Household Finance after a Natural Disaster: The Case of Hurricane Katrina

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July 14, 2016

Abstract

Little is known about how affected residents are able to cope with the financial shock of a natural disaster. This paper investigates the impact of flooding on household finance. Spikes in credit card borrowing and overall delinquency rates for the most flooded residents are modest in size and short-lived. Greater flooding results in larger *reductions* in total debt. Lower debt levels are driven by homeowners using flood insurance to repay their mortgages rather than to rebuild. Mortgage reductions are larger in areas where reconstruction costs exceeded pre-Katrina home values and where mortgages were likely to be originated by non-local lenders.

JEL Classification: D14 G21 Q54

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The authors would like to thank Bruce Fallick, Silke Forbes, Jesse Gregory, Peter Hinrichs, Mark Kutzbach, Nathan Miller, Caitlin Knowles Myers, Sam Schulhofer-Wohl, Jay Shimshack, Tara Watson, and Philippe Wingender for helpful comments and suggestions. The authors would like to thank seminar participants at the Association of Environmental and Resource Economists Summer Conference, the Federal Reserve Bank of Chicago, the Federal Reserve System Committee on Regional Analysis Meeting, Middlebury College, the NBER Insurance Working Group Spring Meeting, Resources for the Future, the University of Cincinnati Finance Department, the University of Maryland, the University of Washington, and the Urban Economics Association Annual Meetings for their helpful comments on this project. We also thank Commander Timothy Gallagher and Christopher Locke for their assistance in accessing and interpreting the New Orleans area flood depth data. Kyle Fee, Anthony Gatti, Jonathon Mobley provided outstanding research assistance. The opinions expressed are those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Chicago or the Board of Governors of the Federal Reserve System.

1 Introduction

Natural disasters caused at least $113 billion of damage per year worldwide during the first decade of the 21st century (Rauch [2012]). Sixteen of the 24 most costly natural disasters over the period 1970-2009 occurred in the US, while the remaining eight were in other highly developed countries (Michel-Kerjan et al. [2012]). Many scientists believe that global climate change will increase the number of severe weather events such as hurricanes (IPC [2008]).

This paper does two things. First, we provide individual-level estimates of the causal effect of a costly natural disaster in the US on levels of household debt and indicators of financial distress. Despite the sizable aggregate cost and long history of natural disasters in developed countries, relatively little is known about how affected residents are able to cope with the financial shock of a disaster. On one hand, the aggregate cost of these disasters are suggestive of large negative wealth shocks for residents living in the disaster areas. On the other hand, the US has insurance markets (e.g., flood insurance) and governmental programs (e.g., federal disaster assistance) whose aims are to assist in smoothing the negative wealth shock of a natural disaster and to mitigate potential losses.

Second, we provide evidence of the role that local and non-local lending institutions play in post-disaster recovery. In particular, we examine the role of local and non-local mortgage lenders and how affected residents' post-disaster outcomes differ based on their affiliation with these institutions.

The setting for this study is the city of New Orleans before and after being hit by Hurricane Katrina in 2005. Hurricane Katrina had a devastating impact on Gulf Coast residents, killing at least 1,833 people and causing an estimated $108 billion (2005$) in property damage (Knabb et al. [2005]). We measure the financial impact using individual-level credit agency data, such as credit score, delinquency rate, and personal debt. The credit agency data are a random 5% sample of US residents with a Social Security number and a credit history. The data are quarterly and matched with Census-block-level flood data. We are able to follow individuals who change residences.

The paper uses a difference-in-differences research design that exploits quasi-exogenous variation in whose home is flooded. We compare the financial outcomes for residents in flooded Census blocks to residents in non-flooded Census blocks. Our strategy is to compare financial outcomes of residents living in locations that are equally likely to flood. Thus, we focus on specifications that isolate variation in flooding that could not be predicted by engineering flood risk variables before the flood.

We find that flooding *reduces* total debt. Figure 1 previews this result by plotting quarterly total debt balances for individuals living in New Orleans at the time of Hurricane Katrina. Debt balances are in dollars and plotted separately for individuals living in the non-flooded, the least flooded, and the most flooded areas. The figure shows similar pre-Katrina trends in total debt among the three groups. After Katrina, there is a sharp and immediate drop in total debt for the most flooded residents.

The reduction in total debt is driven almost exclusively by lower home loan debt. The timing and magnitude of flood insurance payouts is consistent with homeowners using the payouts to pay off mortgages rather than rebuild. Alternative explanations for the reduction in mortgage debt after Katrina either are too small in magnitude or do not fit the observed time pattern.

Surprisingly, there is only modest evidence that residents used credit card debt to smooth consumption and pay for unexpected costs after the flood. On average, there is a temporary increase of about \$500 (15%) in credit card debt after Katrina for the most flooded group, relative to the non-flooded group. There is evidence of a tightening overall credit market for flooded residents after Katrina. However, differences in new credit card debt accumulation between individuals who are more and less likely to be credit constrained are not economically significant.

Two broad measures of financial health, debt delinquency rates and credit scores, also indicate a modest and short-lived effect of Katrina on household finance. We find that the most flooded residents have 90-day delinquency rates that are approximately 10% higher, relative to non-flooded residents, for one quarter following Katrina. Credit scores for the most flooded residents are

about 0.06 standard deviations lower for a two-year period following Katrina. However, it is still possible that households took losses on the asset side of the household balance sheet, such as losing home equity, drawing down bank account savings, or tapping into retirement funds.

The decision to use flood insurance to pay down mortgage debt could be a demand-driven decision by the homeowner or the result of lender pressure to pay down the mortgage. The reconstruction cost for many New Orleans homes was greater than the market value of a similar home (Vigdor [2008]). A simple homeowner rebuilding framework predicts that homeowners who have large rebuilding costs relative to their home value and who receive flood insurance payouts are more likely to pay off their mortgage and move. We find correlational evidence to support this prediction.

At the same time, the institutional features of flood insurance provide a possible way for lenders to pressure borrowers to repay mortgages rather than to rebuild. If a homeowner has a mortgage for which the home is used as collateral, then flood insurance claim checks are written to both the homeowner and the lender. The flood insurance payout is typically held in escrow by the lender. By law, the homeowner can decide how to use the insurance payout, but must nevertheless receive the signature of the lender to release the money.

