

**Breakup and Economic Circumstances of New Orleans Households Four Years after
Hurricane Katrina**

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ABSTRACT

Although it is widely believed that pre-existing social inequalities are amplified by disasters, our understanding of the roles of families and households in mediating this process is poorly understood. Because extended-family households are often formed and maintained for resource sharing and functional assistance, their intactness is of special interest. The breakup of households from a pilot and follow-up full survey that traces the outcomes respectively 1 and 4 years on for members of a probably-sample of pre-Katrina New Orleans households is compared to the breakup of households in a national sample over an equivalent period. Breakup of extended-family New Orleans households following Katrina was more than two times higher than for the national sample after one year. Its impact was amplified by the 50 percent higher prevalence of extended-family households in pre-Katrina New Orleans than nationally, and by the high concentration of poor extended-family households in New Orleans' African-American population.

INTRODUCTION

Most sociological studies of disaster and recovery have focused on the power relations of institutional and organizational actors, and on their impacts on “socially vulnerable” subpopulations defined by their individual and group characteristics such as economic status, age, gender, and race. More than three decades ago, Bolin (1976:267) lamented that “The greater part of disaster research has focused on complex organizations, the community, or individuals with the family as a unit being given only cursory attention.” Tierney’s (2007) recent survey of the field of disaster research indicates that this is still largely true, even while more attention to family processes has occurred through an increased emphasis on gender. Where family and household structure have been studied under the “social vulnerability” framework of disaster research, moreover, this has been largely in relation to unfavorable characteristics for disaster preparation and evacuation such as single-mother households (e.g., Donner and Rodriguez 2008).

In the present study I offer an alternative view of household structure and housing as being central to the post-disaster inequality and racial stratification outcomes for the New Orleans population following Hurricane Katrina. I first describe the centrality for social inequality of housing in the recovery and reconstruction phases following disasters, and describe the protective roles of family households in the family-resource literature and specifically in New Orleans before Katrina struck. I then estimate the incidence of household breakup in the year following Katrina in a representative sample of the people who were living in the City of New Orleans at the time Hurricane Katrina struck at the end of August 2005, and compare this to household breakup in a sample representative of all metropolitan-U.S. households over a similar period. I investigate the intactness or breakup of households in cases both of return to New

Orleans following evacuation and of resettlement elsewhere in the U.S., and in cases both of housing rendered uninhabitable and in housing that was habitable again shortly after the deluge and cleanup.

Empirically, I address three main research questions. First, how did the incidence of household breakup in New Orleans differ from that experienced in the U.S. metropolitan areas as a whole over a similar time period? Second, were higher than normal rates of household breakup largely confined to those households from residences and neighborhoods experiencing major physical damage? Third, what differences were there in the breakup of nuclear versus extended households? These questions are addressed by applying a case-control analytical framework to data from a pilot and full survey representative of New Orleans households in August 2005 (the Displaced New Orleans Residents Pilot Study, DNORPS) and from a national panel survey of households (the Survey of Income and Program and Participation) over a comparable period. In addition, 2000 Census and 2005 American Community Survey data are used both to evaluate the representativeness of the DNORPS and to provide more efficient estimates of the structure and character of its households before Hurricane Katrina.

Results only for the DNORPS and SIPP-after-16-months comparison are given here. Additional results will be provided in the full paper, comparing the DNORS and SIPP-after-four-years outcomes. The larger sample of the DNORS will allow for more control variables to be included in the logistic regression and propensity-matching analyses. For the randomly-selected adult in the DNORS, additional outcomes will be analyzed. In particular, the change in economic circumstances associated with household breakup will be examined.

THEORETICAL FRAMEWORKS ON DISASTERS AND FAMILY

Disaster evacuation, catastrophic displacement, and the exceptionality of Hurricane Katrina

Two terms are commonly used to describe the mass movement of people from their homes (Oliver-Smith 2006:3): *Evacuation* refers to the “removal of people from harm’s way”; while *Displacement* refers to “the uprooting of people from a home ground.” In the broader literature of large-scale population movements, natural disasters are the archetypal case of movement of the “evacuation” type, while “displacement” has usually been reserved for mass movement due to armed conflicts, land expropriations, and gradual environmental deterioration. Bates (2002: 469) is typical in characterizing natural disasters as “Acute disruptions ...[that] produce short-term refugees from a geographically limited area.” The nature of movement out of New Orleans after Katrina does not fit in the model of evacuation and short-term displacement that has dominated “disaster research” especially in developed countries (Picou and Marshall 2007). Quarantelli (2006) describes Hurricane Katrina as instead being best understood as a “catastrophe,” one of whose characteristics is that the scale of physical destructions makes it impossible for displaced residents to obtain shelter with nearby relatives and friends (p.3).

Quarantelli includes as “catastrophes” both Hurricane Katrina’s impact on New Orleans and Louisiana and Hurricane Andrew’s impact on Miami and Southern Florida. Hurricane Andrew, however, had relatively little long-term effect in terms of numbers of permanently displaced people. Smith and McCarty (1996) estimated that 353,300 residents of the main county impacted by Hurricane Andrew were at least temporarily displaced from their pre-hurricane homes, but that only 39,200 left the county permanently because of the storm, with as many as half of these moving only addressed as far as to a neighboring County.

Hurricane Katrina’s impact on New Orleans began with what Fussell and Elliot (2009:383) describe as “...the largest, most complete urban evacuation ever to occur on U.S.

soil...” In terms of sheer size of the evacuation, the scale of Katrina’s was large but not unprecedented. As recently as 2004, approximately 1.4 million people were evacuated in advance of Hurricane Frances hitting Florida. Nigg, Barnshaw, and Torres (2006:113) describe the evacuation of the Gulf Coast areas in the path of Hurricane Katrina as numbering 1.3 million. They remark on two aspects of the Katrina evacuation, however, that merit the term “unprecedented”: the sending of evacuees to distant, out-of-state shelters; and the duration of the evacuation into “weeks or months” instead of the usual duration measured in “days or a couple of weeks at most” (p.121).

This dispersal of the pre-Katrina population affected both its likelihood of return and the manner of its being re-housed elsewhere. Elliot and Pais (2006:302) report that within two weeks, temporary shelters for Hurricane Katrina evacuees had already been established in 24 states and the District of Columbia. The geographic character of the evacuation of New Orleans in the wake of Hurricane Katrina clearly influenced the social geographic character of its longer-term displacement. Race and income differentiated strongly the locations of the evacuated Katrina population and their likelihood of return. Of the people evacuated from New Orleans in the first weeks and months of 2005, 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). Landry et al (2007) found that even among evacuees to Houston, those with lower incomes were less likely to intend to return to New Orleans.

Frey, Singer, and Park’s (2007) analysis of the 2006 American Community Survey (ACS) was the first to use nationally-representative data on former and returned New Orleans residents. As such, it builds an important link between our knowledge about shelter-provision

during the evacuation phase and the subsequent processes of longer-term displacement and location of New Orleans residents. Frey et al found that the Houston metropolitan area accounted for a far larger share of displaced blacks than of displaced whites up to a year after Katrina struck. Displaced whites were much more likely to have moved within Louisiana and within the New Orleans metropolitan area. Frey et al found in supplementary analyses of IRS data that distant movers from New Orleans had lower incomes than did local movers. Sastry (2009a), using the same Displaced New Orleans Residents Pilot Survey data as I use in the present study, similarly found that economically disadvantaged individuals were less likely to have returned to live in New Orleans just over a year after Katrina. The more disadvantaged characteristics of Hurricane Katrina's out-migrants are opposite to those found in regular migration processes, in which positive selection characterizes people with the highest overall and longer-distance migration propensities (e.g., Greenwood 1993). These findings of negatively-selected post-Katrina migrants, however, are consistent with findings about population movement following other disasters (Morrow-Jones and Morrow-Jones 1991).

