

## BREAKUP OF NEW ORLEANS HOUSEHOLDS AFTER HURRICANE KATRINA

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### INTRODUCTION

While short-term evacuation induced by a natural disaster is a relatively common occurrence, long-term displacement of a population is extremely rare. The scale of long-term displacement of New Orleans residents following Hurricane Katrina is unprecedented in developed countries. It is unsurprising, therefore, that little is known especially about what effect the long-term displacement of a population implies for the intactness of households. In the present study, I estimate and analyze the incidence of household breakup among the residents of the City of New Orleans at the time Hurricane Katrina struck in August 2005.

I use a special-purpose survey of New Orleans households as they were before and after Hurricane Katrina, in combination with a national sample of households that serves as a comparison group, to analyze excess household breakup due to the hurricane and its aftermath. I then address the question of how much of the difference in household breakup between New Orleans and the national sample was due to: (1) differences in the distribution of factors associated with higher risk of household breakup; and (2) differences in the risk of household breakup for a given set of risk factors. I further examine the relationship of damage suffered to the residence and to the neighborhood, to excess household breakup.

#### *Evacuation versus displacement*

Two terms are commonly used to describe the mass movement of people from their homes (Oliver-Smith 2006, p.3): *Evacuation* refers to the “removal of people from harm’s way”; while *Displacement* refers to “the uprooting of people from a home ground.” 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) is typical in characterizing natural disasters as “Acute disruptions ...[that] produce short-term refugees from a geographically limited area” (p.469). The nature of movement from and return to New Orleans after Katrina, however, requires a break with existing typologies of evacuation and displacement (Picou and Marshall 2007).

In terms of 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. Almost all of the residents of New Orleans left the city, following both the declaration of a mandatory evacuation and the large-scale infrastructural damage that made continued residence infeasible even among those who refused to evacuate. Nigg et al (2006, p.113) describe the evacuation of the Gulf Coast areas in the path of Hurricane Katrina as numbering 1.3 million.

Even the largest of the relatively frequent major hurricanes that have struck the Gulf Coast in recent decades had relatively little long-term effect in terms of numbers of permanently displaced people. In a study of population displacement from Dade County due to Hurricane Andrew, Smith and McCarty (1996) estimated that 353,300 residents of Dade County were at least temporarily displaced from their pre-hurricane homes by Hurricane Andrew. Of these, only 39,200 people were estimated to have left the county permanently because of the storm, with as

many as half of these moving only as far as to neighboring Broward County. The loss of a major employer, an air force base, may have been the main cause of this. Displacement due to Hurricane Andrew was therefore overwhelmingly short-term and local in character.

Nigg et al remark on two aspects of the Katrina evacuation 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). Added to this has been the reliance of New Orleans evacuees on public institutions to restore their pre-storm housing and neighborhood infrastructural services, and the inability or unwillingness of these institutions to do so (Henkel, Dovidio, and Gaertner 2006; O’Neill 2008).

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 strongly differentiated the locations of the evacuated Katrina population. Among studies describing the populations evacuated from New Orleans in the first weeks and months of 2005, Elliot and Pais (2006, p.302) note that within two weeks, temporary shelters for Hurricane Katrina evacuees had already been established in 24 states and the District of Columbia. Houston, Texas, however, accounted for a disproportionate share of African Americans evacuated from New Orleans, with Houston’s Reliant complex having been made available for a mass transfer of evacuees from New Orleans’ Superdome and Convention Center (see also Brodie et al 2006).

Frey et al’s (2007) analysis of national data in the 2006 American Community Survey (ACS) builds an important link between evacuation and longer-term displacement of New Orleans residents. They find that in Houston accounted for a far larger proportion of displaced blacks than of displaced whites up to a year later. Displaced whites were much more likely to have moved within Louisiana and especially within the New Orleans metropolitan area. Frey et al’s supplementary analyses of IRS data find that distant movers from New Orleans had lower incomes than did local movers. The disadvantaged characteristics of Hurricane Katrina’s “disaster 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 (Greenwood 1993). The post-Katrina findings of negatively-selected migrants, however, are consistent with the findings about population movement following other disasters (Morrow-Jones and Morrow-Jones 1991).

