Spatial Dislocation and Return Migration Among New Orleans Residents After Hurricane Katrina†

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Abstract

In this paper, we used new data from the restricted version of the U.S. Census Bureau's American Community Survey (ACS) to examine the location of pre-Katrina residents of New Orleans in the year after the hurricane. The aim is to describe the displacement and return or resettlement of this population and to analyze the factors that shaped these individuals' location choices. The ACS data provide a unique opportunity to examine the geographic dispersion of New Orleans residents throughout the U.S. in the aftermath of Hurricane Katrina. We found major disparities in return migration, with blacks much less likely to return than whites. Flood damage appeared to be a key factor in shaping the likelihood of return and in accounting for the observed disparities by race.

INTRODUCTION

Hurricane Katrina struck New Orleans, Louisiana, on the morning of August 29, 2005. Virtually the entire population of the city was displaced and forced to resettle, which some did temporarily and others permanently. It is now several years after this event, but little is known about where displaced residents settled and who returned to New Orleans and who did not.

In this paper, we used new data from the restricted version of the U.S. Census Bureau's American Community Survey (ACS) to examine the location of pre-Katrina residents of New Orleans in the year after the hurricane. The aim is to describe the displacement and return or resettlement of this population and to analyze the factors that shaped these individuals' location choices. The ACS data provide a unique opportunity to examine the geographic dispersion of New Orleans residents throughout the U.S. in the aftermath of Hurricane Katrina.

This paper provides an important case study of the patterns of environmentally-induced migration and differences in migration patterns by demographic and socioeconomic factors. It addresses a number of unanswered research and policy questions about the effects of Hurricane Katrina on the New Orleans population, such as: Where did displaced New Orleans residents reside in the year following the hurricane? What factors influenced where people lived, and how did the location of displaced residents vary by demographic and socioeconomic characteristics? And what factors were associated with returning to New Orleans rather than resettling elsewhere?

CONCEPTUAL ISSUES, BACKGROUND, AND PREVIOUS RESEARCH

There are two types of migration following a natural disaster: forced migration (evacuation), which may be mandated and is typically temporary, and voluntary migration due to an increase in "push factors" (Hunter 2005). In contrast to the generally positive selection of internal migrants (Greenwood 1993), permanent migrants in response to previous natural disasters in the U.S. are typically negatively selected—especially those who move longer distances. In contrast to other moves, movers following a natural disaster are older, and disproportionately race/ethnic minorities, socioeconomically disadvantaged, and live in female-headed households (Morrow-Jones and Morrow-Jones 1991).

Although a natural disaster may force people to move, migrants are often still able to choose their destination—if not initially, then usually at a subsequent move. News accounts have suggested, for example, that Katrina evacuees in Atlanta may differ from evacuees in

Houston, since the former contains more evacuees who chose Atlanta as a destination, rather than being sent there by authorities (Ellison 2006). People's cost-benefit decisions about migration and their destination choices (Sjaastad 1962; Lee 1966) are likely to be influenced by characteristics such as age, sex, marital status, number of children, employment, occupation, and previous migration experience (Greenwood 1985; Long 1992), as well as by social networks (Stark and Bloom 1985) and by contextual factors.

A final theoretical perspective that informs our study is one that has arisen from previous studies of the effects of natural disasters on health and well-being. Research on this topic has conceptualized the effects of natural disasters as being shaped to an enormous extent by social and economic characteristics (e.g., Erikson 1976; Klinenberg 2002; Sen 1981). Furthermore, the effects of natural disasters are closely tied to underlying patterns of social and economic stratification, disadvantage, and vulnerability. The poor and race/ethnic minorities tend to suffer the worst outcomes as a result of natural disasters due to predisposing factors, their actual experiences during and in the aftermath of the disasters, and limited capacity to recover. Previous studies of Hurricane Katrina's effects have indeed found that the poor, the elderly, and blacks suffered the worst outcomes (e.g., Sharkey 2007; Elliott and Pais 2006). This perspective points to the importance of examining the disparities in post-Katrina migration and resettlement by socioeconomic status and race.

New Orleans

The size, composition, and characteristics of the New Orleans population at the time of Hurricane Katrina shaped the effects of the hurricane on the city's population. At the beginning of the current decade, New Orleans was the 31st largest city in the country (U.S. Census Bureau 2000). The population of the City of New Orleans in 2005 was 454,863, accounting for about one-third of the total population of 1,338,000 in the metropolitan area (U.S. Census Bureau 2005). According to the 2004 American Community Survey, the majority (69%) of New Orleans residents were black. Whites accounted for 28% of the city's population and Asians 2%.

Prior to Hurricane Katrina, New Orleans experienced high rates of poverty, which, as elsewhere, were associated with crime, shortfalls in the provision of basic services such as health care and education, illiteracy, substandard housing, and lack of opportunity. High rates of poverty and disadvantage among the pre-Katrina population of New Orleans were likely to have affected the displacement experience and the likelihood of return. For example, the choice of

where to migrate may have been constrained in possibly unexpected ways among poor families. Although we would expect poorer New Orleanians to have stayed closer to the city to minimize travel costs and because they lacked cars, limited evidence (e.g., Tizon and Smith 2005) suggests that many may instead have been forced to move further away from the city. Poor families may also have faced challenges in reestablishing connections with displaced friends and neighbors because they could not afford the cost of return visits to the city. Another issue is that concentrated poverty neighborhoods in New Orleans are unattractive places to which to return, particularly for many poor people who experienced better neighborhood environments, job opportunities, schools, and amenities in their new locations. A final issue is that low rates of homeownership place a significant barrier for residents to return to the city because of the difficulty of finding rental housing in New Orleans. Of course, homeowners who are poor themselves face considerable challenges in either renovating or selling their houses in New Orleans.

Research on Demographic Effects of Hurricane Katrina

Existing studies of the demographic effects of Hurricane Katrina fall into two categories: first, early and generally small-scale studies of evacuees and, second, larger-scale studies, including on-going national studies. Aggregate data on the current location of people displaced by Katrina have also been made available by FEMA and the U.S. Postal Service, but neither of these agencies will release individual-level data to researchers.

Little is known about the current location of displaced New Orleans residents (National Academy of Sciences 2007; Briggs 2006). In the initial period following Hurricane Katrina, there were several useful sources of data about where displaced residents from New Orleans were living. In particular, information on the current location of evacuees was available from change-of-address forms filed with the U.S. Postal Service and from registrations with the Federal Emergency Management Administration (FEMA) for aid. Analyses of these data showed that nearly 15% of evacuees from New Orleans relocated to distant cities in the East Coast, Midwest, and West Coast (Tizon and Smith 2005). However, the main destinations for displaced residents were suburban New Orleans, Houston, Dallas, Atlanta, and Baton Rouge. Unfortunately, the usefulness of these data sources waned when the change-of-address forms expired and FEMA aid came to an end.

Large scale studies for studying the effects of Hurricane Katrina include regional and

nationally-representative surveys. Among the studies that focus specifically on the effects of Hurricane Katrina are the Hurricane Katrina Community Advisory Group, the Mississippi Community Study, the Louisiana Health and Population Survey, and the Kaiser Post-Katrina Baseline Survey. National studies include the American Community Survey and the Current Population Survey.

The American Community Survey (ACS) and the Current Population Survey (CPS) provide data on the entire region affected by Katrina as well as the rest of the U.S. Both of these surveys are fielded by the U.S. Census Bureau. Sample sizes in the CPS are too small to support analyses for New Orleans alone, but sample sizes in the ACS are sufficiently large to identify and analyze displaced New Orleanians as well as the current population of the city. The ACS will provide only a brief window into the whereabouts of displaced New Orleans residents: it is a cross-sectional study and asks just a single migration question about place of residence one year previously. Nevertheless, it is difficult to overstate the importance of the ACSs for understanding the effects of Hurricane Katrina on the pre-storm population of New Orleans.

Previous studies that have examined return migration among displaced New Orleans residents includes Sastry (forthcoming), Fussell, Sastry, and VanLandingham (forthcoming), and Groen and Polivka, (forthcoming).

DATA

Our analysis of dislocation and return among the New Orleans population displaced by Hurricane Katrina in the year following the storm used restricted data from the ACS.

The American Community Survey

The ACS is the U.S. Census Bureau's replacement for the long-form in the decennial census (U.S. Census Bureau, 2006). As explained below, the design of the ACS allows us to identify a representative sample of people interviewed in the year following Katrina who resided in New Orleans before Hurricane Katrina, regardless of where in the U.S. they were.

The ACS uses a series of monthly national samples that are fielded on a continuous basis. Full implementation of the ACS for housing units began in 2005. Between 2000 and 2004 there was a large-scale, nationwide demonstration phase, which covered 1,240 counties (out of 3,141 total counties in the U.S.) including Orleans Parish (i.e., the City of New Orleans). The annual sample includes about three million households, which is a 2.3% sample of households in the U.S.