Recovery and reconstruction as inequality-increasing processes

The processes of housing recovery in the area of the disaster or catastrophe are crucial to understanding why socioeconomic differentials in post-disaster population movement are opposite to those in a non-disaster context. Peacock, Dash, and Zhang (2007) review the full set of post-disaster phases of the disaster management literature, from the provision of shelter in the evacuation phase through to the processes of establishing temporary and permanent housing during the "recovery" and "reconstruction" phases. The latter two phases are crucial for a catastrophe of the magnitude of Katrina for New Orleans due to the large-scale destruction both

of residential housing and of economic and service infrastructure that occurred. The general finding in the literature is that recovery and reconstruction programs disadvantage poorer residents, as seen in Fothergill and Peek's (2004) review of two decades of studies of the social impacts of U.S. disasters. Renters, including those in public housing, are often least well provided for in recovery programs, while poorer home owners are less likely to receive insurance payouts sufficient to rebuild than are better-off home owners. These processes all reduce the ability of lower-income individuals and families to return and resettle in the area from which they were displaced. For example, Kamel and Loukaitou-Sideris (2004) found that inequality in the provision of housing assistance across neighborhoods resulted in greater displacement from, and net depopulation of, the more economically-disadvantaged communities affected by the 1994 Northridge earthquake in Los Angeles. A similar process of depopulation of the most economically disadvantaged neighborhoods has occurred to a much greater extent in New Orleans in the reconstruction phase following Katrina (Liu and Plyer 2007; Baade, Baumann, and Matheson 2007).

The dependence of New Orleans evacuees on public institutions and polity to restore their pre-storm housing and neighborhood infrastructural services and the deficiencies in ability and willingness of public institutions to restore this infrastructure, mirroring their initial deficiencies in protection and mitigation of the destructive effects of Hurricane Katrina, has been extensively documented (Henkel, Dovidio, and Gaertner 2006; O'Neill 2008; Freudenburg et al 2008). Researchers have criticized the policy responses specifically on providing for the housing needs of so many who lost their housing in New Orleans temporarily, for long periods, or permanently (e.g., Katz et al 2005). Peacock et al (2007) find more generally that the post-disaster processes of recovering permanent housing tend to be the most market based of all the

phases of the disaster process, and that this disadvantages those with the least economic resources (see also Baade et al). In the rebuilding of New Orleans and other devastated areas following Hurricane Katrina, Gotham and Greenberg (2008) describe the private-sector-contracted “Road Home” program of assistance in rebuilding homes in the impacted areas as favoring home owners over renters, and criticize this and other privatized processes of recovery and reconstruction efforts in the Gulf Coast area for their favoring of more economically powerful actors.

Little is known, however, about the impacts of differentials in housing assistance on family intactness, either in the case of Hurricane Katrina or more generally in post-disaster recovery and reconstruction. The experience of family evacuation, temporary housing, and permanent housing recovery following Hurricane Andrew is suggestive of how family structure may have been involved in the amplification of pre-existing social inequalities. Morrow and Enarson (1996) describe a lack of accommodation of extended-family households in emergency housing provision that was tailored to the nuclear-family model as a deficiency in the recovery program design and implementation following Hurricane Andrew. Morrow (1999) describes three-generation households headed by women as being “...the last families remaining in the temporary trailers nearly two years after Andrew” (p.6). She suggests also an important role of family as resources that can aid in both the evacuation and recovery (see also Litt 2008 for an example in New Orleans when Katrina struck).

Working from a social inequality and stratification perspective, Fussell (2006) describes the severe strains on the maintenance of social networks during the evacuation induced by Hurricane Katrina. Haney, Elliot, and Fussell (2007) describe the splitting of families as having occurred with substantial frequency in the evacuation following Hurricane Katrina. Little is

known, however, about family and household intactness following the initial evacuation. When families have been viewed as resources under strain in post-evacuation Hurricane Katrina studies, caring for children has been the main focus (Peek and Forthergill 2008; Scaramella et al 2008). Extended-family households involving two or more related adults fit uncomfortably within the “social vulnerability” model, in which relatively simple indicators of vulnerability are sought. Because extended-family households are both markers of strength through their resource-sharing and functional-assistance roles, and of economic and physical needs among their members, it is unclear whether a higher prevalence of extended-family households would indicate a greater or lesser vulnerability for a given socioeconomic community profile.

Two demographic groups are more likely to be in extended-family households due to the need for, and benefits of, intra-household resources: young adults and older people. Among elders, unmarried women, especially minority unmarried women, are demographically the largest group to benefit from living with relatives, with coresident family members aiding both their physical functioning and economic well-being (Rendall and Speare 1995; Rendall and Bahchieva 1998; Angel, Jimenez, and Angel 2007). Waite and Hughes (1999) show that these relationships of co-resident elder dependence hold even among younger-old (51 to 61 year old). Among younger adults, single mothers and minority single mothers in particular have been identified as forming extended-family households due to need (Hofferth 1994). The dependence of low-income young adults, either with or without own dependent children, on extended-family households is emphasized by Wasson and Hill (1998) and Wright et al’s (1998) analyses of “doubled-up” housing as a frequent precursor to homelessness. The direction of needs and exchange relationships between adults in extended-family households, moreover, are not

uniform. Younger adults, in particular, may either receive or provide care and economic resources to parents, or both (Speare and Avery 1993; Choi 2003).

Typologies are of limited use, moreover, in the absence of empirical tests. Until now, these have been limited to either qualitative studies (e.g., Litt 2008) or to studies using aggregate data (e.g., Myers et al 2008). Typologies also fail to explicate well the mechanisms by which the individuals or groups do better or worse than others. While elders and single mothers are most commonly identified as vulnerable demographic groups, their vulnerability needs to be understood within the context of the households they live, which may be single-person (for elders), nuclear, or extended. In terms of intactness, a single-elder household and a single-mother “nuclear” household are likely to be less affected in both the shorter and longer term than are larger households. Whether these demographic groups are adversely affected in longer-term displacement processes may depend considerably on whether they previously depended on the resources of an extended-family household.

Disaster-induced displacement and the dissolution of family households

The combination of relative theoretical neglect of family and households in disaster research and infrequency of disasters causing long-term displacement means that little is known from previous natural disasters about their effects on family relocation and breakup. Disaster-induced population displacement can be expected to put pressure on the “intactness” of a household in a number of ways. In the case of a nuclear family unit this may occur, for example, through temporary separation of one parent or partner while damage to housing or neighborhood infrastructure (e.g., schools) is repaired. In some cases, the disaster may precipitate the dissolution of a marital or cohabiting unit. Economic pressures are known to increase the

likelihood of marital and cohabiting union dissolution under non-disaster circumstances (White and Rogers 2000). Economic pressures due to difficulties finding jobs after Katrina may be expected to have increased pressure on displaced New Orleans couples' intactness. Researchers have found that labor-market outcomes are substantially worse for those who were displaced from New Orleans and other areas of displacement due to Katrina than among those than for those who quickly moved back to New Orleans (Vigdor 2007; Zottarelli 2008; Zissimopoulos and Karoly forthcoming). Psychological stresses on individuals and families induced by disasters (e.g., Weisler et al 2007) are also potential family-disrupting effects of the storms.

Household structure before Katrina struck is also likely to have played a major role in household breakup. Extended families are normally at highest risk of dissolution (Richards, White, and Tsui 1987). Difficulties for extended-family households to remain together during evacuation and temporary housing, and to recover previous or new permanent housing, are likely to make extended-family households even more prone to dissolution. Even where their own housing was little damaged, the wider damage to the community including local job losses may put strong pressures on the intactness of extended-family households. For example, adult children and parents living together before may split due to the adult children's jobs no longer being available in the disaster-hit location, forcing them, but not their parent(s), to relocate outside the region.