The Frey et al study is one of the few to provide information about the nature of displacement from New Orleans using population-representative data. A major strength of this study is that it surveys the whole of the U.S., allowing for identification in a retrospective question on place of residence one year before the survey, individuals living in New Orleans in the year 2005. A weakness, however, is its reliance on a standard migration question “where did you live one year ago” to infer disaster-induced movement. The ACS public use sample of the Frey et al study, moreover, does not provide survey date within calendar year 2006, and therefore cannot be used to identify when in 2005 an individual lived in New Orleans and when (before or after Katrina threatened and then extensively destroyed the city) he or she moved.

Another major population-representative study is the Louisiana Public Health Institute’s (2007) analysis of data from the 2006 Louisiana Health and Population Survey (LHPS) from 18 southern Louisiana Parishes from New Orleans up to the Baton Rouge area. The LHPS included questions on whether a move since Katrina could reasonably be attributed to the hurricane and its aftermath, either because of housing damage or loss of job. Louisiana Public

Health Institute (2007) used these questions in estimating storm-induced displacement versus other reasons for out-migration. They first estimated the extent of disaster-induced moves from larger out-migration in the year to late-2006 compared to averages of annual outmigration from the same region over the previous three years. They further used an indirect estimation method to calculate total out-migration from the 18-parish area by subtracting LHPS-measured in-migration from Census Bureau estimates of net migration. The latter were subject to considerable challenges under the extremely difficult conditions for population estimation in a disaster-affected area (U.S. Census Bureau 2006a). Nevertheless, the LPHI study showed the scale of displacement a year after the storms to be extremely large, both within the region and beyond it. They estimated 280,000 people made storm-related moves within the 18 parishes, and a further 400,000 people moved outside the 18 parishes because of the storms.

Neither in the ACS or LHPS is it possible to identify family relocation or breakup. Both identify only individuals' moves. Stability in households can be identified by those that have more than one person still living where they lived a year before. Some instability can be identified by new people joining a household in which the household head did not move. But the composition of pre-Katrina households that are no longer together cannot be recovered by the data in the ACS and LHPS. The prevalence and character of household change due to Hurricane Katrina and its aftermath cannot, therefore, be identified from these surveys.

#### *Displacement and family relocation and breakup*

While population-representative "displacement" studies following Hurricane Katrina have been forced by their data sources to focus on individuals, the infrequency of disasters causing long-term displacement also means that little is known from any previous natural disasters about their effects on family relocation and breakup. It may be speculated that family and household structures were at heightened risk of disruption lasting longer than the initial evacuation, and that some of this disruption will have become permanent. Death of family members and the psychological stresses on individuals and families induced by disasters are potential family-disrupting effects of the storms (Galea, Nandi, and Vlahov 2005; Kaiser Family Foundation 2007; Sharkey 2007; Weisler et al 2007). In studies of the evacuation induced by Hurricane Katrina, some attention has also been given to the importance of use and maintenance of social networks that may be severely strained by the evacuation process (e.g., Fussell 2006). We further know that splitting of families occurred with some frequency in the evacuation following Hurricane Katrina (Haney, Elliot, and Fussell 2007).

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 job losses in New Orleans and difficulties finding jobs elsewhere may be expected, therefore, to have increased pressure on New Orleans couples' intactness. Karoly and Zissimopoulos (2007) find from analysis of Current Population Survey (CPS) data that unemployment rates of migrants who moved back to the areas of displacement were much lower than among migrants who remained further away.

In the case an extended-family household, job losses may have a more direct effect on household breakup. For example, adult children and parents who were 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 and therefore may conceivably be highly resistant to breakup when a disaster accentuates those needs.

Two groups are more likely to be in extended-family households due to the need for resources: young adults and older people. Among younger adults, single mothers and minority single mothers in particular have been identified as a groups that form extended-family households due to need (Hofferth 1994; Wasson and Hill 1998). Younger and middle-aged adults may also, however, provide care and economic resources to parents and therefore the direction of needs and exchange relationships within extended-family households are not uniform (Speare and Avery 1993; Choi 2003). It is useful to place elders' outcomes in response to natural disasters in the context of what is known about elder migration and its relationship to economic well-being and receipt of care in extended-family households in the non-disaster literature (Walters 2002). While elder migrants, like younger adult migrants, are generally positively selected economically, changes (especially declines) in health status sometimes serve as an impetus to migration at older-old ages, as do widowhood events. Migration and extended-family living associated with it may therefore be chosen based on increases in needs. Unmarried women, especially minority unmarried women, benefit most from living with relatives, and are consequently the most dependent on the availability of family members for their physical functioning and economic well-being (Rendall and Bahchieva 1998). The combination of minority, unmarried, and female is found to be especially disadvantageous (Angel et al 2007). Waite and Hughes (1999) show that these relationships of co-resident elder dependence hold even among younger-old (51 to 61 year old).