The ACS is primarily a mail survey, although there is a telephone follow-up for non-respondents to the mailed questionnaire and an in-person follow-up for non-respondents to the telephone interview. The ACS includes 25 housing and 42 population questions, covering topics such as basic demographic characteristics, schooling, employment, disability, commuting, and dwelling characteristics. An identical set of questions has been included in each year of the ACS from 2003 to 2006. The ACS questionnaire is generally completed by one household respondent, who is a member of the household at least 18 years of age.

Residence rules for the ACS, which determine who is considered a resident at a sampled address, are based on a modified *de facto* rule. Everyone who is currently living or staying at a sampled address is considered a resident, except for people staying there only for a short period of time (defined as two months or less). The two-month rule might have led to displaced New Orleans residents being missed by the ACS if standard guidelines were applied. However, in the aftermath of Hurricane Katrina, the Census Bureau clarified the residence rules so that it was very likely that temporary displaced residents would be included in the ACS. The Census Bureau provided this guidance in mailings to respondents, which were revised to include the statement that "if there are any people staying at this address who have evacuated their homes due to Hurricane Katrina, please include them on the questionnaire."[1] Similar guidance was used for questionnaires completed through an interviewer over the telephone or in person.[2]

The ACS was expanded to include group quarters in 2006.[3] Sampling of group quarters for the 2006 ACS was completed prior to Hurricane Katrina, and hence would not include any new group quarters that were set up to house displaced persons from Katrina. Our analysis excludes individuals from ACS 2006 group quarters sample because we do not have comparable information on individuals living in group quarters for the pre-Katrina period.

The ACS achieves very high response rates because of its status as a government survey in which households are required to participate, the use of multiple modes (mail, telephone, and

[1] This statement was included in the ACS prenotification letter, Census Bureau Form ACS-12(L), addressed to households selected for the ACS beginning with the mailing package for the October 2005 monthly sample. It was also repeated in introductory letter, Form ACS-13(L), that accompanied the mailout questionnaire and in a follow-up letter, Form ACS-14(L), sent to residents who had not yet returned their questionnaire after several weeks.

[2] Documented in an ACS Unnumbered Field Representative Memorandum of October 5, 2005.

[3] Group quarters in the ACS include college residence halls, residential treatment centers, skilled nursing facilities, group homes, military barracks, correctional facilities, worker's dormitories, and homeless shelters but exclude domestic violence shelters, natural disaster shelters, and outdoor locations/encampments (U.S. Census Bureau, 2006).

in-person), and the Census bureau's extensive experience and expertise in data collection. For example, among addresses eligible for the January through June 2005 samples of the ACS, interviews were completed in 98% of cases (U.S. Census Bureau, 2006). Furthermore, data quality and completeness is very high in the ACS—equaling or outperforming the Census long form sample and the Current Population Survey on a variety of relevant measures (National Research Council, 2007). Population coverage by the ACS is also very high.

This analysis is based on ACS Restricted Data for 2004, 2005, and 2006,[4] and would not be possible using the public use ACS data. The ACS Restricted Data include the interview date (omitted from public use ACS data), which allows us to distinguish between pre- and post-Katrina migrants from New Orleans among people who reported living in the city one year ago. The restricted data also include substantially greater geographic precision about the current place of residence, which is provided at the level of the Census block. As explained below, this detailed geographic information allowed us to examine the effects of the pre-Katrina residence characteristics on return migration to New Orleans. The ACS Restricted Data also remove confidentiality edits, include detailed information on other measures that may be collapsed or altered in the public use data to protect respondent confidentiality, and identify the household member who completed the questionnaire. Finally, the ACS Restricted Data provide a substantially larger sample size than the ACS PUMS, with almost two-and-a-half times as many cases.

Our analysis of post-Katrina migration was based on information in the ACS about where each person currently residing in a sampled dwelling lived one year ago. Figure 1 shows this part of the ACS questionnaire where, in Question 14, the respondent is asked "Did this person live in this house or apartment 1 year ago?" Response categories include the following: (a) person is under 1 year old; (b) yes, this house, (c) no, outside the United States, or (d) no, different house in the United States. If the last response was provided, two follow-up questions were asked: First, the respondent was asked, "Where did this person live 1 year ago?" with the

[4] We obtained access to the ACS restricted data through the Census Research Data Center at the University of Michigan. Restricted data from the ACS (and other databases produced by the Census Bureau), are available to researchers through a network of Research Data Centers established by the Center for Economic Studies of the U.S. Census Bureau. Access to these restricted data requires approval of the project by the Census Bureau and each researcher to obtain Special Sworn Status from the Census Bureau. All data analysis is conducted within the Research Data Center, which is a secure facility with limited physical access and an isolated computing network. A detailed disclosure review is performed by the Census Bureau before any results are removed from the Research Data Center.

requested response being the name of city, town, or post office. Second, the respondent was asked "Did this person live inside the limits of the city or town?" to which they responded either "yes" or "no" and then provided the name of the county, the name of the state, and the ZIP code. Although ZIP code of previous residence was collected in the ACS and is used in processing the data, the item is unfortunately not available in the research data files. The reported county of residence one year ago provides the finest level of geographic detail in the ACS. A strength of the migration question in the ACS is that it is clear and concise, which should lead to accurate reporting. A drawback is that we get just a single snapshot of place of residence one year ago.

Our aim was to use the migration information in the ACS to construct an analytical file comprised of all individuals in the ACS, from throughout the entire United States, who were surveyed in the 12-month period following the hurricane and were reported to have resided in New Orleans one year ago. Note that this file includes both people who have resettled elsewhere and those that report living in the same house (in New Orleans) at the time of the interview and one year earlier. We also identified a matching group of people who were interviewed in New Orleans in the 20-month period preceding Hurricane Katrina—that is, any time in 2004 or before the end of August 2005.

In addition to data from the ACS, our analysis incorporates measurements of flood-depth shortly after Hurricane Katrina that were computed and made publicly available by the U.S. Federal Emergency Management Administration (FEMA) and measures of neighborhood characteristics from the 2000 Decennial Census.

Flood depth provides a useful proxy for flood damage (McCarthy et al., 2006). Our measure of flood depth is a continuous variable calculated as the difference between flood depth on 2 September 2009, when the floodwaters crested, and the average ground elevation of the Census block. Note that certain blocks with elevation below the flood crest did not flood because of undulation in the elevation between the flood source and the particular block; these blocks received a value of zero for the flood severity proxy. Using Census block identifiers for the current place of residence, which are included in the restricted ACS data, we merged information on flood depth to the data on individuals in the ACS who were residing in New Orleans.

We linked individual ACS records to tract-level summary data from the 2000 decennial census based on the residential location at the time of the ACS interview. For the analysis

presented in this paper, we used a tract-level measure of the percent of the population receiving public assistance. This variable serves as a proxy for the economic status of the household and of the local neighborhood.

Preliminary Analysis of ACS Data

Our preliminary analysis of the ACS data focused on several issues. First, we investigated the representativeness of the post-Katrina ACS sample who lived in New Orleans one year previously based on discussions with Census Bureau staff and an analysis of the ACS data. Second, we examined characteristics of the sample and the variables in order to determine what types of restrictions to the analysis sample were necessary.

The disruption associated with Hurricane Katrina and its aftermath obviously had a major effect on fieldwork operations for the ACS. Cases selected for the September 2005 monthly sample were mailed out in late August, but were unlikely to have been received by any households in New Orleans because mail service was suspended. During September and October of 2005 there were no further mailings of ACS questionnaires or of pre-notification, introductory, or reminder letters for any ZIP codes in which mail delivery had been suspended due to Katrina. No telephone contacts and very limited in-person contacts were attempted in these areas. By October 2005, however, pre-notification and introductory letters that were sent to all other areas of the country included the special instructions described above to include Katrina evacuees on the questionnaire, and similar instructions were given to fieldwork staff who interviewed ACS respondents by telephone or in person. By November 2005, ACS operations were reported as being "back to normal."[5]

The results and conclusions from our own analysis of the ACS data closely match those based on information provided by Census Bureau staff.[6] In particular, for the months of September and October 2005 the samples of current or one-year-ago residents of New Orleans were extremely small and appeared to be non-representative. However, the ACS data for November 2005 and beyond appear to be essentially complete, with little change in sample sizes or coverage over each subsequent month. Our final analysis sample therefore covered the 20-month period prior to Hurricane Katrina and a ten-month post-Katrina period from the beginning

[5] Information on Census Bureau fieldwork procedures for the ACS following Hurricane Katrina was provided by Deborah Griffin, Special Assistant to the Chief, American Community Survey Office, U.S. Census Bureau.

[6] These findings are not presented in this paper because the Census Bureau has not completed a disclosure review of the results.

of November 2005 to 29 August 2006. The pre-Katrina sample was restricted to individuals who reported New Orleans to be their current place of residence. The post-Katrina sample included individuals from throughout the entire U.S. who reported residing in New Orleans one year previously.