Media accounts after Katrina indicate that banks, particularly banks without a large local presence, pressured homeowners to use flood insurance checks to repay their mortgage loans rather than to rebuild their homes (e.g., Butler and Williams [2011]). The business incentives and financial stability of local and non-local lenders are likely to differ after a large disaster. Local lenders may be more willing to continue lending in New Orleans both because homeowners there make up a larger share of local lenders' business than of non-local lenders' and because local lenders face lower costs of monitoring reconstruction.

We use Home Mortgage Disclosure Act (HMDA) data to calculate the pre-Katrina share of loans that each lender made in New Orleans relative to the rest of the country. We define a local lender as one whose share of loans going to New Orleans exceeds that of the median lender. Two years after Katrina

local lenders are back to lending at pre-Katrina levels, while non-local lenders have largely exited the market. Additionally, homeowners who are likely to have a home loan originated by a local bank are less likely to pay off their mortgage immediately after the flood.

This paper contributes to the household finance literature by being among the very first to show the causal effect of a large natural disaster in the US on household finance using individual-level credit and debt information. Our empirical strategy allows us to compare how individuals living in the same disaster area, and who are part of the same local economy, are affected by heterogeneity in the disaster intensity (e.g. Basker and Miranda [2014]; Paxson and Rouse [2008]).

A better understanding of how natural disasters impact household finance is important for several reasons. First, the US has long-standing federal governmental programs in place to aid people who are affected by a natural disaster. However, there is little direct empirical evidence as to their effectiveness. We provide detailed estimates for the net effect of a large natural disaster on household finance *inclusive* of federal assistance. Second, we highlight the critical role that privately held flood insurance policies had on household finance and on the recovery of the region.

We also contribute to the literature on the role that the geographic location of lending institutions plays in the economic recovery of a region after an environmental disaster (e.g., Morse [2011]; Hosono et al. [2012]). We are the first, we believe, to show how a US homeowner's affiliation with a local mortgage lender (rather than a non-local lender) is highly correlated with post-disaster debt levels and the decision to rebuild. One implication of this finding is that the composition of local versus non-local lenders can effect overall regional redevelopment after a natural disaster.

Our paper is most similar to Deryugina et al. [2014] who, using tax return data, find a fairly modest effect on personal finances for those individuals living in New Orleans at the time of flooding. Deryugina et al. [2014] ask what the total effect of Katrina is on individual outcomes for residents of New Orleans as compared with a control group outside the city. Our estimates, by

construction, net out any common shock to New Orleans. We isolate differences in personal finance attributable to Hurricane Katrina that are based on the severity of flooding in each resident's block. One interpretation of the fact that both papers find modest and temporary negative effects on household finances is that the impact of Katrina on non-flooded residents is small.

2 Background and Data Sources

2.1 Hurricane Katrina

Hurricane Katrina hit New Orleans on the morning of August 29, 2005. Katrina was a Category 3 hurricane, with maximum sustained winds of 129 mph when it made landfall about 50 miles southeast of New Orleans (Knabb et al. [2005]). Katrina caused a large coastal water storm surge that overwhelmed the levee protection system surrounding New Orleans and led to massive flooding of the city. The maximum storm surge in the vicinity of New Orleans was about 18 feet (ILI [2006]). The initial levee breaches occurred along the outer levee walls on the eastern side of New Orleans that protects St. Bernard Parish and New Orleans East from Lake Borgne. Within three hours of the initial levee breaches, flood water covered most of New Orleans.

Hurricane Katrina had a devastating impact on Gulf Coast residents. Katrina initially displaced an estimated 450,000 people (ILI [2006]). From one month before Katrina to five months afterward, the city of New Orleans had lost approximately 279,000 residents (Frey and Singer [2006]). At least 1,833 people were killed, and total property damage was estimated at $108 billion (Knabb et al. [2005]).[1] Katrina is easily the most costly hurricane in terms of property damage in US history. Nevertheless, despite the massive economic damage, little is known about the financial impact of Katrina on individual residents (Deryugina et al. [2014]; Gregory [2013]).

Approximately 85% of New Orleans was ultimately flooded (Sills et al. [2008]). Figure 2 shows Census block mean flood water depths in the city of

[1] All dollar figures in the paper are in 2005$.

New Orleans on August 31, 2005. The flood depth data cover Census blocks that include 99.6% of the population of the city of New Orleans proper. The data also cover adjacent townships in St. Bernard Parish (Arabi, Chalmette, Meraux, Poydras, and Violet) and Jefferson Parish (Jefferson and Metairie). That said, throughout the paper, we will refer to the data coverage area as the city of New Orleans. The lightest gray areas on the map are parts of New Orleans with no flooding. We divide the flooded area into four flooding quartiles based on Census blocks. The mean flood depth of Census blocks in the first flooded quartile ranges from just above 0 feet to 1.4 feet, while the mean flood depth for the fourth quartile is 5.4-11.1 feet. The non-flooded areas consist of about the same number of Census blocks as each of the flooded quartiles. So, going by flooding depth, we can break the city into roughly equal fifths.

The source of the flood depth data is the National Oceanic and Atmospheric Administration (NOAA). NOAA derived flood depths by combining a detailed New Orleans area topography map and aerial flood photographs. The flood depth data have a depth resolution of one foot increments and a geographical resolution of 25 square meters. The August 31, 2005 flood photograph used to generate the flood depth data may slightly understate peak flood depths. Flood water heights continued to rise in some areas of the city until September 1, 2005 (ILI [2006]). Unfortunately, flood depth data are not available from September 1, 2005. Flood depth data derived from a September 3, 2005 NOAA flood photograph confirms that flooding had receded in parts of the city.

