Louisiana	-0.115	0.091	0.472	*** 0.124	-1.273	*** 0.087
Male	0.080	0.090	0.055	0.113	0.064	0.084
<i>Age (ref: 30-40)</i>						
22-28	0.372	* 0.147	0.658	*** 0.174	1.065	*** 0.135
41-50	-1.074	*** 0.115	-0.936	*** 0.152	-1.062	*** 0.110
51-65	-1.603	*** 0.122	-1.201	*** 0.151	-1.586	*** 0.115
<i>Education</i>						
Less than High School Graduate	0.213	0.235	0.559	* 0.222	0.394	* 0.199
Some College	0.550	*** 0.144	0.177	0.160	0.093	0.131
College Graduate	0.539	*** 0.135	-0.182	0.159	0.072	0.122
Graduate/Professional	0.592	*** 0.142	-0.455	* 0.186	0.196	0.126
<i>n</i>	4,110					

Source: 2000 Census microdata, Whites ages 18+ in 1995

* p < .05, ** p < .01, *** p < .001

Appendix Table A2b. Regression Parameters and Standard Errors from 1995-2000 Model to Predict Mobility of Black Adults in 2005-2010

	Moved in City		Moved in Metro		Moved out of Metro	
	Coeff.	sig. S.E.	Coeff.	sig. S.E.	Coeff.	sig. S.E.
<i>Intercept</i>	-0.251	* 0.100	-1.483	*** 0.180	-0.753	*** 0.133
<i>Demographics</i>						
Born in Louisiana	-0.012	0.086	-0.785	*** 0.149	-1.560	*** 0.101
Male	-0.035	0.055	0.133	0.116	0.638	*** 0.089
<i>Age (ref: 30-40)</i>						
22-28	0.428	*** 0.077	0.590	*** 0.145	0.685	*** 0.112
41-50	-0.550	*** 0.070	-0.681	*** 0.153	-0.814	*** 0.119
51-65	-0.926	*** 0.078	-1.367	*** 0.194	-1.561	*** 0.149
<i>Education</i>						
Less than High School Graduate	-0.041	0.074	-0.391	* 0.178	-0.023	0.134
Some College	-0.017	0.070	-0.083	0.147	0.300	** 0.114
College Graduate	-0.295	** 0.099	-0.103	0.195	0.769	*** 0.130
Graduate/Professional	-0.020	0.140	0.507	* 0.249	0.768	*** 0.202
<i>n</i>	7,219					

Source: 2000 Census microdata, Blacks ages 18+ in 1995

* p < .05, ** p < .01, *** p < .001