On the other hand, extended-family households are often formed due to strong material needs. This could make them highly resistant to breakup when a disaster accentuates those needs. Community strength may also play an important role in their increased resistance to post-disaster breakup. New Orleans has a history as an economically disadvantaged community, but one with very strong residential roots (Berube and Katz 2005; Fussell 2007). While economic

disadvantage makes for greater vulnerability to uprooting due to lack of economic resources to rebuild, a strong community history offers a psycho-social motive for greater efforts members of the community to recover their physical place together. Sastry (2009a), for example, finds that being born in Louisiana was associated with a higher likelihood of intending to return to New Orleans among those displaced.

DATA AND METHOD

I compare the likelihood of a household breakup among households in New Orleans with a national panel sample to estimate “excess household breakup” associated with Hurricane Katrina and its aftermath for New Orleans over a four-year period. I use a case-control analytical framework that takes adults in New Orleans households as the “cases” and adults in a national sample of households in the same period as the “controls.” The cases and controls are pooled in a logistic regression analyses of the factors influencing breakup in New Orleans households after Katrina and in U.S. households overall, and in a propensity-score matching procedure that provides estimates of the overall effect of Hurricane Katrina on the breakup of New Orleans households given the pre-existing family-structural and socio-economic conditions of New Orleans before Katrina. A description of those conditions in comparison to the country as a whole precedes the analysis.

The “case” sample: The Displaced New Orleans Residents Pilot Study

The present study takes advantage of a unique data source, the Displaced New Orleans Residents Pilot Study (DNORPS, Sastry 2009b), which was conducted in the fall of 2006, and its follow-up full survey, the Displaced New Orleans Residents Study (DNORS, Sastry and Peterson

forthcoming). I describe the DNORPS in some detail here, and the DNORS in outline form only. The DNORPS design was based on a stratified, area-based probability sample of pre-Katrina dwellings in the City of New Orleans (Orleans Parish). The DNORPS defined three flood-depth strata from which units were sampled from: Low (“no-flooding,” 0 feet); Medium (1-3 feet); and High (4+ feet). Within each of these strata a simple random sample was drawn. A total of 344 dwellings were sampled for the study, 327 of which were found to be eligible for interview (the dwelling was occupied in August 2005 by at least one resident who survived to survey date in 2006). Of these, completed surveys were conducted for 147 households, giving an adjusted response rate of 51%. Differences in response rates between flood-depth strata were in the expected direction, with the no-flood stratum having the highest response rate, but these response-rate differences across strata were not statistically significant. Multivariate analyses revealed no systematic patterns of non-response, and that the overall the quality of the data collected was high with no systematic problems with the questions or with item nonresponse (Sastry 2009b). Sample weights are provided with the DNORPS that first adjust for the unequal probabilities of selection between the three strata and that second are post-stratified to the Census Bureaus estimates of the Orleans Parish 2005 mid-year population by age, sex, and race. Because our interest is in the household, we use only the household weights wherever weighted analysis is employed in our analyses.

Sastry (2009a) compares residence at survey date and immediately before Katrina struck to calculate the percentage of all pre-Katrina residents of New Orleans who lived in the city in the fall of 2006 when DNORPS was fielded. Overall, 49% of pre-Katrina residents had returned to live in New Orleans. The most widely-accepted pre-Katrina estimate of the population of New Orleans was the U.S. Census Bureau’s July 1, 2005 estimate which placed the city’s total

population at 454,863 (U.S. Census Bureau, 2006b). Together, these two estimates suggest that the population of New Orleans in the fall of 2006 included approximately 222,900 returned residents (plus any new residents who had not resided in the city prior to the hurricane). This DNORPS-based population estimate is very similar to other independent estimates, including those from the U.S. Census Bureau, which estimated the July 1, 2006 total population to be 223,000 (U.S. Census Bureau, 2007a), the Louisiana Health and Population Survey, which estimated the city's total population in the fall of 2006 to be approximately 200,000 (Louisiana Public Health Institute 2007), and the Kaiser Post-Katrina Baseline Survey, which estimated the city's total population in the fall of 2006 to be approximately 221,000 (Kaiser Family Foundation, 2007).

Sastry (2009a) additionally reports from his analyses of the DNORPS large and statistically significant differences by flood stratum in the percentage of displaced New Orleans residents who have returned to the city. In the unflooded stratum, almost three-quarters of pre-Katrina residents had returned, while in the low-flood stratum about half had returned; in the high-flood stratum, 38% of pre-Katrina residents had returned. This points to a potentially greater strain on the intactness of households from the most physically damaged neighborhoods. In addition to flood-depth stratum, information is available in the survey on the damage suffered to the residence and to the neighborhood. The DNORPS also asked the respondent to report the extent of damage to the pre-Katrina residence. Two codes, "destroyed" or "damaged [and not habitable]," allow for an "uninhabitable" designation. "Uninhabitable" refers to directly after the storm, allowing for the possibility of repairs or rebuilding to make it habitable by survey time. This allows us to identify factors that differentiate between those for whom the storm made return to the same residence either more costly or impossible.

The DNORS is the full-survey follow-up to the DNORPS. Like the DNORPS, the DNORS design was based on a probability sample of pre-Katrina dwellings in the City of New Orleans (Orleans Parish). As a full survey, however, approximately 10 times as many dwellings were sampled, and a substantially longer questionnaire was designed to provide more detail on a breadth of demographic, socio-economic, and physical and mental health topics. Fieldwork extended from mid-2009 through early 2010. Like the DNORPS, before-Katrina and current (survey-period) circumstances were asked of respondents. Also like the DNORPS, basic information, including current whereabouts and post-Katrina migration history, was asked about all members of each pre-Katrina household. Fuller information is collected on the individual and household circumstances of both a randomly-selected adult and about a “knowledgeable” adult who may or may not be the same individual as the randomly-selected adult. The designation of “knowledgeable” was given to that member of the pre-Katrina household who was volunteered in a screener interview as the individual who knows the most about the current circumstances of the pre-Katrina household members.

The DNORPS includes people in households of all sizes. One-person households, however, are by definition not at risk of household breakup, and are therefore excluded from our analyses. I consider in our study only the 110 households containing at least two people in August 2005, just before the Hurricane Katrina mass evacuation. A total of 362 individuals lived in these 110 sample households. The focus of my analysis of the household breakup is on the 143 non-head adults in households of two or more people, and the likelihood that these non-head adults were still living with the household head 13 to 15 months after Hurricane Katrina.

The moves of individual household members, from evacuation just before or just after the storm struck to the time of the survey conducted from the end of September through the end of

November 2006, were asked about in several ways. First, in the roster, a check box was provided to identify whether each roster member still lived with the August 2005 Household Reference Person at survey date. I use this check box as our main source of household breakup information. Additionally, for the first five members on the roster, the following information was collected: whether or not in the pre-Katrina residence at survey date, where currently living if not the pre-Katrina residence place of evacuation, and place where the individual spent the most time since Katrina. These additional questions allow for cross-checks on the roster information on whether each individual is again living with the householder at survey date to be performed, and for corrections to be made where needed.

The “control” sample: the 2004 Panel of the Survey of Income and Program Participation

I use the 2004 panel of the Survey of Income and Program Participation (SIPP) first over the 16 months from Wave 1 in 2004 to Wave 5 to compare household breakup in New Orleans in the 13 to 15 months following Katrina to overall rates and to rates for groups most similar to those in New Orleans on socio-demographic characteristics. This provides for a comparison to the DNORPS. The 2004 SIPP panel ran for 4 years, through 2008. This provides for a comparison group for the four-year period from 2005 to 2009 of the DNORS. The SIPP comparison group through to Wave 5 only is described in detail here. The SIPP comparison group through 2008 will be examined in a similar manner.