2.2 Private Insurance

Homeowners insurance covers wind damage but does not typically cover flood damage. Homeowners can protect themselves from the financial cost of flood damage by purchasing flood insurance. The federal government sets the rates for flood insurance through the National Flood Insurance Program (NFIP). The NFIP's flood insurance polices are sold by private companies at the rates specified by the program. The NFIP collects all premiums, pays all claims,

and bears all of the risk.[2] Approximately two-thirds of New Orleans homeowners had purchased a separate flood insurance policy at the time of Katrina (Meitrodt and Mowbray [2006]). We use administrative claims data on all New Orleans NFIP policies to evaluate the role that flood insurance had in recovering from the flood. At the time of Katrina, there were approximately 120,000 policies in force. The NFIP paid out approximately $9.4 billion in claims in 2005, with an average payout of $111,000.

In the context of Katrina, the details of the administration of flood insurance payouts are important. If a flooded home with flood insurance has a home loan secured by the home itself, then the flood insurance claims check is written to both the homeowner and the mortgage company. In such cases, the mortgage company and the homeowner must sign the check before the money can be distributed. Typically, the insurance money will be distributed to the mortgage company to hold in escrow. The mortgage company will usually release the insurance money in disbursements as repair work is completed. The expectation of both the NFIP and the U.S. Department of Housing and Urban Development (HUD) is that the payout should be used to repair damages to the home (HUD [2012]).

Rather than repairing the home, a homeowner could decide to use either all or a portion of the flood insurance money to pay down a home loan. By law, a mortgage company cannot obligate a homeowner to use the insurance settlement to pay down the mortgage. Nevertheless, as discussed in Section 5.2, media accounts and government documents following Katrina indicate that some mortgage companies pressured homeowners to use the flood insurance money to pay off their mortgages.

2.3 Public Disaster Assistance

Katrina led to several sources of federal disaster assistance. First, Katrina triggered a Presidential Disaster Declaration (PDD). The PDD system is a

[2]Private companies are compensated by the NFIP for selling its flood insurance policies. Policies can also be purchased at the same rates directly from the government. Gallagher [2014] and FEM [2008] provide more details on the NFIP and the rate setting process.

formalized process for states to request federal assistance following large natural disasters. A PDD opens the door to two major types of disaster assistance: Public Assistance and Individual Assistance. Public Assistance is available to local and state governments in the impacted area to remove debris, repair infrastructure, and aid in the reconstruction of public buildings. Individual Assistance is available to residents. All residents can receive cash assistance for temporary and emergency expenses, such as interim housing. Homeowners can also access low interest disaster loans to rebuild their residences. In addition, they can access a limited amount of money for housing repair. At the time of Katrina, up to $15,700 in grants were available to each homeowner for housing repair and replacement (GAO [2006]).

Second, Katrina led to congressionally approved disaster assistance that went beyond that authorized by the PDD. Congress approved $67.9 billion (2009$) as part of two supplemental appropriation bills (Michel-Kerjan et al. [2012]). The bills included authorization to use HUD Community Development Block Grants to assist with rebuilding. In Louisiana, the HUD block grants funded the creation of the Louisiana Road Home program. This program provided grants of up to $150,000 to homeowners for rebuilding costs not covered by insurance.

Third, the federal government used its role in the secondary mortgage market to pass a moratorium on home foreclosures for one year following Katrina (Overby [2007]). All homes purchased with mortgages securitized by the Federal Housing Administration, Department of Veterans Affairs, Freddie Mac, or Fannie Mae could not be foreclosed on through July 2006. That is, homeowners with such mortgages could not lose their homes to foreclosure if they fell behind in their mortgage payments. Finally, federal social safety net transfers (e.g. unemployment insurance, public medical spending), while not a direct form of disaster assistance, have been shown to increase following large natural disasters in the US (Deryugina [2013]).

2.4 Credit and Debt Information

We use individual-level credit and debt information from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax (CCP) to evaluate the effect of Katrina on household finance (Lee and van der Klaauw [2010]). Equifax, one of several large consumer credit repository and credit scoring companies in the US, is the source of the data in the CCP. The panel is built using a 5% sample of the US population that is selected based on the last two digits of the Social Security number. Thus, the sample population is made up of individuals with a credit history whose credit file includes a Social Security number.

Consumer credit account information is divided into four main types: home loans, auto loans, credit card accounts, and student loans. Home loan information separately tracks first mortgages, home equity loans, and home equity lines of credit. Credit card accounts cover all types of issuers: banks, bank card companies, national credit card companies, credit unions, and savings & loan associations, as well as department stores and other retailers.

The CCP provides the number of accounts for each loan/debt type, the balance in each type of account, indicators for whether the individual is behind on payments for each type of account, and indicators for foreclosure and bankruptcy. Throughout the paper we report home loan debt balances that have been imputed when data are missing because of non-reporting (the Online Appendix provides details). The panel also supplies the age, Census block of residence, and Equifax Risk Score (TM) for each individual. The Equifax Risk Score is a trademarked measure of consumer credit risk and ranges from 280-850. A higher score indicates a higher measure of creditworthiness. The Appendix's Table 1 shows how the CCP data compare with information collected from the decennial US Census. Using the CCP panel and Census data we show that the implied share of adults in the US with a credit history is roughly consistent with that estimated by the Fair Isaac Corporation (FICO) (Jacob and Schneider [2006]).

2.5 Engineering and Census Data

The estimation strategy of the paper uses the intensity of flooding as a measure of potential flood damage. Our preferred model controls for two measures of engineering data that are correlated with flood intensity. The first source of engineering data is the Army Corps of Engineers flood risk map for New Orleans. The map divides the area of New Orleans into flood risk zones. Flood zone A is the highest risk zone and corresponds to the 100-year flood plain. The 100-year flood plain is defined by FEMA as the area of land that will be "inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year" (FEM [2016]). While the majority of New Orleans is in the 100-year flood plain, there is still a substantial portion of the city that is zoned as being outside the 100-year flood plain (Appendix, Figure 1). The second source of engineering data is mean land elevation above sea level. The elevation data are from the US Geological Survey (USGS). Half of New Orleans has an elevation of 1.5 feet or less above sea level (Appendix, Figure 2).

Table 1 compares how the engineering characteristics from The Appendix's Figures 1 and 2, demographic and socioeconomic characteristics from the 2000 Census, and CCP credit and debt characteristics vary by the level of flooding after Katrina. Flood depth is divided into the same five groupings as in Figure 2. The mean elevation for all five groups varies from about one foot to just over two feet and is negatively correlated with the depth of flooding. The table also suggests a strong positive correlation between being in the flood plain and depth of flooding. That is, 98% of the blocks in the most flooded quartile are in the flood plain, compared to just 53% in the least flooded quartile.