## 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. I use a case-control matching procedure that takes the New Orleans households as the "cases" and the national sample households as the "controls." I conduct an overall match and also match separately those physically damaged and undamaged housing units and neighborhoods to the national sample. This allows me to estimate both the overall effect of Hurricane Katrina in New Orleans on the likelihood of household breakup, and the effect for the residents whose own housing units and neighborhoods were more or less severely affected.

### *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 2007a), which was conducted in the fall of 2006. 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 unadjusted response rate of 45%. The response rates between strata were in the expected direction, with the no-flood stratum having the highest response rate (51%) and the high-flood stratum having the lowest response rate (39%). However, these response-rate differences across strata were not statistically significant. Preliminary 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 2007a).

Sastry (2007b) 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, 2007), the Louisiana Health and Population Survey, which estimated the city's total population in the fall of 2006 to be approximately 200,000 (LPHI, 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). In the first part of the results below, I provide additional representativeness checks in the form of comparisons to the 2000 Census PUMS file for households in Orleans Parish.

Sastry (2007b) 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 suggests a likelihood of higher incidence of household breakup experienced by pre-Katrina residents of 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 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 moves of individual household members, from evacuation just before or just after the storm struck to the time of the survey in October/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 in October/November 2006. 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) over the 12 months from Wave 1 in 2004 in the 12 months to Wave 4 and 16 months to Wave 5<sup>1</sup> to compare household breakup in New Orleans in the approximately 14 months following Katrina to overall rates and to rates for groups most similar to those in New Orleans on socio-demographic characteristics. 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 effect of the SIPP households being from different geographical areas than the New Orleans sample, independent of Hurricane Katrina, I also conducted analyses using only the Alabama, Louisiana, Mississippi states, but found no difference to the findings from the SIPP national sample. Because New Orleans is part of a metropolitan area, however, I included only households in metropolitan areas in the final national sample.

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 1 year later. Out of 99,000 SIPP 2004 panel sample individuals, 2,200 (2.7%) attrited from households in which the householder did not, while 800 (1.0%) remained in the survey while their original householder attrited. The 3,000 cases where one but not both attrited accounted for just under two-thirds (64%) of all splits between the householder and a given individual, with the 1,700 cases when both are followed but living in different residences 1 year later accounting for the remaining 36%. There were 9,600 (14.8%) of cases in which both the individual and the householder attrited between Wave 1 and Wave 4. These cases are excluded from the analysis. It may be that those households have a higher rate of splits than households where either the individual or the householder was followed. If so, this will have the effect of downwardly biasing rates of separation in our national estimates. The use of the SIPP Wave 5, providing a longer period than in the DNORPS for households to break up, however, will act as an offset to such a bias.

## ANALYSIS PLAN AND PRELIMINARY RESULTS

The analyses are conducted as follows. First, I compare the pre-Katrina household structures and other household characteristics. I compare the characteristics of those in pre-Katrina New Orleans households in the DNORPS with those in the 2000 Census Public Release Microdata (PUMS). I also use the 2000 Census PUMS to compare the characteristics of those in all households nationally with those in the base period (Wave 1) of the 2004 SIPP panel.

Second, I use the DNORPS to describe the movement and associated household breakup outcomes for our target populations of interest, being households and individuals in households in which there were at least two people before Hurricane Katrina. 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 our national estimates of breakup in the SIPP.

Third, I use a matching procedure to control for household structure and other socio-economic

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<sup>1</sup> Results from coding of breakup over 12 months only are presented in this preliminary draft; breakup over 16 months will also be used in the final version, using Wave 5 data.

factors other than Hurricane and its aftermath that are likely to influence household breakup. This matching is done both overall and by level of housing or neighborhood damage and by nuclear versus extended-family relationship to the household reference person.

### ***1. Household structure and housing damage as risk factors for household breakup***

I consider household structure factors associated with household intactness and with different types of household splits. I compare characteristics of households of two or more persons (pre-Katrina) that were respectively habitable or uninhabitable following Katrina. The size distribution of households, both weighted and unweighted, are first presented. I first note that weighting by probability of selection into the sample changes the distribution very little. Referring to the weighted results, uninhabitable housing units were of larger average pre-Katrina size, with a mean of 3.49 people compared to the 2.99 people of habitable units. Two or three-person households accounted for 72.8% of habitable units of two or more people, but for only 52.5% of uninhabitable units of two or more people. Uninhabitable housing units were much more likely to have been occupied by extended families (56.0%) than were habitable units (25.5%).