For examples of previous analyses using the SIPP to investigate household breakup, see Speare and Avery (1993) and Mutchler and Burr (1991). To evaluate the sensitivity of our results to the SIPP households coming from a national mix of urban and rural areas and from geographical areas different from that of the New Orleans sample, I conducted analyses

alternately using only the SIPP's metropolitan area households and using only households in the three Gulf Coast states of the Alabama, Louisiana, Mississippi. After finding no substantial differences in migration and breakup between the three SIPP groups of included households (described in results below), I included only households in metropolitan areas in the final national sample. This has the advantages of matching New Orleans to a large number of similar individuals who were, like New Orleanians before Hurricane Katrina, living in households in U.S. metropolitan areas.

I code a "split" in the SIPP when either the householder or the individual (but not both) is lost to follow-up ("attrits"), or when both are followed but are living in different residences 16 months later. Out of 27,432 SIPP 2004 panel adults who were not the householder, 1,539 (5.6%) attrited when the householder remained in the survey, while 446 (1.6%) remained in the survey while their original householder attrited. These 1,985 cases where one but not both attrited accounted for two-thirds (65%) of all splits between the householder and a given individual. An additional 1,064 cases in which both the head and non-head remained in the survey but were living in different residences 16 months later accounted for the remaining 35%.

There were 4,550 (16.6%) of cases in which both the individual and the householder attrited between Wave 1 and Wave 5. These cases are excluded from the analysis. It may be that those households have a higher rate of breakup than households where either the individual or the householder was followed (recall that in most cases of household breakup coded in the SIPP, attrition of one member occurs, and breakup is recognized on the basis of not all attriting). If so, this will have the effect of downwardly biasing rates of breakup in our national estimates, to an upper bound of those 16.6% of cases in which both the individual and his or her household were lost to follow-up. This potentially biases upwards our estimates of the effects of Hurricane

Katrina on household breakup. The slightly longer time between Wave 1 and 5 in the SIPP (16 months) than in the DNORPS (13 to 15 months), however, will offset this bias to some extent. Moreover, there may also be a bias towards greater non-response for non-intact households in the New Orleans (DNORPS) sample. Therefore it is not obvious that our estimates of excess household breakup in the DNORPS compared to the SIPP will be biased either upwards or downwards. Both the absolute and relative magnitudes of bias in the SIPP and DNORPS are unfortunately difficult to estimate due to the lack of a suitable standard for comparison.

RESULTS

I first present descriptive statistics on the intactness of households of two or more people in the DNORPS, by whether the household or any of its members moved, by whether the household was in a residence that was either “habitable” or “uninhabitable” after Katrina, and by the type of household structure at baseline (nuclear versus extended, and whether this household extension is limited to vertical extension ---- adult children and parents living together). The DNORPS households are compared to households in the SIPP of the same structure (nuclear, vertical extension only, horizontally-extended households). I describe a household as having moved (“displaced”) when none of the pre-Katrina household is living in the pre-Katrina residence of the household. Simple descriptive statistics are used to explore the associations of household structure and the incidence of breakup in New Orleans, and in comparison with national estimates of breakup in the SIPP.

Second, I compare the distributions of pre-Katrina household structures for New Orleans households between the DNORPS households as at August 2005 and the 2005 ACS and 2000 Census Public Release Microdata (PUMS), Orleans Parish only (U.S. Census Bureau 2007b;

University of Minnesota 2009).¹ I further compare these New Orleans households to national estimates of household structures and characteristics in the 2000 Census and in Wave 1 of the 2004 SIPP panel. These comparisons serve the joint purposes of identifying the unique features of pre-Katrina New Orleans households and checking the DNORPS' representativeness with respect to the distributions of structures of New Orleans households. A similar descriptive comparison will be conducted for the DNORS sample, but using the greater socio-economic and demographic detail available in the DNORS questionnaire and allowed by the larger sample size.

Third, I use a combination of propensity-score matching and logistic regression estimation to explore the characteristics of New Orleans individuals and households that induce higher or lower probabilities of adult household members' separating ("splitting") from the household head, and to estimate the overall effects of experiencing Hurricane Katrina on a given individual's splitting from the household reference person. Both methods are used to estimate differentials in the probability of splitting by post-storm housing habitability and by the adult individual's spousal versus extended-family relationship to the household head. Results only for the DNORPS and SIPP-after-16-months comparison are given here. Additional results will be provided in the full paper, comparing the DNORS and SIPP-after-four-years outcomes. The larger sample of the DNORS will allow for more control variables to be included in the logistic regression and propensity-matching analyses. For the randomly-selected adult in the DNORS, additional outcomes will be analyzed. In particular, the change in economic circumstances associated with household breakup will be examined.

Movement from the pre-Katrina residence and breakup of the household

By our definition of "displaced" as those who had not returned to their pre-Katrina residence by

survey date, all household breakup involves the displacement of at least one pre-Katrina household member. A household remains intact if either no household member was displaced or if all household members were displaced but they were all living together at survey time. A major advantage of these definitions of displacement based solely on change of residence is that they allow the moves associated with the breakup of New Orleans households following Katrina to be compared to a national sample that was not subject to the particular conditions of storm-induced displacement. The patterns of moves associated with breakup of groups of all New Orleans households, and of New Orleans households from housing units and neighborhoods that were either habitable or uninhabitable after Katrina, may then be compared to national patterns of movement and breakup (in the SIPP).

As throughout this analysis, sample size restrictions in the DNORPS mean that that the number of variable categories needs to be minimized. I classify residences into “habitable” and “uninhabitable” through a combination of their location in either the “high-flood” stratum (all coded as “uninhabitable”) versus in the “medium-flood” and “no-flood” strata and of self-reported condition of the individual housing unit. This was in response to the question “What was the extent of damage to your housing from Katrina and flooding?” I classified as “uninhabitable” those housing units in medium- and no-flood strata for which the respondent reported the residence had been destroyed or rendered uninhabitable (“Damaged so badly that you couldn’t live in it”). I classified as “habitable” those units that were undamaged or damaged but still habitable, and located in the medium flood or no flood strata, Almost all housing units in the “high-flood” stratum would also have qualified as “uninhabitable” based on self-reports on the condition of their individual housing units.

For the “household breakup” outcome variable, I code households as “intact” if all pre-

Katrina members remained together at the fall 2006 survey date and “non-intact” otherwise. The main source here is the check box for still living with the Household Reference Person at survey date.² I investigate different forms of breakup both by classifying households by the pre-Katrina size and structure, and through analysis of whether the entire household was “displaced” (no members of the household again in the pre-Katrina residence one year later). Individual household members’ splits from the household reference person are later analyzed according to their relationship to the reference person in addition to their personal characteristics and characteristics of the household.

[TABLE 1 ABOUT HERE]

In total, I estimate from the DNORPS that 53.9% of New Orleans households with two or more people were displaced entirely, the majority of which (30.9%) remained completely intact (see Table 1). Adding to the entirely-displaced households the 13.9% of households in which at least one, but not all, household members moved, as many as two thirds (67.8%) of New Orleans households experienced the displacement of at least one individual following Hurricane Katrina. Our two-category damage classification is strongly correlated with displacement, and moderately correlated with household breakup. Among “uninhabitable” residences, 75.0% were displaced entirely ---- that is no pre-Katrina members of the residence lived in it a year later. Again, the majority of these displaced households remained intact (42.7%, versus 32.3% that did not). In contrast, among households from residences and neighborhoods that remained habitable (“habitable”), only 12.5% were displaced entirely.