We restricted the analysis sample to include only non-Hispanic blacks and whites. We did so because members of other race and ethnic groups comprise a very small fraction of the pre-New Orleans population (about four percent in total), and because the small group is itself highly heterogeneous. We also restricted attention to those aged 25 years and older as of December 31, 2005. Because most adults have completed their schooling by this age (or have entered the highest education category), this restriction allows us to consider educational attainment as an age- and time-invariant characteristic and use it as a proxy for socioeconomic status. Finally, the very high levels of item completeness in the ACS meant that almost no observations needed to be dropped because of missing information on key variables.

Variables

Our analysis focuses on individual-level information on place of residence for the pre-Katrina population of New Orleans in the year after the hurricane. Because essentially the entire population of New Orleans was displaced from the city by Hurricane Katrina, we can interpret residence anywhere in the City of New Orleans as return migration. For individuals living outside New Orleans, we only know their location at the time of the ACS interview, which we consider to be their current place of residence. Because our analysis sample includes individuals from households whose interviewed were spread over a ten-month period, the current location of pre-Katrina residents of New Orleans actually traces out the process of resettlement or return following the initial displacement.

The specific outcome measures of migration include a set of nested indicators of whether or not the person is currently living: in the same dwelling in New Orleans as they did prior to Hurricane Katrina, anywhere in the City of New Orleans (including their pre-Katrina residence), or anywhere in the New Orleans metropolitan area (including anywhere in the City of New Orleans). A second set of outcome measures classifies individuals' place of residence into four separate categories: the New Orleans metropolitan area, elsewhere in Louisiana, in a neighboring state (i.e., Arkansas, Mississippi, or Texas), or elsewhere in the U.S. The third outcome measure is based on a pair of indicators of whether the person returned to his or her pre-Katrina dwelling

and the duration between the date of Hurricane Katrina and the date of interview. This last measure exploits variation in date of interview to describe the dynamics of return migration.

Independent variables for our analysis included basic demographic characteristics, such as each individual's age, race, and sex; background variables, including place of birth and citizenship; socioeconomic status, measured by educational attainment and percent of the tract population receiving public assistance; and flood depth, which provided an indicator of housing damage and neighborhood destruction.

Summary statistics for the individual-level variables we examined are presented in Table 1. Two-thirds of pre-Katrina New Orleans residents were black and the remaining one-third were white. One-quarter of adults 25+ years of age had completed some college, 19 percent had a bachelor's degree, and 14 percent had a post-graduate degree. The remaining 44 percent had a high school diploma or less education, with about one-third of this group being high school drop-outs. One-quarter of adults in our analysis sample were 60 years of age or older and 31 percent were 25 to 39 years of age. Adults aged 40 to 59 years were the largest group, comprising 45 percent of the total. Nearly three-quarters of adults were born in Louisiana and virtually all—97 percent—were U.S. citizens. There were slightly fewer males (45 percent) than females (55 percent).

METHODS

Our descriptive and regression analyses use propensity score reweighting to address several concerns with the post-Katrina ACS sample. In this section, we first describe the construction of the propensity score weights and then describe our regression modeling approaches.

Propensity Score Weights

The analysis of migration and resettlement of pre-Katrina New Orleans residents in the year after the storm is descriptive, but is enhanced by the use of propensity-score reweighting of the post-Katrina sample (DiNardo et al., 1996; Rosenbaum and Rubin, 1983). Propensity score reweighting addresses the concern that changes in eligibility, response rates, living arrangements, and other factors will affect the representativeness of the post-Katrina sample of New Orleans residents. The reweighting approach allowed us to adjust for differences in the distributions of measureable individual characteristics between the pre- and post-Katrina samples. Propensity score reweighting allowed us to make comparisons for a single cross-sectionally representative

population, the pre-Katrina population of New Orleans, between two points in time: before Katrina and after Katrina.

Our approach to propensity score weighting follows DiNardo (2002). We begin by considering an outcome of interest, *y*, for the New Orleans population after Hurricane Katrina under the scenario that the independent variables, *x*, had the same distribution after (*A*) Katrina as they did before (*B*) Katrina. That is, we want to examine the following distribution of the outcome, *y*:

$$f_B^A(y) \equiv \int f^A(y \mid x) h(x \mid t = B)\, dx . \tag{1}$$

The challenge in examining this distribution is that *x* is a vector comprising many variables and the necessary integration is challenging to perform. One solution is to define a weight, *w*, such that

$$\int f^A(y \mid x)\, h(x \mid t = B)\, dx = \int w f^A(y \mid x)\, h(x \mid t = A)\, dx . \tag{2}$$

To find the appropriate weight, *w*, we begin by pooling the data from before and after Hurricane Katrina and observe that

$$h(x_j = x_0) = h(x_j \mid t = B)\, P_B \,/\, P(t = B \mid x_j = x_0) \tag{3}$$

and

$$h(x_j = x_0) = h(x_j \mid t = A)\, P_A \,/\, P(t = A \mid x_j = x_0), \tag{4}$$

where P_A is the probability that the observation comes from the after-Katrina cross-section and $\rho^A(x) \equiv P(t = A \mid x_j = x_0)$ is the propensity score associated with the observation being from the after-Katrina period, and P_B and $\rho^B(x)$ are similarly defined for the before-Katrina cross-section. The propensity score is a number in the unit range and represents the probability that an observation will be from the after-Katrina period given the observed set of characteristics (Rosenbaum and Rubin, 1983).

Using Equations (3) and (4) we can now derive the distribution of *y* in the after-Katrina period but with the distribution of independent variables matching the before-Katrina period as:

$$f_B^A(y) = \int \frac{1 - \rho^A(x)}{\rho^A(x)} \left(\frac{P_A}{P_B} \right) f^A(y \mid x)\, h(x \mid t = A)\, dx , \tag{5}$$

and the appropriate weight is thus given by:

$$w = \frac{1-\rho^{A}(x)}{\rho^{A}(x)} \frac{P_A}{P_B}. \quad (6)$$

We estimated the propensity score by pooling the pre- and post-Katrina cross-sectional data and estimating a logistic regression model that included potentially relevant exogenous explanatory variables and incorporated the ACS person sampling weights. Because we suspected that factors affecting the representativeness of the post-Katrina sample may have varied over time, we estimated a separate propensity score model for each two-month period in the post-Katrina sample.

The propensity score models included a set of categorical variables describing each person's age in ten-year intervals, race and ethnicity, sex, and educational attainment. We conducted a specification search in order to identify the models with the best fit, estimating models with all possible one-way, two-way, three-way, and four-way interactions. We compared the different specifications using the Akaike information criterion (AIC), because it allowed us to assess goodness of fit while accounting for model complexity. Our decision rule was to select the model specification with the smallest AIC for each two-month window. In all but one case, the model with the lowest AIC was the most parsimonious specification that included only the main effects.

The main assumption underlying propensity score reweighting is that there are no unobserved effects operating to influence the likelihood of an observation appearing in the post-Katrina sample compared to the pre-Katrina sample. The main concern is the extent to which the hurricane led to differential rates of non-response or ineligibility in the post-Katrina ACS that are not adequately adjusted by the covariates or the sample weights. The propensity score approach also requires all variables used to construct the score to be exogenous. The only variable for which this might be questioned is educational attainment; however, this is an important control because it is our sole available measure of socioeconomic status. By restricting our sample to adults who were 25 years of age and older, we reduced the likelihood of changes in educational attainment between the pre-Katrina and post-Katrina periods; by using relatively broad categories for educational attainment, we minimized the effects of any changes that did occur. We also expect the nature of the disaster and the displacement to reduce the likelihood of individuals obtaining additional schooling over the study period. Finally, if certain groups are greatly underrepresented in the post-Katrina cross-section, then the estimated weights may take

on large values for these groups. Variability in weights is a potential problem because observations with large weights can dominate the weighted analysis and can lead to large variances for the parameter estimates. We conducted a detailed analysis of the estimated propensity score weights and, although we do not report any details here, the results indicated that the weights were well behaved with few outliers on either tail of the distribution.

A major reason why the propensity score weights for our analysis are so well-behaved is that the post-Katrina sample of individuals who lived in New Orleans before the hurricane is highly comparable to the corresponding pre-Katrina sample even before the propensity score weights are applied. This result is illustrated in Table 2, which is based on the full-year public use ACS data for 2005 and 2006 and considers residents of the New Orleans metropolitan area (rather than the restricted ACS data for the City of New Orleans, which is the focus of our analysis but for which we did not obtain disclosure clearance). The two columns in Table 2 show weighted summary statistics for the pre-Katrina and post-Katrina samples. For all of the variables the estimates are very similar, with essentially no differences in variables with two categories (e.g., race and sex) and only slight differences in variables with multiple categories (i.e., education and age).