Nationally in 2004 (SIPP 2004 panel Wave 1), two or three-person households accounted for 67.4% of residences with two or more people. Extended-family households accounted for 25.6% of all residences with two or more people. These proportions are similar to those for habitable units in New Orleans. The households that became uninhabitable in New Orleans after Katrina therefore had especially high proportions with larger household sizes and with extended-family members, both compared to households of units that remained habitable after Katrina and to households nationally.

I also use the 2000 Census PUMS to compare the DNORPS household structure for New Orleans<sup>2</sup> and to compare to the SIPP household structure nationally. In all indicators of household composition, extended-family households are more common in New Orleans than nationally. We describe here results for relationship to reference person among non-head individuals aged 18 and over. "Spouse or partner" is a less prevalent non-head status in New Orleans in both the Census and the DNORPS than it is in the nationally in both the Census and the SIPP. This is largely compensated for by the higher prevalence of "Child of reference person" among adults (those aged 18+) in New Orleans. In the 2000 Census, spouse or partner accounted for 50% of New Orleans non-heads compared to 65% nationally, while child-of-head accounted for 30% in New Orleans but only 20% nationally. Comparing the DNORPS to the SIPP, the New Orleans versus national differences are in the same direction, but of greater magnitude. In the DNORPS, spouse or partner accounted for only 41% of New Orleans non-heads compared to 67% nationally, while child-of-head accounted for 40% in New Orleans versus 22% nationally in the SIPP.

### ***2. Movement from the pre-Katrina residence and breakup of the household***

The entire DNORPS sample (including 1-person households) included a total of 187 individuals in 49 extended households, and 216 individuals in 98 non-extended households. Of these individuals, 176 and 212 respectively were listed among the first 5 members on the household roster, and therefore have data collected on their moves since Katrina. For the rostered

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<sup>2</sup> Ideally, the DNORPS would be compared to the 2005 distribution for the ACS before Katrina. However, the 2005 ACS PUMS includes both pre- and post-Katrina households. The 2004 ACS PUMS had too small a sampling fraction to allow identification of households within as small a geographical area as Orleans Parish.

members beyond the first 5, we know from the DNORPS only if they were checked as still living with the householder.

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. One 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. I am then able to compare to the national sample, the patterns of moves associated with breakup of groups of New Orleans households that were subject to different levels of storm damage.

As throughout this analysis of the small, pilot survey, sample size restrictions mean that the number of categories needs to be minimized. I classify residences into “damaged” and “undamaged.” I classify all residences located in the “high-flood” stratum as “damaged.” For residences in the “medium-flood” and “no-flood” strata, I classify residences as “damaged” based on the condition of their individual housing unit. This was self-reported in response to the question “What was the extent of damage to your housing from Katrina and flooding?” I classified as “damaged” 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”). For those units that were undamaged or damaged but still habitable, I classified them as “undamaged.” Almost all housing units in the “high-flood” stratum also qualified as “damaged” based on self-reports on the condition of their individual housing units.

For household breakup, I code “intact” if all pre-Katrina members remained together at the fall 2006 survey date and “non-intact” otherwise. I investigate different forms of breakup both by classifying households by the pre-Katrina size and structure, and through analysis of individual household members’ splits from the household reference person according to their relationship to the reference person in addition to characteristics of the household.

In total, I estimate from the DNORPS that 54.2% of New Orleans households with two or more people were displaced entirely (53 unweighted households), while 68.0% (70 unweighted households) experienced the displacement of at least one individual. Our two-category damage classification was a strong predictor of displacement, and a moderate predictor of household breakup. Among “damaged” residences, 75.3% (45 of 63 unweighted households) were displaced entirely ---- that is no pre-Katrina members of the residence lived in it a year later. In contrast, among households from residences that remained habitable, only 16.7% (8 of 48 unweighted households) 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 undamaged residences. Of the 29.5% that became non-intact, 23.6% (11 out of 15 unweighted households) still had at least one member living in the pre-Katrina residence. For damaged residences, of the 43.2% that became non-intact, only 8.8% (8 out of 28 unweighted households) still had at least one member living in the pre-Katrina residence. The remainder experienced household break-up involving the displacement of members to different residences just over a year later. Among “damaged” residences, 43.2% (28 of 63 unweighted households) were non-intact. Among “undamaged” residences, 29.5% (15 of 48 unweighted households) were non-intact.