Household break-up can involve the displacement of at least one but not all members

from the pre-Katrina residence. This phenomenon was much more common for habitable residences. While 28.3% became non-intact, 23.5% still had at least one member living in the pre-Katrina residence. For uninhabitable residences, of the 41.2% that became non-intact, only 8.9% still (or, more accurately given the time required for reconstruction, again) had at least one member living in the pre-Katrina residence.

I further compare the breakup and partial or entire displacement of households in the uninhabitable and habitable New Orleans residences with the national sample from the 2004 SIPP panel 16 months after the first survey wave. I compared SIPP estimates for all U.S. households, for metropolitan areas only, and for the three Gulf States, Louisiana and neighboring Mississippi and Alabama, only. Because the results for these three comparison groups are similar to each other, I describe only those for metropolitan areas. Overall, three quarters (75.5%) of households nationally with two or more people remained intact and in the same residence (versus 32.3% in New Orleans), and a further 10.3% of households moved as an intact unit into a new residence (versus 30.9% in New Orleans). The remaining 14.2% of households that were “non-intact” were predominantly cases of one or more household member moving out while one or more remained in the residence a year later (12.1%). Nationally, cases of household breaking up with all members moving, but to more than one new residence, made up only 2.1% of all households of two or more people in 2004. This latter figure provides the largest contrast with our estimates for New Orleans: A quarter (23.0%) of New Orleans households had all members move but to more than one new residence.

[TABLE 2 ABOUT HERE]

Household breakup by pre-Katrina household structure

The probability of household breakup is much higher for extended-family than for nuclear-family households both in New Orleans and nationally, but it was especially so for extended-family households in New Orleans after Katrina (see Table 2). I define extended-family households to include households with at least one child of head aged 18 or over, as well as households with relatives or non-relatives of the householder other than children. While nationally 6.9% of nuclear-family households had at least one member leave over the year, the break-up rate of New Orleans nuclear-family households following Katrina (8.0%) was not statistically different. The break-up proportions of the two types of extended household, however, were twice as great in New Orleans as nationally. As many as 54.0% and 77.9% of New Orleans households I classify respectively as vertically and horizontally extended in 2005 (pre-Katrina) were non-intact in at the 2006 survey date, compared to 24.8% and 45.3% of such households nationally.

Because Katrina-induced displacement appeared to take its greatest toll on extended households, it is important to consider the prevalence and types of extended-family households in New Orleans versus nationally. We do this first in Table 2 at the household level, comparing again to national metropolitan area estimates in the SIPP (see “distribution” columns of Table 2). Nuclear-family households account for almost three quarters (72.6%) of households of two or more individuals nationally, but just under half (47.0%) only in New Orleans. Vertically-extended households, moreover, make up as many as a third (34.3%) of New Orleans households, more than twice the national percentage (15.6%).

[TABLE 3 ABOUT HERE]

I next consider the forms of household extension in New Orleans versus nationally in more detail, taking adult non-head individuals as the units of analysis. Their distributions are compared between New Orleans and nationally in Table 3. In Panel A of Table 3, the 2005 ACS and 2000 Census are used to compare to the DNORPS household structure for New Orleans. The 2000 Census and the 2004 SIPP are used to represent the national distributions of household structures. Results are overall very similar between the respective data sources. Only the “partner/friend/visitor” category exhibits substantial differences between data sources, probably due mostly to differences in this category between the survey instruments. Irrespective of data source, however, fewer non-heads are “spouse” in New Orleans (around 40%) than nationally (55 to 60%). Significantly for the study’s examination of the breakup of extended-family households after Hurricane Katrina, the category of “Child of reference person,” is approximately 1.5 times as common in New Orleans nationally, at around 30% of non-head adults in New Orleans versus 20% nationally. Other forms of vertical extension are relatively uncommon in both New Orleans households (6 to 7%) and nationally (4%).

In Panel B of Table 3, the race and poverty dimensions of extended-family household relationships in the 2000 Census are presented for New Orleans only. The Census is used to obtain large enough sample sizes to analyze relationships and poverty rates by relationship separately for the non-Hispanic white and black adult populations of New Orleans. Both the high proportion of adults living as non-heads in New Orleans and the high levels of household poverty experienced by non-heads in New Orleans are seen to be very largely phenomena of the city’s African-American population. The non-Hispanic black population of New Orleans formed 61.8% of all adults aged 18 and over in 2000, versus 31.4% for non-Hispanic whites. One in

four (25.1%) of black adults was a relative of the householder (“head”), with 17.2% a child-of-head and 7.9% related in another way to the head. Among non-Hispanic white adults, meanwhile, fewer than 1 in 10 was living as a relative of the householder in 2000. The New Orleans household poverty rates of 22.1% for adult children of heads and 23.2% for other relatives of heads also largely reflect black extended-family poverty: 25.5% of black adult children of heads and 27.7% of black other relatives of heads lived in a poor household. Almost a third (30.6%) of black children-of-head aged 18-24 year olds lived in a poor household, suggesting that the economic situation of these young adults and their families was likely to have been especially precarious before Hurricane Katrina struck the city.

These high poverty rates of extended-family households, moreover, are after accounting for the benefits of income pooling and household consumption economies of scale built into the family-based official poverty rate. In contrast approximately half of black adults living as unmarried partner of head or other non-relative of head (e.g., housemate or boarder) were poor when using the official poverty rate that does not account for the income of the head and any of the head’s co-resident family members (Bauman 1999). A further 38.4% of black household heads with no co-resident family member were poor. This again suggests that living as a relative of head is likely to be poverty-alleviating for many black adults in extended-family households.

Multivariate analysis of the separating or splitting off from the pre-Katrina household head

I considered earlier household breakup as occurring when any one pre-Katrina household member splits off from the others. I next consider individuals’ splitting from the household. “Splitting” is defined in relation to the household reference person (“household head”). The same outcome variable, splitting from the household reference person, is used in both bivariate

and multivariate analyses. In the bivariate analyses I estimate the simple association of splitting with being in New Orleans versus in the U.S. as a whole (limiting the U.S. population to those living in metropolitan areas). In the multivariate analyses, I estimate the increase in probability due to Hurricane Katrina of an adult experiencing a split from the household reference person. Estimates of the bivariate and multivariate associations are made separately between non-head individuals in habitable and uninhabitable housing units, and between non-heads living in three types of relationship to the head: spouse, adult child of head, and other relationship to head. In each case the comparisons are made between the DNORPS for pre-Katrina New Orleans residents and the SIPP for the national, metropolitan-area household population. Two DNORPS individuals were discarded from these analyses due to missing data on educational attainment or employment, leaving a total of 141 non-head adults in the DNORPS sample.

The New Orleans (DNORPS) sample of adult individuals in households of two or more adults is matched to a national control group on factors other than the Hurricane and subsequent flooding. I first use propensity-score matching to apply a case-control approach to the analysis of the breakup of New Orleans households. The propensity-score matching method provides strong theoretical properties based on a treatment/control framework (Imbens 2004; Morgan and Harding 2006). Under this framework, the distribution of the group that experiences the “treatment” is applied to the “control” group. The interpretation is then an estimate of an average treatment effect *on the treated* (“ATT”). In the present study, “treatment” has two interpretations. The first is simply having lived in New Orleans when Hurricane Katrina struck. The second is having lived in New Orleans in a housing unit or neighborhood made uninhabitable by Hurricane Katrina.