For all of the analyses, we used the product of the estimated propensity score weights, w_i, and the ACS person sampling weights, s_i. We normalized these weights so that the products of the two weights sum to one.

Regression Analysis

In order to examine post-Katrina locations and migration decisions among adults who were pre-Katrina residents of New Orleans, we used several different modeling approaches. First, we used logistic regression to examine whether or not a person moved back to their pre-Katrina dwelling, moved back to the City of New Orleans, or moved back or stayed within the New Orleans metropolitan area. Second, we estimated multinomial regression models to examine the location of each person, distinguishing among those who were residing: (1) within the New Orleans metropolitan area; (2) elsewhere in Louisiana; (3) in a state bordering Louisiana—Texas, Mississippi, or Arkansas; or (4) in another U.S. state. Finally, we estimated current status hazard models to examine duration effects on the likelihood of individuals returning to their pre-Katina dwellings. We used three different specifications of the baseline hazard, based on the Weibull distribution, a step-function obtained using a pooled adjacent

severe violators algorithm, and a spline. The results were very similar across the three specifications, hence we only report those based on the parametric Weibull specification of the baseline hazard which provides the most parsimonious specification.

For the current-status hazard model analysis, we adopted an approach that allowed us to incorporate pre-Katrina characteristics of the residence. We examined the effects of flood depth, which served as an indicator for damage to the dwelling and local neighborhood, and a measure of neighborhood economic status as a proxy for pre-Katrina household-level economic status which is not measured in the ACS. Based on previous research, we expected that housing and neighborhood damage were tied to when individuals were allowed to return to New Orleans and the time required to restore their dwelling to a habitable state.

Information on the location of the pre-Katrina dwelling is unavailable for people who, in the post-Katrina period, reported living in a different dwelling than one year ago. We tackle this missing data problem by examining the fraction of specific population segments that had returned to New Orleans, within an integrated modeling framework using a grouped estimation strategy.[7]

Our goal is to estimate following conditional survival function for the duration of displacement from the person's pre-Katrina dwelling,

$$S(t \mid x, z) = \Pr(r_t = 0 \mid x, z), \tag{7}$$

where r_t is the place of residence at time *t*, equal to one if the individual is living at his or her pre-Katrina address and zero otherwise; *x* is a vector of time-invariant covariates; and *z* is a vector of covariates describing characteristics of the pre-Katrina residence. Note that *z* is only observed for individuals who are living in their pre-Katrina dwelling when they are interviewed in the post-Katrina period.

We used a two-step approach for estimating the model parameters in Equation (7) that exploits the availability of the pre-Katrina data. Let $p(x, z, r_t)$ denote the proportion of the population with $X = x$, $Z = z$, and $R_t = r_t$. Because r_t can only take two values (0 and 1), the following identity must hold:

[7] The proportion of a pre-Katrina population subgroup who did not return to the city after the hurricane is not directly observed in the post-Katrina data. However, we can estimate that proportion using two observed quantities: the pre-Katrina size of the subgroup and the size of the post-Katrina subgroup who had returned to the city.

$$p(x,z) = p(x,z,r_t = 0) + p(x,z,r_t = 1). \quad (8)$$

Consistent estimates of $p(x,z)$ and $p(x,z,r_t = 1)$ can be obtained from the available data. We let $\bar{p}(x,z)$ be the weighted fraction of pre-Katrina observations with $X = x$ and $Z = z$, noting that $\bar{p}(x,z)$ provides a consistent estimate of $p(x,z)$. We define $\bar{p}(x,z,r_t = 1)$ to be the weighted fraction of observations with $X = x$, $Z = z$, and $R_t = 1$, which provides a consistent estimate of $p(x,z,r_t = 1)$. Next, we let $\bar{p}(x,z,r_t = 0) = \max[0, \bar{s}(x,z) - \bar{s}(x,z,r_t = 1)]$,[8] and we define $W_t = \sum_{i \in N_t} s_{it} w_{it}(x,z,r_t = 1)$ to be the total weight of the time *t* observations. The likelihood contribution of data at time *t* is given by:

$$\hat{l}(x,z,r_t) = \begin{cases} [S(t \mid x,z)]^{\bar{p}(x,z,r_t=0)W_t} & \text{if } R_t = 0 \\ [1 - S(t \mid x,z)^{\bar{p}(x,z,r_t=1)W_t} & \text{if } R_t = 1 \end{cases}. \quad (9)$$

The joint log-likelihood function is given by the sum of the logs of likelihood contributions of all *X* and *Z* contributions over the post-Katrina period (months 3 – 12). We assumed that the return times follow the Weibull distribution, which leads to the following specification for the conditional survival model:

$$S(t \mid x,z) = \exp(-(\lambda t)\exp(x\beta_x + z\beta_z)). \quad (10)$$

We obtained consistent parameter estimates using maximum likelihood estimation.

For each of the three different modeling approaches, we estimated a sequence of models. We began by estimating a bivariate model, to examine differences in the outcomes for the key covariates—race and education. Next, we estimated the effects of these two covariates simultaneously. Finally, we added a set of demographic variables to this previous model specification. These controls included age, place of birth, and U.S. citizenship. We calculated robust or bootstrapped standard error estimates, which adjusted for the clustering of individuals by household.

RESULTS

We present results of a descriptive analysis first, before turning to the results of our regression analysis.

[8] We use the maximum of these two values to ensure that that sampling variability in the two independently estimated proportions, $\bar{p}(x,z)$ and $\bar{p}(x,z,r_t = 1)$, does not lead to a difference that lies outside the unit interval. In principle, the quantity $p(s,z) - p(x,z,r_t = 1)$ cannot be less than zero.

Descriptive Results

We begin by summarizing the location of pre-Katrina residents of New Orleans in the year after the hurricane. We then describe the timing of return and, in particular, the pattern of return to the same or to a different dwelling. Finally, we show the distribution of the pre-Katrina population and the returned population by flood depth.

Among those surveyed in 2006, 40 percent of New Orleans residents had returned to their pre-hurricane dwellings and 24 percent had relocated to a different dwelling within the New Orleans metropolitan area (see Table 3). Just under two-thirds of the pre-Katrina population thus remained within the metropolitan area in 2006. Of the remaining 37 percent of pre-Katrina New Orleans residents who moved away from New Orleans, about one-quarter moved elsewhere in Louisiana (10 percent of the total pre-Katrina population) and 36 percent moved to Texas (13 percent of the total). In other words, 86 percent of the pre-Katrina population of New Orleans was either in Louisiana or Texas in the year following Hurricane Katrina.

The other major destination states were Georgia, with 7 percent of the displaced population and 3 percent of the total population, California, with 4 percent and 1 percent respectively, and Florida and Mississippi, each with 3 percent of the displaced population and 1 percent of the total population. The remaining destination states included, in order, Alabama, Maryland, Arkansas, North Carolina, Tennessee, Virginia, New York, Ohio, and South Carolina; together, these states accounted for 14 percent of the displaced population and 5 percent of the total population. All other states accounted for 7 percent of the displaced population and 2 percent of the total population.

Figure 2 uses Kaplan-Meier survival curves estimated with the restricted ACS data to describe the timing of return migration to the same dwelling or to the City of New Orleans in the 12 months following Hurricane Katrina. The figure shows that three months after Katrina (i.e., in November 2005) less than 30 percent of pre-hurricane residents had returned to their dwelling and about 35 percent of residents had returned to the city. Return rates to the same dwelling increased very slowly in the following eight months, although there was a jump in return to the same dwelling 10 months after the hurricane (i.e., in June 2006) that may have represented the effects of families returning to New Orleans following the end of the school year at their displaced locations. By the first year anniversary of Hurricane Katrina, just under 40 percent of displaced residents had returned to their pre-storm dwelling, an increase of approximately 10

percentage points over the preceding ten months.

The rate of return to any dwelling in New Orleans was more rapid. Between November 2005 and August 2006, about 25 percent of the pre-Katrina population of adults 25+ years old returned to the city, with about three-fifths of these individuals returning to a different dwelling than the one they had lived in before the hurricane. By the first anniversary of the hurricane, 60 percent of pre-Katrina residents of New Orleans were again living in the city while 40 percent were living elsewhere. About two-thirds of the returned residents were living in their pre-Katrina dwellings while one-third were living in a different dwelling.

We show the relationship between flood exposure and return migration in Figures 3 and 4. These figures plot kernel density estimates of the distribution of the pre-Katrina population aged 25+ years by flood depth for the 20-month period prior to the hurricane (the solid line in each figure). Two separate post-Katrina distributions of this population are shown for the 10-month period from November 2005 to August 2006. The dotted line describes the conditional distribution of individuals by flood depth among those who returned to their pre-Katrina residence. The dashed line describes the conditional distribution of individuals by flood depth among those who returned to any dwelling in New Orleans, including their pre-Katrina address. The flood depth indicator is calculated for Census blocks and reflects the depth of flooding on 2 September 2005; for locations that were not flooded, the flood depth is negative and equals the elevation of the land above the flood waters.