I further compare the breakup and partial or entire displacement of households in the damaged and undamaged New Orleans residences with the national sample from the 2004 SIPP panel to 2005, one year later. Overall, four in five households (80.8%) with two or more people remained intact in the same residence, and a further 8.0% of households moved as a unit into a new residence. The remaining 11.3% 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 (10.0%), with cases of the household breaking up and with all members moving but to more than one new residence made up only 1.3% 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 (24.3%) of New Orleans households had all members move but to more than one new residence, mostly due to the one third (33.5%) of *damaged* New Orleans households had all members move but to more than one new residence. This was almost as many households that moved intact (41.4%). Among *undamaged* New Orleans households, 6.3% had all members move but to more than one new residence, equal to the proportion (6.2%) that had the whole household move intact.

#### *Movement of New Orleans individuals*

Displacement from the pre-Katrina residence differed strongly by flood-depth stratum for those whose individual residence was still habitable: with 50% of people in high-flood 42% of people in medium-flood strata still not back in their pre-Katrina home at survey date, while only 18% of people in the no-flood stratum continued to be displaced.

Both the sample stratum and habitability of own residence after the storm are strong predictors of an individual’s continued displacement from the pre-Katrina residence at survey date. An (unweighted) 80% of those individuals in the deepest flood stratum were still displaced in 2006, compared to 56% in the medium flood stratum and 34% in the no-flooding stratum. Having a residence made uninhabitable made continued displacement at survey date almost equally common across strata, with 82% of people in medium and high flood strata, and 74% of people still displaced. In contrast, continued displacement from the pre-Katrina residence differed strongly by stratum for those whose individual residence was still habitable: with 50% of people in high-flood 42% of people in medium-flood strata still not back in their pre-Katrina home at survey date, while only 18% of people in the no-flood stratum continued to be displaced.

Turning to results for the household reference person (“householder”), again considering only those living with at least one other person before Katrina struck, just under half (43.9%) were again in their pre-Katrina residence one year later (at survey date). Of those who remained displaced, two thirds (67.7%) lived away from New Orleans and 32.3% lived again in New Orleans but in a different residence. I refer to the former as being “externally displaced” and the latter as being “internally displaced.”

#### *Household breakup, overall and by household structure*

Householders of all three mobility groups (returned to their pre-Katrina residence, internally displaced, and externally displaced) could have experienced a household breakup, and householders of all three groups could have managed to keep their household intact. I consider all households with two or more people in 2005 to explore household intactness to the 2006 survey date. In these preliminary findings, I use only the check box for still living with the

Household Reference Person at survey date.<sup>3</sup> Overall, 62.0% of householders had their households remain entirely intact. Households remained entirely intact for 73.0% of those householders who were back in their pre-Katrina residence, for 58.2% of internally-displaced householders, and for 52.2% of externally-displaced householders.

Even under normal circumstances, the frequency of being in a household in which at least one member leaves is quite high. Nationally (in the SIPP), overall only 75.4% of householders of had their households of at least two people remain entirely intact one year later (71.2% among households whose householder was African American). This means that the overall rate of household breakup in New Orleans (38%) was about 50% higher than the national average (25%).

Of all New Orleans households that did not remain intact, just over three quarters (77.3%) involved a separation between the householder and at least one of his/her spouse/partner or close relative, where "close relative" is a child, parent (or parent-in-law), or sibling. By far the most common form of separation was that between an adult child and parent, either of whom may have been the householder. This accounted for more than half of all individuals who split from the householder.

The corresponding national proportion of those households that did not remain intact that involved a separation between the householder and at least one of his/her spouse/partner or close relative was similarly just over three quarters (77.7%). Nationally, splits involving the child (any age) or parent of householder accounted for 40.0% of all individuals who split from the householder. Splits of a spouse or unmarried partner accounted for a further 18.4% of all individuals who split from the householder. Splits of a grandchild (8.4%) or sibling (4.8%) accounted for a further 13.2% of all individuals who split from the householder. Splits involving other relatives of householder accounted for a further 11.6%.