Unlike a multivariate regression analysis, the ATT estimates are directly comparable to

bivariate estimates of simple differences in means or proportions. In the present case, the difference between the proportions of non-head adult individuals in New Orleans and nationally who split from the household head is estimated after applying the distribution of characteristics of New Orleans residents to the national sample. The interpretation is analogous to that from a directly standardized demographic rate estimator (e.g., Smith 1992), where New Orleans provides the “standard” population whose distribution of characteristics is applied to the national sample of households. In place of using the distribution represented by cell proportions, however, the ATT estimator reweights the national sample on the propensity-scores of the New Orleans sample. The “propensity score” is just an estimate of the probability that an individual of a given set of characteristics will be in the DNORPS sample given that he or she is in either the DNORPS or the SIPP sample. The major advantage of the propensity score over a simple demographic standardization estimator is that it solves the problem of dimensionality with multiple predictor variables. These variables in the present study are relationship to reference person, the non-head’s age, education, and employment status, the race of the household head, and whether the housing unit is owned or rented (described in the logistic regression model below).

Different propensity-score estimators may be used, including nearest-neighbor one-to-one matches and several types of one-to-many matching estimators. The use here of a very large national sample in combination with a one-to-many matching procedure results in major gains in statistical efficiency compared to a one-to-one match (Smith 1997). Also useful for statistical efficiency is the near equality in the numbers of individuals living in housing that became uninhabitable versus in housing that remained habitable, and the large proportion of extended-family households in the DNORPS sample.

Among possible matching estimators, I use the “stratification” estimator, in the Stata statistical package (Becker and Ichino 2002). This weights equally the differences between the New Orleans and the nationally sample within a given stratum containing a given range of propensity scores, with the weights given by the New Orleans sample (the “treatment” sample). The boundary points and number of strata are chosen optimally as part of the propensity-score estimation routine. I use normalized sample weights respectively of the DNORPS and SIPP in the propensity-score estimation routine. In the matching routine, standard errors are calculated either analytically or by bootstrap. Only the bootstrap incorporates design effects, and so is used here in the comparisons where statistical significance may be affected by choice of variance estimation method. I further use the “common support” option that eliminates all national sample observations that do not match to a New Orleans non-head adult.

[TABLE 4 ABOUT HERE]

Estimates of the bivariate associations of being a New Orleans resident with splitting from the household head, and of the (“treatment”) effect of experiencing Hurricane Katrina on splitting from the household head among New Orleans residents, are presented in Table 4. Overall, a third (33.1%) of New Orleans non-head adults were living separately from the pre-Katrina household head after the year and one to three months since Hurricane Katrina struck. Most of this (18.1%) may be interpreted as a consequence of Hurricane Katrina and its aftermath for New Orleans residents. Note that this “treatment effect” is smaller than the difference between the New Orleans and national proportions ($33.1\% - 12.9\% = 20.2\%$), implying a larger propensity for breakup among non-head adults in New Orleans than nationally even before

Hurricane Katrina. This is seen for non-heads both whose residence was made uninhabitable by Hurricane Katrina and for non-heads whose residence was still habitable. For those non-head individuals whose residence became uninhabitable, 38.2% were not living any longer with the head in late 2006. This compares with 12.9% nationally, and 24.8% of this difference is attributable to Hurricane Katrina. For non-heads who were in residences still habitable after Katrina, almost twice as many as nationally (22.8% versus 12.9%) separated from the head, though the “treatment” effect of 9.2% was only marginally significant in a two-tail test of difference from 0. The largest “treatment” effect was that for adult children of head. The 33.5% estimate is interpreted as implying that one in three adult children of head separated from the household head following Katrina, when they would not have separated from the head under “normal” circumstances. Instead of a “normal” splitting incidence of one in five, one in two adult children of head separated from the head following Hurricane Katrina. In contrast, only 2.6% of spouses are interpreted to have split from their husband or wife due to Hurricane Katrina, a magnitude not statistically different from zero. The fact that the treatment effect only half the observed difference (9.3% - 4.2%) implies that New Orleans married couples had characteristics already predisposing them more to separate than married couples nationally.

[TABLE 5 ABOUT HERE]

In Table 5, I present logistic regression estimates of models similar to those implicitly estimated by the propensity-score matching estimators of Table 4. In the logistic regression model, we see clearly the benefits of leveraging the small samples of the DNORPS with the very large samples of the SIPP. All coefficients except “Black household head” are significantly

different from zero, due to the high statistical power afforded by the 23,000 SIPP observations. The main coefficients of interest are those that interact the DNORPS with relationship to household head and that interact DNORPS with “residence uninhabitable.” The statistically significant interaction of DNORPS with “residence uninhabitable” strengthens the finding from the propensity-score matching estimates. This statistically significant interaction in the logistic regression estimator means that not only are the effects of having experienced Hurricane Katrina and having one’s house destroyed or otherwise made uninhabitable different from “normal” conditions, but also the effect of having one’s house destroyed or otherwise made uninhabitable on experiencing household breakup is statistically larger than that of having lived in New Orleans when Hurricane Katrina struck but not having had one’s house destroyed. Note too that this is an effect after controlling for living in an owner-occupied house versus renting. The main-effect coefficient for “DNORPS” (New Orleans pre-Katrina residents) in the first column is only marginally significant (at the $p < .10$ level), however, just as it was for the individuals from habitable residences in the propensity-score matching estimator. Thus the evidence for broader community impacts on household breakup is suggestive rather than conclusive on the basis of the data of the present study.

The coefficient for extended family relationship to head is statistically different in the DNORPS from the SIPP, implying again a higher impact on dissolution for extended-family households following Katrina than under normal conditions. The coefficient for the interaction of being the spouse of head with living in New Orleans is positive but not statistically significant. Low statistical power in our study is likely to be a problem for detecting effects of Hurricane Katrina on spousal separation. In additional statistical testing of contrasts between coefficients, I found that the coefficient for the interaction between living in an extended-family

relationship to the head with “DNORPS” was not statistically significant different from the coefficient for the interaction between living in an extended-family relationship to the head with “DNORPS” (results not shown). This means that while we can be confident that Hurricane Katrina increased the likelihood of household breakup relative to living in an extended-family relationship to the head under “normal” conditions, we cannot be confident that this was *not* the case also for Hurricane Katrina’s effect on married couples. The lower effect of splitting estimated among spouses who are employed compared to those not employed (see the coefficient for Employed*spouse) is also consistent with greater dissolution of married couples after Katrina, as previous studies of displaced Katrina residents cited earlier showed major negative employment outcomes among those displaced by Hurricane Katrina. However, in our combined-data estimation this spousal-employment relationship with dissolution is a general national finding rather than one specific to the New Orleans sample (results for the non-significance of the control variables interacted with DNORPS not shown).

DISCUSSION

A catastrophic natural disaster such as Hurricane Katrina for the City of New Orleans will have major impacts not only on individuals but on social structure. Focusing specifically on the household as a key unit of social structure, I compared the household-structure dynamics between a representative sample of pre-Katrina New Orleans residents traced just over a year after the Hurricane and an all-U.S. metropolitan residents sample from a nationally-representative survey over an equivalent period. To maximize the statistical power of the New Orleans observations, I used propensity-score estimation with one-to-many matches to the national panel survey observations. I further used Census and American Community Survey

data to anchor the pilot study estimates of pre-Katrina New Orleans household structures and associated racial composition and poverty rates.

These data and methods yielded an estimate that Hurricane Katrina and its aftermath increased the rate of household breakup to 2.5 times its usual level. An important insight for understanding the relationship of household structure to the processes of amplification of the racial stratification in the post-disaster outcomes of Hurricane Katrina comes from the observation that extended-family households in pre-Katrina New Orleans, and especially poverty in pre-Katrina extended-family households, were seen to be very largely confined to the African-American population. The high prevalence of extended-family households among the African-American population of New Orleans households preceding the disaster, and the high increments to the conditional probabilities of breakup attributed to the storms, were both important determinants of the highly-elevated level of household breakup. Extended-family households, and the unequal manner in which their needs were provided for in pre- and post-disaster planning and policy implementation, are therefore found to have played an important role in amplifying the socioeconomic and racial inequality of disaster-induced displacement. A population's household organization and societal and policy responses to it are likely to be especially important when loss of housing is such a prevalent outcome as it was in New Orleans. A focus on housing and household structure and composition is especially important for understanding the inequality-increasing and racial stratification processes of catastrophes and disasters because of the known large differentials in household structure along race and poverty dimensions.