The relationship among the curves is of interest. By comparing either of the two conditional densities, which show the population who returned to New Orleans, with the unconditional density of the population before the hurricane, we can see the conditional likelihood of returning to New Orleans by flood depth. We can also see which locations within New Orleans, defined by flood depth, absorbed pre-Katrina residents who returned to the city. Finally, note that the unconditional distribution of the pre-Katrina population by flood-depth/elevation captures the entire population and hence integrates to 1. The total area under each of the two conditional distributions provide separate measures of the fraction of the population that returned to New Orleans and that returned to their pre-Katrina dwelling. We compute the curves for the entire population in Figure 3 and for the population defined by race, comparing blacks vs. whites, in Figure 4.

Figure 3 shows that the pre-Katrina population of New Orleans had a bimodal

distribution centered at a flood-depth of about 3 feet and tapering off towards each tail. The mode just above the zero flood depth mark is due to flooding in areas with positive elevation (i.e., pools of water) and unflooded locations in areas with negative elevation (i.e., islands), both caused by undulations in the terrain. (Another hypothesis is that the dimple in between the two modes reflects sparsely-populated areas in and around the city's central business district.) The dashed line shows that most of the pre-Katrina residents who returned to New Orleans after the hurricane returned to locations with low or no flooding. Very few people returned to locations that had more than 1 – 2 feet of flooding, although the majority of the population lived in these areas prior to the hurricane. This occurred because most dwellings in these areas experienced severe damage due to the flooding. The fact that some people were able to return to their pre-Katrina dwellings in these flooded areas suggests that not all dwellings suffered severe damage (e.g., those with a raised foundation) or that people were residing in temporary accommodations, such as trailers. Comparing the dashed and dotted lines, we see that the vast majority of people who returned to New Orleans, across the entire flood depth distribution, did so to the same dwelling in which they had lived before the hurricane. Finally, note that the dashed line lies above the solid line across much of the higher-elevation areas, indicating that these areas actually had a higher population after the hurricane than before.

Figure 4 has two panels that show the distribution of the pre- and post-Katrina population by flood depth for blacks separately from whites. Very few blacks lived in areas of New Orleans that did not flood. Whites, on the other hand, were distributed across all areas of the city. However, the mode of the distribution of the white population by flood depth was well to the left of that for blacks. These graphs indicate that a far higher proportion of whites than of blacks returned to New Orleans after Hurricane Katrina and that a major reason was that blacks were more likely to have lived in areas that flooded. Graphs for the distribution of the pre- and post-Katrina population of New Orleans by education level (our measure of socioeconomic status) are very similar to the patterns by race and hence are not shown.

Regression Results

Our regression analysis examined the same issues from the descriptive analysis. We begin by presenting, in Table 4, results from logistic regression models of return migration to New Orleans among pre-Katrina residents of the city who were displaced by the hurricane. Exponentiated parameter estimates are shown in the table, along with robust standard errors (in

parentheses) and an indicator of the statistical significance of each parameter estimate. The exponentiated parameters are interpreted as odds ratios. Thus, the first parameter in Table 4 indicates that blacks had 70 percent (1 – 0.303 = 0.697) lower odds of returning to the same house in New Orleans than did whites. The three asterisks indicate that this coefficient is statistically significant at the .01 level.

The first panel in the table examines whether pre-Katrina residents returned to the same dwelling. Blacks (Model 1) and individuals who had completed less schooling (Model 2) were significantly less likely to return to their pre-hurricane dwellings. When we controlled for both race and education simultaneously (Model 3), the education coefficients lost their statistical and substantive significance. However, the parameter for blacks remained statistically significant and was almost unchanged—indicating that race, rather that education, was the more important of these two factors in accounting for return migration to the same house. The final model specification (Model 4) adds variables describing age, place of birth, and citizenship to Model 3. The age coefficients are statistically significant, and indicate that the likelihood of returning home was substantially higher among middle-aged and elderly adults compared to adults aged 25 to 39 years. However, the addition of these variables did not change the basic results for race and education.

The second panel in Table 4 has results for the same four model specifications, but the outcome is whether or not the person returned to the City of New Orleans—either to their home or to a different dwelling. The general pattern of results remains the same as before. However, note that although blacks are substantially less likely to return to the City of New Orleans than are whites, these odds are higher than their odds of returning to the same dwelling.

The final panel in Table 4 shows the results for models of whether or not the person returned (or stayed) anywhere in the New Orleans metropolitan area. Again, the general conclusions remain unchanged—blacks and those with less schooling are less likely to have returned to (or stayed in) the New Orleans metropolitan area. However, when both factors are controlled simultaneously, race emerges as the only significant factor and appears to account for the effects of schooling. In other words, individuals with less schooling are less likely to return to their former home, city, or metropolitan area largely because they are more likely to be black, and blacks have substantially lower odds of returning. One other finding of interest in this model is that individuals born in Louisiana were 67 percent more likely to have returned or stayed in

the New Orleans metropolitan area than those who were born elsewhere, a result that was statistically significant at the .01 level.

In Table 5, we present regression results from a parallel set of models for a multinomial outcome that distinguishes individuals who returned to the New Orleans metropolitan area (the reference category) from those who resided elsewhere in Louisiana, in a neighboring state, or elsewhere in the U.S. Model 1, which includes only an indicator of race, shows that blacks were almost three times more likely than whites to be elsewhere in Louisiana than in the New Orleans metropolitan area, over six times more likely to be in a neighboring state, but only 64 percent more likely to be elsewhere in the U.S. Taken together, these results are the complement to the finding that blacks were less likely to have returned to New Orleans. Of particular interest is the pattern of displacement, which shows that displaced blacks were substantially more likely than displaced whites to have been living in a neighboring state. Individuals with more schooling were significantly less likely to have been living elsewhere in Louisiana or in a neighboring state, but no less likely to be living elsewhere in the U.S. When we controlled for both race and education, the major disparities by race again persisted while the education disparities were diminished substantially. Controlling for the remaining variables in the fourth model did not alter this finding. The results in Model 4 indicate that older individuals were significantly less likely than younger individuals to relocate anywhere away from the New Orleans metropolitan area. People born in Louisiana were significantly more likely to be living elsewhere in the state than in metropolitan New Orleans, but significantly less likely to be living in a neighboring state or elsewhere in the U.S.

The final set of regression results are presented in Table 6, and show current status hazard model estimates of the duration of displacement from the pre-Katrina dwelling in New Orleans. We examined the effects of race and educational attainment in two separate sets of models because they were estimated using grouped data and hence are limited in the number of covariates that could be included. The first race model replicates our earlier finding that blacks had a substantially lower hazard of returning to their pre-Katrina dwelling. Two separate bivariate models with the race covariate are shown, which differ in the samples that are used for estimation. Model 1 includes only post-Katrina observations while Model 2 pools pre-Katrina and post-Katrina observations—which is necessary incorporating place of residence characteristics in the two subsequent models. The results from Models 1 and 2 are very similar,

indicating that the criterion used for selecting the sample is unlikely to affect the subsequent results.

In Model 3, we add the effects of flood depth on the hazard of returning to the pre-Katrina dwelling. This covariate has a major effect on the likelihood of return, with residence in a high flood depth location associated with dramatically lower rates of return. In particular, individuals whose dwelling was in an area with 4+ feet of flooding had a relative risk of returning to the dwelling that was 90 percent lower than individuals whose dwelling was in an area that did not flood. The effect of race was attenuated substantially after controlling for flood depth, with about one-third of the observed disparity in return rates between blacks and whites apparently accounted for by differences in the distribution of dwellings by flood depth that disfavored blacks. Before controlling for flood depth, blacks had a relative risk of return of returning to their New Orleans dwelling in the year after Katrina that was about 63 percent lower than whites; after incorporating this control, blacks had a relative risk of return that was only 40 percent lower than whites. In Model 4 we examined the effects of a poverty indicator, namely the percent of the local tract population that received public assistance. This variable was not significantly related to return rates once race was controlled, and the effects of race hardly changed following its inclusion.

The next panel shows the parallel set of four models, but focusing on disparities in return rates by education. As before, there are major observed differences in return rates by completed schooling. Over the study period, individuals with a bachelor's degree had a relative risk of return to their dwelling in New Orleans that was 53 to 63 percent higher than those with just a high school diploma; for those with a graduate degree, the relative risk was almost 100 percent higher. Flood depth and public assistance rates both appear to account for much of the advantage of individuals with more schooling. After either of these variables was included in the model, there were declines in both the magnitude and the statistical significance of the education effects on return rates, with larger declines associated with flood depth than with public assistance.