The middle panel of Table 1 shows the Census variables. The socioeconomic Census variables–median household income, poverty rate, median home value, proportion owner occupied, and proportion with a college degree–paint a mixed picture across the five groups. For example, the poverty rate is lower in the fourth quartile relative to the first quartile, but so too is the proportion of the residents with college degrees, while median income is quite similar in both quartiles. Additionally, the proportion of housing units that are owner-

occupied is higher in the fourth quartile relative to the first quartile, while the median home value is lower. There are also some differences in Census demographic characteristics. The first and fourth flooded quartiles have similar proportions of older and Hispanic residents, but the fourth quartile has a larger share of African Americans.

The Census characteristics for the second and third quartiles reveal that the residents in either are consistently the least economically advantaged among the quartiles (or all five groups): either the second or third quartile features the lowest household income, highest poverty rate, lowest home value, and lowest proportion of college educated. The middle quartiles are also consistently different from the first and fourth quartile in terms of their demographics. Compared with the first and fourth quartiles, the middle quartiles have a lower proportion of residents 65 and older, higher proportion of African Americans, and lower proportion of Hispanics.

The bottom panel of Table 1 shows average CCP characteristics for residents of New Orleans in 2005Q2 by each flood group. The CCP characteristics show a pattern not unlike that seen among the Census variables. Comparing the first and fourth flooded quartiles, we see that the Equifax Risk Scores (TM), total debt balance, and the likelihood of a delinquency are similar between the two groups. The middle quartiles are consistently different from the other two quartiles: They feature lower risk scores and higher delinquency rates, indicating that they are economically disadvantaged relative to the first and fourth quartiles.

Table 2 displays the results of our investigation on which engineering and Census variables are correlated with the depth of flooding. The five columns correspond to five different ordinary least squares (OLS) regressions. The dependent variable for each regression is the Census block mean depth of flooding on August 31, 2005. The specification shown in column 1 includes only the mean, minimum, and maximum elevation above sea level and the proportion of the block that is in the 100-year flood plain. These four variables alone account for 32.7% of the variation in flood depth. Adding squared, cubed, and interaction terms for these engineering variables increases the explained

variation to 39.9%. Columns 3 and 4 demonstrate that a 2000 Census block group measure of median home value (the smallest unit of geography available in public use tabulations) explains only 3.6% of the variation in flood depth by itself and does not change the R-squared when added to the specification with the engineering variables. The full set of Census-block-group-level socioeconomic and demographic variables (listed in Table 1) are added to the regression in column 5. Adding the socioeconomic and demographic variables increases the R-squared modestly from 39.9% to 44.5% relative to the specification that only includes engineering variables.

3 Empirical Specification

We begin our discussion of the empirical specification with a simple panel data difference-in-differences regression model that we specify as

$$y_{i,b,t} = \beta D_b * P_t + \gamma D_b + \delta P_t + \varepsilon_{i,b,t}, \tag{1}$$

where $y_{i,b,t}$ is a particular outcome for individual i in period t, and the b subscript indicates the Census block in which they lived at the time of Hurricane Katrina (2005Q3). The outcomes we focus on in the paper are measures of debt, delinquency, creditworthiness, and migration. D_b is a vector of indicator variables indicating whether the block that person i resided in at the time of Hurricane Katrina (2005Q3) was in one of the four flood depth quartiles. This vector can be regarded as a set of treatment dosage indicators. If all quartile indicators are zero, then the block was not flooded and the individual is part of the control group. P_t is a post-Katrina indicator variable that equals 1 if the time period is 2005Q4 or after and 0 otherwise. β is the vector of coefficients of interest and measures the change in means (from pre- to post-Katrina) of the outcome variable for each of the treatment dosage groups relative to the change in means for the control group. Standard errors are robust to heteroskedasticity and are clustered at the block level.

The key assumption of Equation (1) is that the post-flood trend for the dependent variable for the non-flooded group is a valid counterfactual for each flooded group had there been no flood. Figure 1 provides strong visual support for this assumption. The (unconditional) pre-flood time trend for total debt is very similar for the non-flooded, least flooded, and most flooded groups. The most flooded group exhibits a sharp and immediate decrease in total debt at the time of Hurricane Katrina. Approximately two quarters after Katrina, for all three groups total debt exhibits essentially the same upward trend as before the flood. There are, however, effects on the levels of debt between the three groups that persist until the end of the sample. The level of total debt for the non-flooded and least flooded groups continue to grow at rates that could have been predicted based on pre-flood trends had there been no Hurricane Katrina. This is not the case for the most flooded group. Total debt is much lower for the most flooded quartile relative to what would have been predicted solely from the pre-flood time trends.

Of course, similar pre- and post-flood trends between the three groups do not guarantee that, had each flooded group *not* been flooded, the financial variables would have exhibited a similar time series pattern as that of the non-flooded group. For example, we know that the engineering determinants of the flood depth (percentage of the land in the 100-year flood plain and land elevation) differ between the groups. If residents sort based on these flood engineering characteristics so that more vulnerable residents are more likely to live in higher flood risk areas of New Orleans, then this could lead to an overestimate of β.

Our preferred specifications control for differences in the engineering and Census variables. To achieve this, we add the engineering and Census variables and their interactions with the post-Katrina indicator to our simple difference-in-differences regression model. In this model, the difference-in-differences estimator will only attribute variation in the outcome variables as due to flooding if it arises from variation in flood depth that is *uncorrelated* with the engineering and Census variables. We also add a cubic in age and individual fixed effects to the baseline specification to control for life-cycle patterns in the out-

come variables and any time-invariant, person-specific unobservable variables that may influence the outcomes. The resulting specification is

$$y_{i,b,t} = \beta D_b * P_t + \gamma D_b + \delta P_t + \eta X_b * P_t + \theta X_b + \kappa f(A_{i,b,t}) + \alpha_i + \varepsilon_{i,b,t}, \quad (2)$$

where X_b represents the engineering and Census-block-group socioeconomic and demographic variables, $f(A_{i,b,t})$ denotes a cubic function of age, and α_i denotes an individual fixed effect. Note that the time-invariant control variables not interacted with the post-Katrina indicator, X_b, drop out of our model because of multicolinearity once block of residence at the time of Katrina or individual fixed effects are included.