Both the social vulnerabilities and stratification literatures have emphasized the economic inequality and racial divides that catastrophes such as Hurricane Katrina can exacerbate. In addressing the broader, adverse consequences of disaster for a population, the concept of "social

vulnerability” to disaster has figured prominently (Cutter et al 2003), including specifically analysis of the Gulf coast region (Cutter and Emrich 2006). This literature, however, has focused largely on pre-disaster preparation and evacuation. Poor and elderly individuals have been considered as particularly vulnerable, but mostly without reference to their household structures. Factors associated with vulnerability during evacuation may or may not coincide with those associated with disadvantage in the post-disaster recovery and construction phases. Physical housing recovery is clearly very important in these phases, and the interactions of housing with pre-disaster household structure are likely to be crucial for post-disaster well-being.

Political-economic processes have been emphasized in the racial stratification literature (e.g., Henkel et al 2006; Yarnal 2007; Freudenburg et al 2008), but again with little reference to their interaction with family and household organization. The present study extends the understanding of racial stratification mechanisms to include household structure and its post-disaster dynamics and interactions with housing recovery. The high prevalence of economically-disadvantaged among black and extended-family households in pre-Katrina New Orleans. This is a more extreme case of the generally greater economic vulnerability and reliance on extended-family households of elderly African-Americans (Rendall and Bahchieva 1998; Angel, Jimenez, and Angel 2007) and African-American single-mother families (Hofferth 1994) nationally. Housing and household structure is therefore likely to be crucial as a mechanism of amplifying racial inequality increase following disasters and catastrophes, and a fuller development of their role in the mechanisms underlying their dynamics is called for in analyses of the broader political-economic processes of recovery and reconstruction.

The effects of catastrophes on extended-family households are potentially important at all ages, and not only for elders. While elders’ needs for extended-family assistance have

traditionally been emphasized (e.g., Rendall and Speare 1995), economic vulnerability has been shown to be higher in some cases for the adult children than for their middle-aged and older parents (Speare and Avery 1993; Choi 2003). In the relationships of individuals within households in New Orleans explored in the present study, adult children were found to be by far the largest single group to separate from the household head following Hurricane Katrina. Further investigation into outcomes of household-structure change for both adult children and their parents is needed here. In some cases, these adult children will have played crucial roles caring for and economically sustaining elderly, household-heading parents. In others, children may have been more dependent on their parent or parents as home owners or renters.

The greater need of the young adult of the household on family-extension is especially likely to be the case when the non-head child herself has children. Loss of housing may have severe consequences for both single-parent families and for single adults, including homelessness (Wasson and Hill 1998; Wright et al 1998). A 30% household poverty rate, for example, was seen among 18-24 year old children of African-American pre-Katrina New Orleans' householders. More research is called for to understand the post-Katrina impacts also for these younger groups. Not only homelessness, but also the problems of living for extended periods in "doubled-up" housing (Ahrentzen 2006), should be considered.

A view of families as resources during and after a disaster event also calls for attention to the processes of post-disaster moves into the households of family inside or outside the disaster region. Both socioeconomic status and the location of kin network will be important here. Morrow and Enarson's (1996) study of Hurricane Andrew recovery found much longer durations of stay with family living away from the disaster area among lower-income displaced individuals. For those whose relatives are within the affected area and not outside it, there will

be greater “destruction” of family resources especially in a catastrophe (Quarantelli 2006). This is a case of an opposite process to that of the disaster typology of resources that focuses on family and kin within the devastated area as resources to aid in evacuation. Within this “evacuation phase” vulnerability framework, for example, Morrow (1999:7) describes immigrant and new communities as more “vulnerable” for their lack of interconnectedness. Connectedness to kin outside the devastated area, however, may be more important in recovery after a catastrophic event such as was Hurricane Katrina and its aftermath for the city of New Orleans.

Understanding the roles of family and kin network may fit better within a broader “social embeddedness” theoretical framework that emphasizes the strong and weak ties to bring resources to bear, as discussed by Iversen and Armstrong (2008). The concept of “kin embeddedness” was introduced early to the disaster literature by Bolin (1976) in his study of displacement following a catastrophic flood impact on Rapid City, South Dakota. In both this and the landmark study of Erikson (1976), the primacy of the family unit was found to increase as other community structures broke down either due to physical destruction or under community conflict in the recovery and reconstruction processes.

Finally, the dynamics of household structure and post-disaster housing conditions may usefully be related to the general involuntary migration literature (Hunter 2005). It may also be useful in future studies to place elders’ involuntary migration outcomes in response to natural disasters in the context of what is known about life-course elder migration and its relationship to economic well-being and receipt of care in extended-family households in the non-disaster literature (e.g., Walters 2002). While retirement-age migrants, like younger adult migrants, are typically positively selected on economic characteristics, declines in health status and spousal death may serve as need-based impetuses for migration at older-old ages. Comparisons of the

migration and extended-family living outcomes for elders following housing losses in disasters and catastrophes with those associated with elders' life-cycle-needs migration may yield additional insights into the dimensions of social inequality arising from post-disaster household-structure changes.

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Table 1 Distributions of households by members' moves and household intactness, all households with two or more members

Household Intactness and whether all moved	New Orleans			National		
	All	Uninhabitable	Habitable	All	universe limited to metropolitan areas	universe limited to Gulf States*
Household intact						
No household members moved	32.3	16.1	63.9	76.1	75.5	76.4
All household members moved	30.9	42.7	7.8	9.9	10.3	8.8
Household non-intact						
All household members moved	23.0	32.3	4.7	2.0	2.1	1.7
Some household members moved	13.9	8.9	23.5	12.1	12.1	13.1
All Households	100.0	100.0	100.0	100.0	100.0	100.0
Sample N	110	62	48	26,383	19,323	1,159

Notes:

"Uninhabitable" is designated when the household respondent reports that the housing unit was destroyed or damaged so seriously as to make it uninhabitable, or when the housing unit was in a neighborhood with a flood depth of 4 or more feet.

* Alabama, Louisiana, Mississippi

Data Sources:

New Orleans: Displaced New Orleans Residents Pilot Study (13 to 15 months from late August 2005)

National: Survey of Income and Program Participation, Wave 1 to Wave 5 (16 months from late 2004 to early 2006)

Table 2 New Orleans and national household intactness by household structure

Household structure	New Orleans		National (metropolitan areas)	
	distribution	% non-intact	distribution	% non-intact
nuclear	47.0	8.0	72.6	6.9
extended				
vertical only	34.3	54.0 **	15.6	24.8
horizontal	18.6	77.9 **	11.8	45.3
all households	100.0	36.8 **	100.0	14.2
Sample N	110		19,323	

Notes:

statistical significance, New Orleans difference from national sample

* p < .05

** p < .01

Data Sources:

New Orleans: Displaced New Orleans Residents Pilot Study (13 to 15 months from late August 2005)

National: Survey of Income and Program Participation, Wave 1 to Wave 5 (16 months from late 2004 to early 2006), metropolitan areas only

Table 3 Adults' relationships to household head and poverty by race before Hurricane Katrina