CONCLUSIONS

We used new data from the restricted version of the U.S. Census Bureau's American Community Survey from 2004 to 2006 to examine return migration and the location of pre-Katrina adult residents of New Orleans aged 25 years and older who were displaced by the

hurricane. Our analysis focused on outcomes during a 10-month period towards the end of the first year after the hurricane, from November 2005 to August 2006, among all individuals throughout the country who reported living in New Orleans one year previously. We compared this group to a pooled sample of pre-Katrina residents who lived in the city and were interviewed for the ACS between January 2004 and August 2005. Although the pre-Katrina and post-Katrina samples appeared to be quite similar, we implemented a propensity score weighting procedure to further enhance the comparability between the two samples. The propensity score models fit well and the propensity score weights were well behaved.

Three main conclusions emerged from our analysis. First, the ACS, which has replaced the long form of the decennial census in the U.S., provides excellent opportunities now and into the future for studying migration behavior. The status of the ACS as a continuous, on-going national survey also makes it uniquely positioned for examining the population effects of large-scale human caused and natural disasters. As illustrated by our analysis, it is straightforward to create comparable samples from before and after an event. The use of enhancements such as propensity score reweighting lead to accurate and reliable comparisons between pre-disaster and post-disaster populations.

Second, the displacement and return migration experience of New Orleanians was strongly shaped by location within the city—which, in turn, determined flood depth and housing damage. In the year following Hurricane Katrina, only 40 percent of New Orleanians had been able to return to their dwellings in the city. These dwellings were largely located in areas with little or no flooding, suggesting that the effects of the floodwaters were to devastate dwellings, neighborhoods, and entire sections of the city.

Third, blacks had significantly lower rates of returning to New Orleans following Hurricane Katrina and were more likely to be displaced to areas outside of the New Orleans metropolitan area. Our analysis indicates that blacks were more likely than whites to have lived in flooded neighborhoods and that this was a major factor—although not the only factor—in accounting for their lower likelihood of return. We also observed disparities in return migration by educational attainment, a proxy measure for socioeconomic status. However, disparities by race were stronger than disparities by education. Finally, we found that older individuals and natives of Louisiana were more likely to have returned to New Orleans. Both groups probably had deeper family, social, and economic ties in the area that served to balance the many

challenges individuals and families faced in returning to the devastated city.

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Table 1. Descriptive Statistics for Pre-Katrina New Orleans Residents Aged 25+ Years from the 2005 American Community Survey Public Use Data

Variable	Percent	(SE)
Race		
White	35.4%	1.7%
Black	64.6%	1.8%
Education		
HS dropout	14.2%	1.1%
High school	30.0%	1.6%
Some college	23.2%	1.3%
Bachelor's	18.7%	1.4%
Graduate	13.9%	1.0%
Age		
Age 25-39	30.6%	1.6%
Age 40-59	45.0%	1.7%
Age 60+	24.5%	1.4%
Place of birth		
Louisiana	72.5%	1.7%
Elsewhere	27.5%	1.7%
Citizenship		
U.S.	97.2%	0.6%
Other	2.8%	0.6%
Sex		
Male	45.2%	1.2%
Female	54.8%	1.2%
Weighted population	277,257	
Observations	1,921	

Notes: Robust standard errors reported; only blacks and whites included.

Table 2. Comparison of Descriptive Statistics for 2005 Residents Aged 25+ Years of the New Orleans Metropolitan Area from the 2005 and 2006 American Community Surveys

Variable	2005 ACS	2006 ACS
Race		
White	59.1%	59.1%
Black	36.3%	36.2%
Education		
HS dropout	17.4%	19.4%
High school	31.8%	31.1%
Some college	25.9%	27.3%
Bachelor's	15.9%	13.9%
Graduate	9.0%	8.3%
Age		
Age 25-39	30.0%	27.7%
Age 40-59	45.6%	46.1%
Age 60+	24.4%	26.3%
Place of birth		
Louisiana	72.1%	72.1%
Elsewhere	27.9%	27.9%
Citizenship		
U.S.	97.0%	96.7%
Other	3.0%	3.3%
Sex		
Male	47.0%	46.9%
Female	53.0%	53.1%
Weighted population	783,286	734,831
Observations	6,473	6,292

Notes: Only blacks and whites included; 2005 ACS based on the New Orleans metropolitan area sample; 2006 ACS estimates based on respondents throughout the U.S. who reported living in the New Orleans metropolitan area one year previously.

Table 3. Post-Katrina Location in 2006 of Pre-Katrina Residents of New Orleans Aged 25+ Years from the 2006 American Community Survey

Location	Percent
Pre-Katrina residence	39.8
Elsewhere in New Orleans metro	23.5
Elsewhere in Louisiana	10.0
Texas	13.1
Georgia	2.8
California	1.3
Florida	1.0
Mississippi	1.0
Alabama	0.8
Maryland	0.8
Arkansas	0.7
North Carolina	0.7
Tennessee	0.4
Virginia	0.4
New York	0.4
Ohio	0.4
South Carolina	0.4
Other	2.4
Weighted population	277,257
Observations	1,921

Notes: Only blacks and whites included; estimates based on 2006 ACS respondents from throughout the U.S. who reported living in New Orleans one year previously.

Table 4. Logistic Regression Models of Return Migration among Pre-Katrina Residents of New Orleans Aged 25+ Years in the 2004 – 2006 American Community Survey

	Returned to same house in New Orleans				Returned to City of New Orleans				Returned to Metropolitan New Orleans			
Variable	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Race												
White†	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.
Black	0.303***	.	0.316***	0.322***	0.399***	.	0.404***	0.391***	0.321***	.	0.323***	0.282***
	(0.041)	.	(0.015)	(0.016)	(0.022)	.	(0.025)	(0.024)	(0.014)	.	(0.016)	(0.013)
Education												
HS dropout	.	1.084	1.140	1.071	.	1.061	1.098	1.032	.	0.966	1.002	0.941
	.	(0.214)	(0.244)	(0.218)	.	(0.195)	(0.216)	(0.191)	.	(0.158)	(0.178)	(0.157)
High school†	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.
Some college	.	1.005	0.883	0.911	.	0.819	0.741*	0.760	.	0.852	0.755*	0.782
	.	(0.168)	(0.134)	(0.147)	.	(0.104)	(0.090)	(0.098)	.	(0.111)	(0.091)	(0.103)
Bachelor's	.	1.691***	1.024	1.101	.	1.420**	0.961	1.023	.	1.551**	0.964	1.036
	.	(0.470)	(0.182)	(0.212)	.	(0.337)	(0.162)	(0.185)	.	(0.414)	(0.168)	(0.199)
Graduate	.	2.348**	1.355	1.422*	.	1.780***	1.149	1.211	.	1.742***	1.012	1.103
	.	(0.990)	(0.346)	(0.391)	.	(0.564)	(0.243)	(0.278)	.	(0.543)	(0.192)	(0.238)
Age												
Age 25-39†	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.
Age 40-59	.	.	.	1.981***	.	.	.	1.948***	.	.	.	1.777***
	.	.	.	(0.630)	.	.	.	(0.551)	.	.	.	(0.450)
Age 60+	.	.	.	2.419***	.	.	.	2.346***	.	.	.	2.353***
	.	.	.	(1.011)	.	.	.	(0.897)	.	.	.	(0.904)
Place of birth												
Louisiana	.	.	.	1.028	.	.	.	1.230	.	.	.	1.665***
	.	.	.	(0.151)	.	.	.	(0.214)	.	.	.	(0.413)
Elsewhere†	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.
Citizenship												
U.S.	.	.	.	1.234	.	.	.	1.239	.	.	.	1.377
	.	.	.	(0.467)	.	.	.	(0.475)	.	.	.	(0.601)
Other†	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.	.
Observations	2,670	2,670	2,670	2,670	2,670	2,670	2,670	2,670	2,670	2,670	2,670	2,670

Notes: Standard errors with household-level clustering in parentheses; † Reference category; *p<.10; **p<.05; ***p<.01; Only blacks and whites included.