4 Results

4.1 Effect of Flooding on Debt, Delinquency, Credit Score, and Migration

4.1.1 Total Debt

Table 3 presents estimates of difference-in-differences specifications using the dollar amount of total debt balances as the outcome variable. Column 1 estimates Equation (1), while Columns 2-7 estimate versions of Equation (2). Throughout this subsection and the next, we use a balanced panel of individuals that were living in the city of New Orleans at the time of Katrina (2005Q3) and were continuously in the CCP for the 12 quarters before and after Katrina. We selected a balanced panel with three years before and after Katrina as a compromise between longer-length panels that would have limited the number of individuals in the sample and shorter-length panels that would have only allowed us to estimate relatively short-term effects of flooding. The simple difference-in-differences estimates range from -$6,781 for individuals living in the least flooded quartile to -$16,861 for individuals living in the most flooded quartile (relative to the change in debt levels in the non-flooded blocks). Model

estimates in columns 3-7 show that the point estimates are relatively stable at approximately -$4,000 for the least flooded quartile, approximately -$6,700 and -$9,700 for the 2nd and 3rd quartiles, and approximately -$11,000 for the most flooded quartile regardless of the exact covariate controls. Our preferred specification is Column 7 that includes individual fixed effects.

Table 3 shows that flooding is associated with large reductions in debt balances and that the debt balance reductions are larger in magnitude in blocks that experienced more flooding. We complement the analysis of Table 3 with an event study approach that examines the effect Katrina had on quarterly debt balances for our entire sample period. The event study approach allows for a finer analysis of debt levels and trends. We implement the event study by replacing the post-Katrina flood depth quartile interaction variables in our preferred specification (Table 3 Column 7) of Equation (2) with a series of quarter-by-flood-depth interaction variables. The 2005Q2 interactions are the omitted category.

Figure 3 plots the coefficients and upper and lower (95%) confidence bounds for the least flooded (squares) and most flooded (circles) flood depth quartiles. Note that, for clarity of the presentation, all of the event study figures in the paper and appendix only plot estimation results for the least and most flooded quartiles. Debt balances are not statistically different for either group for the three-year period before Katrina. Figure 3 shows that the reductions in debt balance for individuals in the most flooded quartile begin immediately after Katrina and persist until the end of the sample. None of the quarterly coefficients for the least flooded quartile are statistically significant at the 5% level.

4.1.2 Composition of Debt

Table 4's columns 1-3 estimate our preferred difference-in-differences specification separately by debt category. Column 1 shows a large and statistically significant drop in home loan balances of $12,181 for the most flooded group. In fact, the drop in total debt (Table 3, column 7) can almost entirely be attributed to the reduction in home loan balances. There is no overall change

in debt that is large and statistically significant during the three-year period following Katrina for credit card or auto debt.

We also estimate the quarterly event study model for each category of debt for the most and least flooded quartiles. Panels A and B of Figure 4 display the results for home loan and credit card debt (auto debt is discussed in the Appendix). There are four important results. First, there is strong support for the common trends assumption underlying the estimates in Table 4. None of the estimated pre-Katrina quarterly coefficients are statistically significant for any of the types of debt. Second, the timing of the drop in home loan balances matches the drop in total debt. Consistent with Figure 3, 80% of the post-Katrina drop in debt occurs by 2006Q1, with the largest reduction in debt measured in 2008Q1. Third, there is a temporary, one-quarter increase of approximately $500 in credit card balances in the first quarter following Katrina for both the most flooded and least flooded (p-value 0.09) groups. This represents a 15% increase over a pre-Katrina mean credit card balance (2005Q2) of about $3,800 for the most-flooded group. Fourth, there is no statistically significant change in quarterly debt levels for auto debt in the least- or most-flooded quartiles (see Appendix).

4.1.3 Delinquency and Credit Score

Table 4's columns 4 and 5 show the impact of flooding on two non-debt measures of financial health. Column 4 estimates the change in the propensity to have at least one account that is 90 or more days delinquent. The change in the average quarterly delinquency rate is not statistically significant for any of the flooded groups. Column 5 estimates the change in the Equifax Risk Score (TM) and shows a statistically significant drop for the 2nd, 3rd, and 4th quartile groups. For example, there is a 4.4 point (0.04 standard deviations) drop in the score for the most flooded group.

The delinquency and credit score estimates in Table 4 mask evidence of a larger temporary decline in the financial health of flooded New Orleans' residents relative to that of non-flooded residents. Figure 4 displays quarterly estimates for delinquency (Panel C) and credit score (Panel D). Four quarters

after Katrina there is (approximately) a 2.5 percentage point (10%) spike in the share of residents with at least one 90 day delinquent account for both flood groups. One possible reason for a delayed effect is that there was a one-year grace period on making payments for most mortgages (see Section 2.3). Similarly, the Equifax Risk Score (TM) shows a temporary drop of approximately 4 to 7 points (0.04 to 0.06 standard deviations) for both flooded quartiles for about a year and a half after Katrina. The drop is somewhat larger and persists longer for the most flooded group.

4.1.4 Migration

Table 4's column 6 shows the estimates of the effect of flooding on the decision to leave the New Orleans-Metarie-Hammond Combined Statistical Area (CSA). We define an indicator variable equal to one if an individual living in New Orleans in the previous quarter moves and doesn't return to the CSA for at least three years. Compared with the non-flooded residents, those in the most flooded areas of New Orleans migrate at greater rates after Katrina. The average quarterly migration rate is 1.2 percentage points larger in the most flooded areas, which is quite large compared to the mean of the quarterly migration rate for the sample which is 1.6%. There is no overall difference in migration rates between the least flooded and non-flooded residents. At 1.1 percentage points, the increase in the migration rate of the second most flooded group (Quartile 3) is almost as large as that of the most flooded group. The increase for Quartile 2, 0.6 percentage points, is about half as large as the most flooded group. The migration results are qualitatively similar if we define migration as leaving for at least one year or if we define migration as leaving the city of New Orleans (rather than the CSA). However, the difference in migration rates between the most and least flooded is greater if we define migration as leaving the city of New Orleans. Quarterly event study results (see Appendix) indicate that the relative increase in the propensity to leave the CSA peaks the first quarter after Katrina.