	New Orleans			U.S.	
	2005 DNORPS	2005 ACS	2000 Census	2000 Census	2004 SIPP
A. Distribution of (non-head) adult^ household members by relationship to head					
Spouse	42.7	41.8	38.4	55.8	59.8
Partner/friend/visitor	3.8	7.8	11.2	9.3	5.2
Child	31.0	29.1	28.8	19.1	20.8
Child-in-law			0.8	0.8	
Parent	2.6	3.2	2.3	2.2	2.7
Parent-in-law			0.5	0.7	
Sibling	4.4	3.3	4.0	2.5	2.4
Sibling-in-law			0.3	0.6	
Grandchild	3.5	3.1	2.7	0.9	0.8
Other relative		4.0	2.4	1.5	
Other non-relative	1.9	7.7	8.5	6.7	3.4
Other	10.0				
total	100	100	100	100	100

B. Race and poverty composition by relationship to head in New Orleans, 2000 Census

	Relation to head (distribution)			Poverty rate		
	All	black (non-Hisp.)	white (non-Hisp.)	All	black (non-Hisp.)	white (non-Hisp.)
Household head (householder)	56.2	54.4	61.0	25.3	33.0	11.8
head with no coresident family	22.3	16.5	33.6	28.2	38.4	17.4
Spouse of head	17.8	15.6	21.3	8.5	11.9	3.2
Adult children-of heads	13.3	17.2	5.9	22.1	25.5	5.3
18-24 year old children of heads	6.7	9.0	2.2	27.2	30.6	5.5
Other adult non-head relatives	6.1	7.9	2.6	23.2	27.7	4.0
Unmarried partner*	3.1	2.9	3.7	38.7	47.0	24.1
Other adult non-head non-relative	3.4	2.1	5.7	43.7	50.7	38.0
all adults in households	99.9	100.1	100.2	22.8	28.8	11.3
Total adults	334,939	206,999	105,093			
Proportion non-Hispanic black and white		61.8	31.4			

Notes: ^ "adult" is defined as age 18 and over

* Poverty rate is high in part due to its being calculated based on the resources and needs only of relatives in household.

Data Sources:

DNORPS = Displaced New Orleans Residents Pilot Study, household structure in August 2005

ACS = American Community Survey, IPUMS interactive tabulation (www.ipums.org)

Census: IPUMS interactive tabulation.

SIPP = Survey of Income and Program Participation 2004 Panel, Wave 1, metropolitan areas only.

Table 4 Percentage of non-heads adults living separately from the household head after 13-16 months

	Observed Percentages Splitting from Household Head				p-value DNORPS vs SIPP~	Propensity Score Estimator of the Hurricane Katrina Effect on the Hurricane Effect on Splitting ⁺⁺	
	U.S. [^] (SIPP ⁺)		New Orleans (DNORPS ⁺)			estimate	t-value
all non-heads	12.9		33.1 **		<.001	18.1 **	4.62
[confidence interval]	12.4	13.5	24.5	41.7			
sample N ^c	22,046		141				
non-heads, residence habitable ^a			22.8 *		0.021	9.2 #	1.85
[confidence interval]			12.3	33.2			
sample N	20,902		64				
non-heads, residence uninhabitable ^b			38.2 **		<.001	24.8 **	4.43
[confidence interval]			26.5	49.9			
sample N	21,363		77				
spouse of head	4.2		9.3		0.115	2.6	0.78
[confidence interval]	3.8	4.5	0.1	18.5			
sample N	12,996		58				
adult child of head	19.6		52.8 **		<.001	33.5 **	4.42
[confidence interval]	18.3	20.8	35.2	70.5			
sample N	4,789		45				
other relationship to head	31.8		48.6 *		0.026	17.5 *	2.31
[confidence interval]	30.1	33.6	33.0	64.1			
sample N	4,474		38				

Notes:

+ DRNORPS = Displaced New Orleans Residents Pilot Study; SIPP = Survey of Income and Program Participation

[^] Non-head individuals living in Metropolitan Areas of the U.S.

~ All contrasts are to SIPP "all non-heads". Chi-square test of independence between surveys adjusts for clustering in families in both DNORPS and SIPP (all metropolitan areas of the U.S.), and for stratified sampling in the DNORPS.

Estimates are weighted for unequal probability of selection into sample.

++ Uses propensity-score stratification method of matching, with normalized sample weights in the propensity-score equation. The estimate is interpreted as the additional percentage of individuals that split from the head due to experiencing Hurricane Katrina and its aftermath in New Orleans.

a. undamaged residence or damaged but still habitable, not in high flood stratum

b. residence destroyed or damaged and uninhabitable, or in high flood stratum

c. Sample N is the number of observations used in the many-to-one match of the propensity score estimator, estimated with the "common support" option. This results in inclusion of all DNORPS, but not all SIPP, observations.

p < .10; * p < .05; ** p < .01

Table 5 Logistic regression of splitting from the household reference person, DNORPS and SIPP pooled⁺

	coefficient	std error	coefficient	std error
Intercept	-1.7707 **	0.096	-1.764 **	0.096
Household socio-economic characteristics				
Black household head	-0.015	0.064	-0.010	0.064
Owner-occupied	-0.375 **	0.052	-0.373 **	0.052
Individual characteristics				
<i>Age group (reference 22-29 years old)</i>				
age 18-21	-0.296 **	0.069	-0.300 **	0.069
age 30-39	-0.366 **	0.068	-0.370 **	0.068
age 40-39	-0.643 **	0.075	-0.644 **	0.075
age 50-64	-0.876 **	0.083	-0.877 **	0.083
age 65+	-0.435 **	0.091	-0.437 **	0.091
<i>Relationship to Household Head (reference: spouse)</i>				
Adult child of household head	0.849 **	0.098	0.838 **	0.098
Other relationship to household head	1.533 **	0.089	1.530 **	0.089
<i>Education (reference: not high school grad.)</i>				
High School graduate	0.014	0.063	0.012	0.063
Any college	-0.242 *	0.097	-0.242 *	0.097
Any college*nonspouse	0.221 *	0.101	0.216 *	0.101
Employed	-0.601 **	0.090	-0.602 **	0.090
Employed*nonspouse	0.748 **	0.102	0.751 **	0.102
DNORPS*spouse	-		0.586	0.540
DNORPS*child of household head	-		1.631 **	0.341
DNORPS*other relationship to household head	-		0.827 **	0.315
DNORPS	0.606 #	0.313	-	
DNORPS*residence uninhabitable	0.923 *	0.420	-	
Likelihood Ratio	2,926.2		2,925.8	
Sample N, DNORPS	141		141	
Sample N, SIPP	22,774		22,774	

Notes:

+ DRNORPS = Displaced New Orleans Residents Pilot Study; SIPP = Survey of Income and Program Participation

Except for the relationship-to-head variables, whose interaction coefficients are presented, none of the regression coefficients were statistically different between the DNORPS and the SIPP when full interactions between surveys were modeled (results not shown).

Statistical tests of the parameters' differences from zero adjust for clustering in families in both DNORPS and SIPP and for stratified sampling in the DNORPS. The regression model estimates are unweighted.

p < .10; * p < .05; ** p < .01

END NOTES

¹ Ideally, the DNORPS would be compared to the 2005 distribution for the ACS before Katrina. However, the 2005 ACS PUMS includes very few post-Katrina households, and is weighted to reproduce the June “mid-year” population of individuals and of households. The similarity of the 2005 ACS PUMS results with those in the 2000 Census PUMS (described below) is also reassuring with regard to the ACS’s representation of pre-Katrina household structures. The 2004 ACS PUMS unfortunately had too small a sampling fraction to allow identification of households within as small a geographical area as Orleans Parish.

² I made corrections by inspection for probable errors in the check box based on the survey’s history of moves between August 2005 and survey date by each of the up-to-five individuals for which this history was provided. Typically this involved checking the state of current residence of all household members, the state of residence immediately after evacuation, and the state of residence for most of the time since the Hurricane. Where current state of residence was the same for household members, I assumed they were living together. This treatment further ensures that excess household breakup in the DNORPS is not due to differences in the survey instrument.