Table 5. Multinomial Logistic Regression Models of Place of Residence among pre-Katrina Residents of New Orleans Aged 25+ Years in the 2004 – 2006 American Community Survey

Variable	Model 1		Model 2		Model 3		Model 4	
A. Elsewhere in Louisiana compared to New Orleans Metro								
Race								
White†	.	.	.	.	.	.	.	.
Black	2.736***	(0.621)	.	.	2.434***	(0.604)	2.171***	(0.540)
Education								
HS dropout	.	.	0.996	(0.257)	0.967	(0.257)	1.044	(0.277)
High school†	.	.	.	.	.	.	.	.
Some college	.	.	1.121	(0.276)	1.240	(0.309)	1.218	(0.309)
Bachelor's	.	.	0.513**	(0.152)	0.751	(0.233)	0.714	(0.222)
Graduate	.	.	0.469**	(0.139)	0.723	(0.212)	0.735	(0.221)
Age								
Age 25-39†	.	.	.	.	.	.	.	.
Age 40-59	.	.	.	.	.	.	0.687*	(0.139)
Age 60+	.	.	.	.	.	.	0.476***	(0.124)
Place of birth								
Louisiana	.	.	.	.	.	.	1.566*	(0.392)
Elsewhere†	.	.	.	.	.	.	.	.
Citizenship								
U.S.	.	.	.	.	.	.	0.428	(0.277)
Other†	.	.	.	.	.	.	.	.
B. Neighboring state (TX, AR, MS) compared to New Orleans Metro								
Race								
White†	.	.	.	.	.	.	.	.
Black	6.374***	(1.293)	.	.	6.074***	(1.388)	6.974***	(1.633)
Education								
HS dropout	.	.	1.180	(0.245)	1.129	(0.245)	1.220	(0.265)
High school†	.	.	.	.	.	.	.	.
Some college	.	.	1.111	(0.217)	1.304	(0.268)	1.257	(0.267)
Bachelor's	.	.	0.489***	(0.122)	0.958	(0.255)	0.909	(0.247)
Graduate	.	.	0.430***	(0.110)	0.943	(0.257)	0.894	(0.254)
Age								
Age 25-39†	.	.	.	.	.	.	.	.
Age 40-59	.	.	.	.	.	.	0.540***	(0.102)
Age 60+	.	.	.	.	.	.	0.391***	(0.085)
Place of birth								
Louisiana	.	.	.	.	.	.	0.598***	(0.117)
Elsewhere†	.	.	.	.	.	.	.	.
Citizenship								
U.S.	.	.	.	.	.	.	0.764	(0.335)
Other†	.	.	.	.	.	.	.	.
C. Elsewhere in U.S. compared to New Orleans Metro								
Race								
White†	.	.	.	.	.	.	.	.
Black	1.640***	(0.313)	.	.	1.885***	(0.404)	2.718***	(0.668)
Education								
HS dropout	.	.	0.811	(0.200)	0.793	(0.198)	0.813	(0.203)
High school†	.	.	.	.	.	.	.	.
Some college	.	.	1.351	(0.291)	1.457*	(0.320)	1.395	(0.319)
Bachelor's	.	.	1.090	(0.271)	1.439	(0.378)	1.317	(0.363)
Graduate	.	.	0.965	(0.238)	1.321	(0.351)	1.112	(0.306)
Age								
Age 25-39†	.	.	.	.	.	.	.	.
Age 40-59	.	.	.	.	.	.	0.497***	(0.093)
Age 60+	.	.	.	.	.	.	0.436***	(0.099)
Place of birth								
Louisiana	.	.	.	.	.	.	0.338***	(0.066)
Elsewhere†	.	.	.	.	.	.	.	.
Citizenship								
U.S.	.	.	.	.	.	.	0.846	(0.370)
Other†	.	.	.	.	.	.	.	.
Observations	2,670		2,670		2,670		2,670	

Notes: Standard errors with household-level clustering in parentheses; † Reference category; *p<.10; **p<.05; ***p<.01; Only blacks and whites included; Reference outcome category is residing in the New Orleans metropolitan area.

Table 6. Current-Status Hazard Models of Duration of Displacement from the Pre-Katrina Dwelling in New Orleans Among Residents Aged 25+ Years in the 2004 – 2006 American Community Survey

	Models for Race				Models for Education			
Variable	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Race								
White†	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
Black	0.380***	0.366***	0.604**	0.393***	.	.	.	.
	(0.043)	(0.061)	(0.123)	(0.068)	.	.	.	.
Education								
HS dropout	.	.	.	.	1.070	1.036	1.307	1.146
	.	.	.	.	(0.170)	(0.211)	(0.299)	(0.223)
High school†	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
Some college	.	.	.	.	1.005	1.035	0.936	0.917
	.	.	.	.	(0.147)	(0.185)	(0.190)	(0.159)
Bachelor's	.	.	.	.	1.533***	1.625**	1.397	1.345
	.	.	.	.	(0.212)	(0.320)	(0.301)	(0.255)
Graduate	.	.	.	.	1.963***	1.983***	1.543*	1.620**
	.	.	.	.	(0.286)	(0.432)	(0.366)	(0.325)
Flood depth								
No flooding†	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
0 – 2 feet	.	.	0.415***	.	.	.	0.390***	.
	.	.	(0.098)	.	.	.	(0.078)	.
2 – 4 feet	.	.	0.210***	.	.	.	0.222***	.
	.	.	(0.050)	.	.	.	(0.046)	.
> 4 feet	.	.	0.105***	.	.	.	0.149***	.
	.	.	(0.027)	.	.	.	(0.034)	.
Public asst. (%)								
Very low†	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.
Low	.	.	.	0.777	.	.	.	0.522***
	.	.	.	(0.168)	.	.	.	(0.104)
Medium	.	.	.	1.038	.	.	.	0.661**
	.	.	.	(0.229)	.	.	.	(0.126)
High	.	.	.	0.720	.	.	.	0.400***
	.	.	.	(0.203)	.	.	.	(0.095)
Duration	1.253*	1.246	1.091	1.266*	1.253	1.278*	1.160	1.255*
	(0.170)	(0.193)	(0.174)	(0.174)	(0.179)	(0.186)	(0.172)	(0.168)
Observations	2,670	4,470	4,470	4,470	2,670	4,470	4,470	4,470

Notes: Bootstrapped standard errors with household-level clustering in parentheses; † Reference category; *p<.10; **p<.05; ***p<.01; Model 1 included only post-Katrina observations; Models 2 – 4 combined pre-Katrina and post-Katrina observations; the baseline hazard is specified as following the Weibull distribution; Only blacks and whites included; Flooding indicator based on Census block of residence and flood depth on 2 September 2005; Percent receiving public assistance based on Census tract of residence and data from the 2000 Census.

Figure 1. Migration Questions in the 2004-2006 American Community Survey

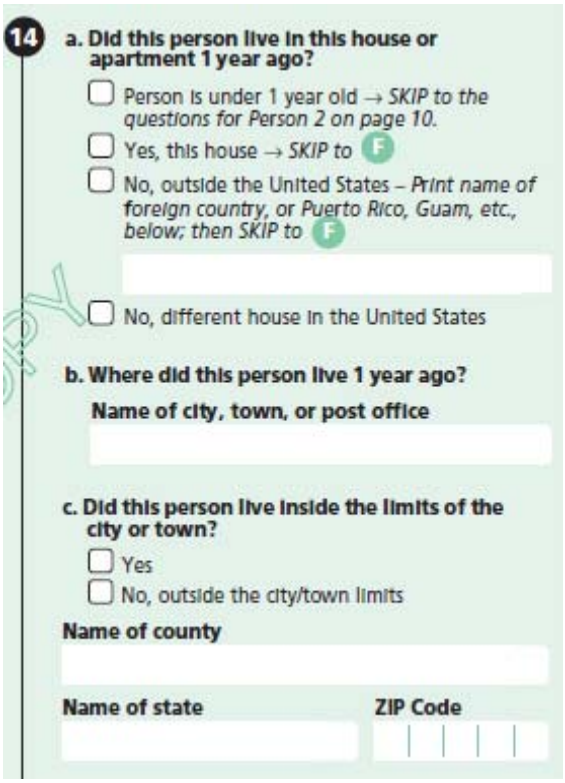


Figure 2. Kaplan-Meier Survival Function for Return of Pre-Katrina New Orleans Residents Aged 25+ Years to their Pre-Storm Dwelling (Top Line) or to the City (Bottom Line) Using the 2004 – 2006 American Community Survey