The high level of post-Katrina New Orleans migration is well documented (e.g., Frey and Singer [2006]; AHS [2011]). Our results corroborate earlier find-

ings of a positive correlation between flood depth and migration (e.g., Paxson and Rouse [2008]; Groen and Polivka [2010]). In particular, we highlight the large difference in migration rates between the least and most flooded residents. Section 5 provides a framework to interpret how flood damage, home value, and pre-existing insurance together effect the decision to migrate.

4.2 Credit Constraints and Credit Card Debt

The modest and short-lived increase in credit card debt following Katrina is surprising given the magnitude of flooding and the importance of credit cards as a financial instrument (Ekici and Dunn [2010]). For example, the permanent income hypothesis predicts that individuals who experience an unexpected negative wealth shock will smooth the cost of this shock across time periods by using savings or through borrowing. However, the fact that some consumers may face credit constraints is a possible reason for not observing a larger increase in credit card debt (e.g., Gross and Souleles [2002]; Sullivan [2008]; Jappelli and Pistaferri [2010]; Gelman et al. [2015]).

Three quarters of residents in our sample have a credit card account at the time of Katrina, with a mean balance of $5,020 conditional on having a credit card. Nationally, approximately 58% of credit card owners carried a balance from one month to the next (Ekici and Dunn [2010]). Unfortunately, we are only able to observe the total debt balance and thus we are unable to identify the portion of the debt that is due to a carried balance in the CCP.

One measure of credit demand observable in the CCP is the number of consumer-initiated credit inquiries (Bhutta and Keys [2014]). We run our preferred difference-in-differences specification with the number of inquiries as the dependent variable to estimate changes in the demand for additional credit (see Online Appendix, Table 3). There is an increase of about one additional inquiry per ten residents per quarter in the three most flooded quartiles after Katrina. We run the same specification with a proxy for the number of new accounts to estimate changes in supply. Our proxy is equal to the number of accounts in the current quarter minus the number in the past quarter if this

difference is positive, and zero otherwise. We estimate negative coefficients for all flood quartiles and find a statistically significant decrease in the number of new accounts for the most flooded residents. Taken together these results suggest an overall tightening of credit for the most flooded residents.

Next we investigate if the overall tightening of credit differentially effects borrowing for more credit constrained residents. We use two measures to identify credit constrained residents: credit score and available credit card balance. We divide residents in our sample into two groups based on whether their 2004Q2 credit score is above or below the sample median of 633. We then estimate the effect of flooding on credit card debt separately for the low and high credit score samples. The average change in credit card debt for the three years following Katrina is an order of magnitude larger than that for the low credit score sample. However, the increase in estimated credit card debt, $441, is economically small and not statistically different from zero. Results are similar if we divide residents into two groups based on whether they are within $500 of their available balance in 2004Q2. Quarterly event study estimates that divide the sample by credit score or available credit show no trends in pre-Katrina credit card debt for the least and the most flooded residents. Credit card debt peaks at about $850 in the quarter after Katrina for less credit constrained residents in the most flooded areas and just misses statistical significance at conventional levels (probability value 0.107). Event study estimates are statistically insignificant for the more credit constrained and least flooded residents.

There is clear evidence of a tighter overall credit market after Katrina (as measured by inquiries and new accounts). The tightening credit market is most evident for New Orleans residents in the deepest flood waters. Nevertheless, there is only suggestive evidence that the tighter overall market differentially effected credit card borrowing for residents more likely to be credit constrained.

4.3 Flood Insurance and Reduced Mortgage Debt

In this subsection, we provide evidence for the underlying mechanism that explains the reduction in mortgage debt after Katrina. Recall that the vast majority of the reduction in home loan balances occurs within six months of Katrina (Figure 4, panel A). Approximately 25% of the residents in the most flooded quartile who had a home loan at the time of Katrina no longer had a home loan two quarters after Katrina (see Appendix). Thus, any explanation must account for both the large magnitude and the rapid reduction in mortgage debt.

4.3.1 Flood Insurance

Flood insurance can account for the reduction in mortgage debt after Katrina. The timing of the flood insurance claims payouts matches the observed drop in mortgage debt. Moreover, the magnitude of the flood insurance payouts is also large enough to account for the size of the mortgage debt reduction.

Panel A of Table 5 uses NFIP administrative records to provide a flood insurance payout measure for New Orleans homeowners by depth of flooding. We compare the total flood insurance claims paid to residents in 2005 to the total mortgage debt owed by residents at the time of Katrina. For the most flooded group, the ratio of insurance claims to mortgage debt is 0.80. This implies that the amount of flood insurance payouts would be large enough to pay off 80% of the total existing mortgage debt for these homeowners if all the claims dollars were applied toward paying down mortgage debt rather than rebuilding. The same statistic for the non-flooded group is 9%.

Home sales, foreclosures, and federal government assistance are all alternative explanations that could account for reductions in mortgage debt. However, the timing and magnitude of these sources of mortgage relief can only explain a small part of the drop in mortgage debt immediately after Katrina.

4.3.2 Home Sales

Panel B of Table 5 provides estimates for the fraction of the observed drop in home debt in Orleans Parish that could be explained by home sales. The statistics in Panel B are calculations of the ratio of the total revenue from home sales for the six months after Katrina to the total value of mortgage debt owed by residents at the time of Katrina. Revenue from property sales could pay off just 1% of the existing mortgage debt in the most flooded group if all of the sales revenue were applied toward existing mortgage debt.

Home sales trends reinforce the finding in Panel B. During the two-year period before Katrina, the number of quarterly home sales in the most flooded Orleans Parish blocks follow a very similar trend to the least flooded blocks (see Appendix). Both groups of blocks hover around 200 home sales per quarter. In the first quarter after Katrina, sales plummet for the most flooded group. Sales recover in the second quarter after Katrina to pre-Katrina levels. The number of properties sold in the two quarters after Katrina is less than 2% of the total estimated number of residents with a home loan.