The conditional probability of household breakup is higher for extended-family than for nuclear-family households nationally, but it was especially so for extended-family households in New Orleans after Katrina. I define extended-family households to include households with at least one child aged 18 or over, as well as households with relatives of the householder other than children. Nationally, 25.6% of all households (and 38.9% of households with an African-American householder) were extended. The incidence of household breakup nationally was, as for New Orleans following Katrina, highly differentiated by nuclear versus extended household type. While 5.2% of nuclear-family households had at least one member leave over the year, 20.1% of vertically extended households and 38.5% of households with members other than adult children or grandparents/grandchildren experienced this kind of break-up. However, the break-up proportions of each type of extended household nationally were only half those of the corresponding New Orleans extended household type. Only 31% of the 49 DNORPS households I classify as extended in 2005 (pre-Katrina) were intact in at the 2006 survey date (a 69% rate of breakup). Nationally, the difference was much less between extended and nuclear family households: 64.2% of the households I classify as extended in 2004 were intact 12 months later in 2005, versus 79.3% of nuclear-family households. Thus extended-family households in New Orleans were twice as likely to break up after Katrina as were extended-family households nationwide over a similar annual period. Nationally, extended-family households headed by an African American householder had an annual rate of breakup of

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<sup>3</sup> In the final version, corrections will be made 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.

36.2%, about half that of all New Orleanian householders.

This suggests that Katrina-induced displacement took its greatest toll on extended households and much less on nuclear-family households. Its toll was equally heavy, moreover, on the intactness of extended households for which the residence itself was damaged and those for which it was not substantially damaged.

#### *Housing unit habitability, neighborhood flooding, and household breakup*

Of the 352 individuals living in households with two or more people before Katrina, just over half (56%) lived in a household that became uninhabitable. This was associated with a higher incidence of household breakup: 44.9% of individuals from uninhabitable housing units experienced household breakup versus 34.6% of individuals from habitable housing units. In total, 66 individuals (27.4% of all 241 sampled persons who were not the householder) split from the householder. But 44 (32.1%) of the 137 non-householder individuals from uninhabitable housing units split from the householder versus 22 (21.2%) of the 104 non-householder individuals from habitable housing units.

The larger proportion of extended-family households among uninhabitable housing units is sufficient to account for the lower proportion of households remaining intact, and the higher proportion in which the householder split from a co-resident close relative, among those from uninhabitable units than among those from habitable units. That is, there is no apparent effect of losing the house on household breakup. Restricting the analysis to extended-family households only, households in which the housing unit became uninhabitable were no more likely to breakup than were those that remained habitable.

The relationship-to-householder distributions of those individuals that split from the householder differed little by whether the housing unit was habitable or uninhabitable following Katrina. In both cases, exactly half of those who split from the householder were the son or daughter of the householder, while no other specific category accounted for more than 11%. Adult children (aged 18 or older) accounted for 75% of all children separating from the householder among individuals in uninhabitable units, however, versus 100% in habitable units. Nationally, 7.9% of adult children separate from the householder over a 1 year period, with separation rates highest for children in their 20s and early 30s (around 12% per year).

### **3. Estimating the affect of Katrina on household breakup: a matching procedure**

The New Orleans 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 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.

I estimate the increase in probability due to Hurricane Katrina of an adult experiencing a split from the household reference person. This adult may be any relationship to the head, including spouse/partner, adult child, parent, sibling, grandchild, other relative, or roommate/border. I

match to a national sample on relationship to reference person, own age and education, reference person's age and education, race of reference person, and whether the housing unit is owned or rented.<sup>4</sup>

I conduct a one-to-many match of one "case" to many "controls," using kernel weighting to weight the closest matches to the New Orleans "case" more than the farther matches. I first remove all cases from the national sample that are not found in New Orleans, such as rural households. The resulting estimator is equivalent to a regression in which only observations with a support in common with the New Orleans adults is estimated, and in which the weights of the observations are equal to the distribution in the New Orleans adult sample. The kernel matching technique is only one possible technique, with another commonly used technique being a one-to-one nearest-neighbor match. The use 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 important for statistical efficiency is the near equality in numbers of housing units made uninhabitable and those that remained inhabitable, or alternately in the numbers of individuals living in housing that became uninhabitable versus in housing that remained habitable (196 individuals versus 156 individuals in the total DNORPS sample). Similarly, the large proportion of extended-family households in New Orleans and in the DNORPS sample in particular is advantageous for application of the propensity-score matching separately for those in a nuclear versus extended relationship to the reference person.

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<sup>4</sup> Other variables will also be considered in the final version of the paper.

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