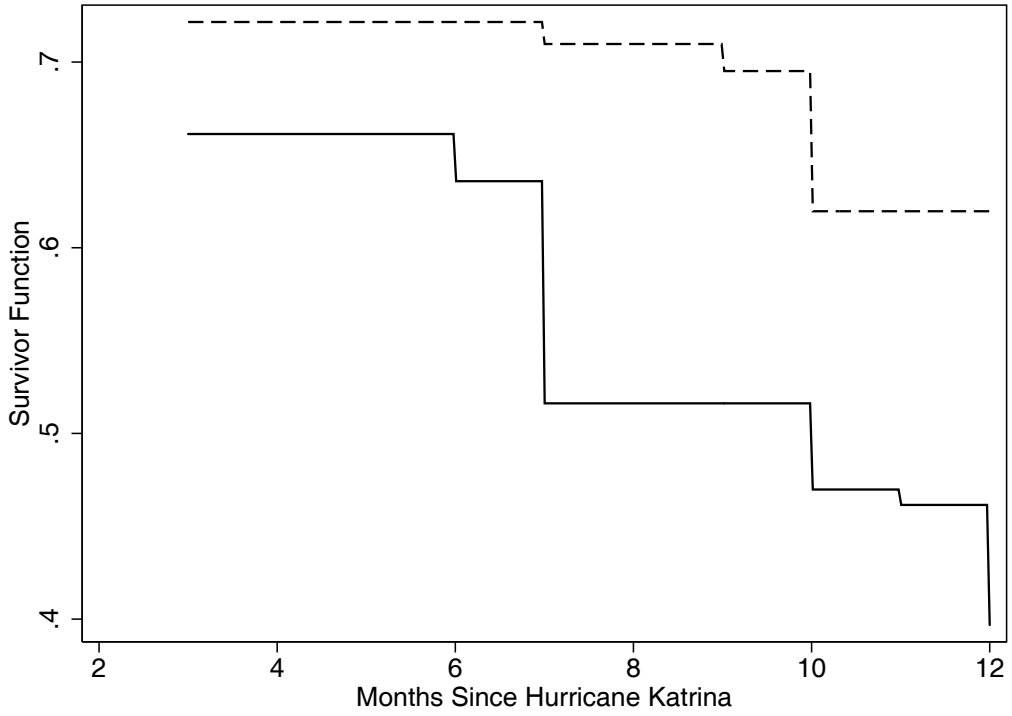
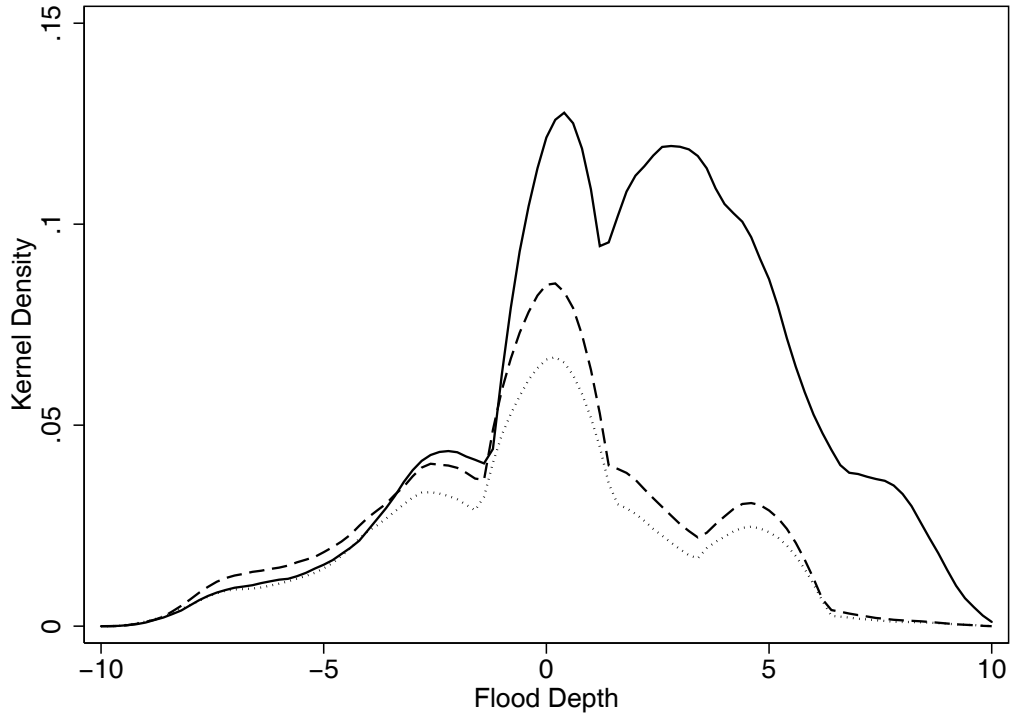


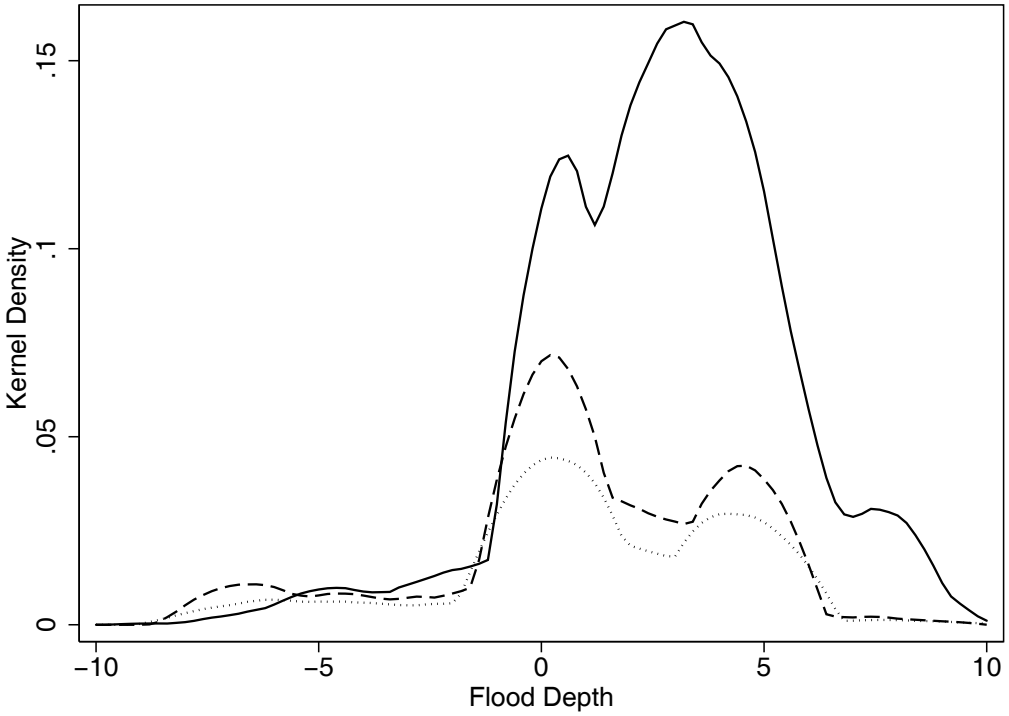
Figure 3. Distribution of the Pre-Katrina New Orleans Population Aged 25+ Years by Flood Depth Before and After Hurricane Katrina Using the 2004 – 2006 American Community Survey



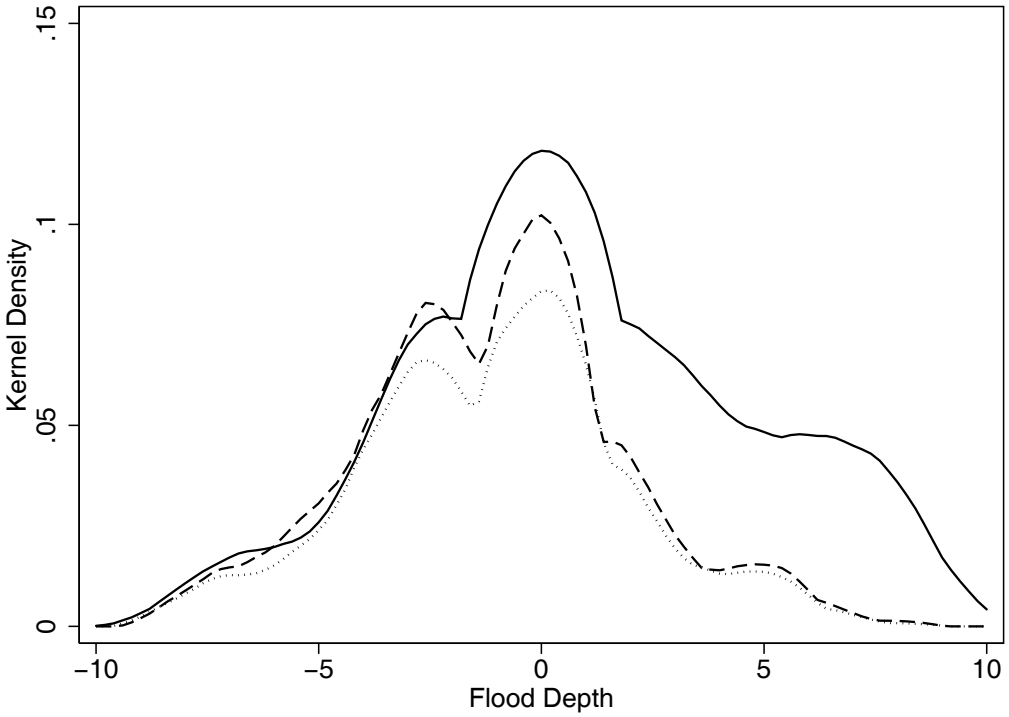
Note: Solid line shows distribution of pre-Katrina population by flood depth; dashed line shows normalized distribution of New Orleans residents who returned to the city; dotted line shows normalized distribution of New Orleans residents who returned to their pre-Katrina dwelling.

Figure 4. Distribution of the Pre-Katrina Population in New Orleans Aged 25+ Years by Flood Depth Before and After Hurricane Katrina, by Race, Using the 2004 – 2006 American Community Survey

A. Blacks



B. Whites



Note: Solid line shows distribution of pre-Katrina population by flood depth; dashed line shows normalized distribution of New Orleans residents who returned to the city; dotted line shows normalized distribution of New Orleans residents who returned to their pre-Katrina dwelling.