4.3.3 Foreclosures and Mortgage Write-downs

Panel C of Table 5 investigates whether Katrina led to a change in foreclosures. Panel C displays point estimates and robust standard errors from three separate regressions of a foreclosure start indicator variable on a post-Katrina indicator. Each regression considers the six months before and after Katrina. There are no foreclosure starts for the most flooded group in the CCP in the two quarters after Katrina. Thus, the point estimate for the most flooded group implies a 100% drop in foreclosure starts. One reason for the zero foreclosure start rate is the moratorium on foreclosures for mortgages securitized by the Federal Housing Administration, Department of Veterans Affairs, Freddie Mac, or Fannie Mae (Overby [2007]). The implied foreclosure start rate decreases by 58% if we expand to our entire panel period. Overby [2007], using data from the Orleans Parish Recorder of Mortgages, also finds a large reduction in foreclosure start rates in the year after Katrina.

Further evidence that the reduction in mortgage debt is due to accounts being paid off rather than being written down by the lender comes from descriptive codes attached to the mortgage data in the CCP. In 2006Q1, 35% of the individuals living in the most flooded blocks that had a mortgage at the time of Katrina had a flag on their mortgage account indicating that the account was paid, closed, and had a zero balance. In contrast, only 0.2% had a flag indicating that the bank had charged off or written down the account.

4.3.4 Federal Government Assistance

There are two major sources of government assistance after Katrina. The first source is funding made available through the Individual Assistance program following the issuance of a Presidential Disaster Declaration. Approximately $3.3 billion in Individual Assistance was distributed to New Orleans residents in 2005, of which, about one-third was for housing repair and replacement (GAO [2006]). Around $9.4 billion, or about nine times as much money for housing repair and replacement was paid out in flood insurance. The second source is the Louisiana Road Home program, the supplemental federal assistance program that provided large sums of money to New Orleans residents to assist with rebuilding. The Louisiana Road Home program did not begin disbursing money until more than one year after Katrina (Newswire [2006]).

5 Interpreting the Reduction in Mortgage Debt

The decision to use flood insurance to pay down mortgage debt could be a demand-driven decision by the homeowner. Alternatively, lender incentives after Katrina might lead the suppliers of the loans to pressure homeowners to pay down their mortgages. This section outlines a simple homeowner rebuilding decision framework that highlights the connection between flood insurance, mortgage debt, and the decision to rebuild. We find evidence consistent with the prediction that homeowners who have large rebuilding costs relative to their home value and who receive flood insurance are more likely to move. Next, we discuss how lender incentives could differ between local and national

mortgage providers, as well as how these differences might incentivize certain lenders to pressure homeowners to pay down mortgage debt using flood insurance payments. We present evidence that homeowners with loans originated by non-local lenders have larger reductions in mortgage debt, relative to those with loans originated by local lenders.

5.1 Homeowner Rebuilding Decision

We consider a simple decision framework regarding a flooded homeowner's decision of whether to rebuild their home after Katrina or move to a different home.[3] The flood damage has two main effects. The first one is a wealth shock caused by the destruction of part or all of the structure of the home. The second one is the shift in the relative price of housing (possibly due to shifts in both land values and construction costs and possibly differing in the short- and long-run) that results from the flood damage.[4] The decision of whether to rebuild or to move and pay off any existing mortgage balance will be influenced by a number of factors, including: the extent of the flood damage, the amount of flood insurance coverage, the mortgage balance, the market value of the home, the value of the land, and the replacement cost of the home. To the extent that households must tap into savings, take on additional debt, or have lost home equity, they are likely to incur some welfare loss from Katrina.

Consider the case of a flooded homeowner with no credit constraints whose house was totally destroyed by Katrina. Abstracting from the psychological attachment one may have to the lot where the house stood, the decision of whether to rebuild or not will depend upon whether there are houses available with a similar set of amenities and characteristics at a market price below the

[3]Greenwood [1997] provides a review of migration models, including models that emphasize differences in location-based utility. Other studies that model the migration and rebuilding decisions for New Orleans residents after Katrina include Gregory [2013], Landry et al. [2007], and Paxson and Rouse [2008].

[4]Katrina could potentially shock other factors, such as income, that might affect a homeowner's rebuilding decision. However, provided that the depth of flooding is random, conditional on our control variables, home damage should be independent of these other effects.

construction cost of rebuilding. The greater the flood damage is, relative to the market value of the rebuilt house, the less likely it is that rebuilding will make sense, financially. The market value of the land may also play a role in the rebuilding decision. The value of the land will reflect the option value of rebuilding in the future less the present value of property taxes for the vacant lot. However, Vigdor [2008] provides evidence that prior to Katrina, housing in New Orleans was priced below marginal cost, implying that land values were very low. It is likely that land values, particularly in heavily flooded areas, remained low after Katrina.

The main testable rebuilding-related prediction of the simple decision framework is that the greater the flood damage is relative to the home's value the more likely the homeowner is to move rather than rebuild. A flood insurance claim payout is equal to the flood damage (or the policy limit) less the deductible for those with a flood insurance policy, and as such represents a lower bound on homeowner reconstruction costs. Homeowners with relatively low home values are more likely to be in a situation where the cost to repair their current home is greater than the market price of a similar house.[5]

Table 6 shows how key housing variables in the homeowner rebuilding model vary by geography within New Orleans. The table uses zip-code-level housing characteristics for eight geographic areas, or "neighborhoods," of New Orleans. The eight columns in the table present summary statistics for each of the eight neighborhoods. The table combines NOAA flood depth data with information from the NFIP, the CCP, the 2000 US Census, and tax assessor data provided by CoreLogic. We use the tax assessor data to create parcel-level indicator variables for a severely damaged property and a severely damaged property that is rebuilt.[6]

[5]For the sake of illustration, suppose a home is insured up to its market value $75,000, has a mortgage of $20,000, is severely flooded by Katrina, and has a rebuilding cost of $100,000. The homeowner could borrow another $25,000, repair the home, and own a home worth $75,000 with a $45,000 mortgage (provided access to credit). Alternatively, the homeowner could pay off the current mortgage, and purchase a similar home for $75,000 with a $20,000 mortgage.

[6]A severely damaged property is defined as a parcel with at least a 50% drop in assessed value between the last pre-Katrina assessment and the first post-Katrina assessment

Panel A of Table 6 displays pre-Katrina housing characteristics. There is much variation in the key housing variables among the neighborhoods. For example, the median home value varies between a high of $154,000 in Metairie (Jefferson Parish) to a low of $64,000 in the 9th Ward. Moreover, the average mortgage balance (conditional on having a mortgage) is nearly three times as high in Uptown as it is in the 9th Ward.

Panel B of Table 6 shows initial evidence in favor of the prediction that homeowners in locations with a larger flood insurance claim payouts relative to the home value will be more likely to move. Four of the eight geographic areas have an average (conditional) claim-to-median-home-value ratio that exceeds one. This suggests that in these areas the typical flooded homeowner with insurance would have received an insurance check for reconstruction costs that exceeds the pre-Katrina market value of the home. These same four areas have the lowest share of homeowners still living in their pre-Katrina Census block three years after Katrina.

We test the predicted correlations from the decision framework by running OLS regressions. The Appendix's Tables 5 and 6 display regression coefficients for models where the dependent variables are whether the resident moves and whether the resident rebuilds. We run specifications that aggregate up to the zip code level, as well as specifications at the individual level (for moving) and the parcel level (for rebuilding). The moving regressions provide consistent support for the insurance claim to home value prediction, while the rebuilding regressions are more mixed. In the moving regressions, we regress the proportion of residents living in the same block three years after Katrina on the ratio of the average (conditional) insurance claim to median home value and the log mortgage balance. The most parsimonious specifications control for only flood depth and flood insurance coverage. We also consider specifications that include socioeconomic and demographic control variables (see the Appendix's Table 4 for a complete list). The estimated coefficient for the claim-to-value

(Gregory [2013]). A rebuilt severely damaged property is defined as one that has at least a 100% increase in assessed value on the 2nd post-Katrina assessment (relative to the 1st post-Katrina assessment). The Appendix provides a description of the tax assessor data. Note that these data are not available for Jefferson Parish.

variable is always negative and statistically significant, implying that a larger claim-to-value ratio is correlated with fewer residents living in the same block three years after the storm. In the rebuilding regressions, the insurance-claim-to-home-value variable is statistically significant with the expected sign only in the parcel-level regression with the full set of controls.

5.2 Local versus Non-local Lending Institutions

Differences in post-Katrina incentives for local and non-local lenders could help to explain the observed reduction in mortgage debt after Katrina. Media accounts after Katrina indicate that some lenders, particularly those without a local presence, pressured homeowners to use flood insurance checks to repay their mortgage loans (e.g., Butler and Williams [2011]). Further, the Louisiana Attorney General opened an investigation into reports of mortgage companies withholding insurance money intended for home repairs four months after Katrina (General [2005]).[7]

Incentives for local and non-local lenders differ after Katrina for at least two reasons. First, the success of companies with a large lending presence in New Orleans is highly dependent on the continued borrowing of New Orleans' residents and on the overall economic well-being of the city. The economic recovery of a region after a large disaster is far from certain, and New Orleans was characterized by both a declining population and a declining number of jobs before Katrina (Vigdor [2008]). Companies that have a relatively small share of their business in New Orleans may prefer to protect themselves from the uncertain economic environment of post-Katrina New Orleans by reducing their lending exposure and allocating capital elsewhere.[8]

[7]Moreover, when Hurricane Isaac hit Louisiana and Mississippi in 2012, HUD published a letter to "reinforce its existing policy requiring lenders to release insurance payouts" as in the past HUD "noticed some lenders would instead use these insurance funds to pay off the outstanding mortgage balance, leaving many homeowners without the resources they need to rebuild their homes" (HUD [2012]).

[8]We would expect that a lender that sells the original mortgage to be less responsive to post-Katrina uncertainty and risk. Overall, in the three-year sample period before Katrina, 62% of new loans were sold by the mortgage originator. Non-local lenders sold loans at a higher rate, (75% versus 42%), but still retained roughly a quarter of all new loans.

Second, mortgage companies are responsible for monitoring reconstruction of damaged homes throughout the rebuilding process to verify that insurance payouts are spent on fixing the property such that the collateral value of the home is properly restored. Local lenders are likely to have more personnel based in New Orleans and to have a higher degree of local knowledge about rebuilding conditions and local contractors.[9] As a result, the costs to monitor the reconstruction process and to protect their investment are likely to be lower for local lenders than non-local lenders.

Non-local lenders interested in lowering their exposure to New Orleans after Katrina can do so by issuing fewer new mortgage loans or by inducing current borrowers to pay down their mortgage debt. We find evidence consistent with both ways of reducing debt exposure. Non-local lenders dramatically reduce their lending to New Orleans (relative to local lenders) after Katrina. At the same time, the most-flooded homeowners are more likely to retire their mortgage accounts if their mortgages were (likely to be) orginated by a non-local leader.

We create our measures of local and non-local lenders by merging mortgage origination information from HMDA and lender branch location information from the FDIC's Summary of Deposits data with our CCP panel. Ideally, we would know which of the home loans that we observe in the CCP were held by a local lender. Unfortunately, this information is not part of the CCP. As a proxy for whether home loans are held by a local or non-local lender, we construct three different Census-tract-level measures of the degree of local mortgage lending activity.

Our preferred measure of local lending is based on the proportion of loans each lender makes in the New Orleans CSA relative to their total lending activity. We calculate the proportion of loans a lender makes for properties in the New Orleans CSA relative to the lender's total loans for each lender that issued at least one HMDA-measured home loan in the CSA. Each lender

[9] A related literature has recognized the role that local banking institutions have in leveraging "soft" information on applicants relative to larger national banks (e.g., Berger et al. [2005]; Agarwal and Hauswald [2010]; Chavaz [2014]).

is assigned this lender-specific New Orleans CSA loan ratio number. Next, we calculate the average loan ratio for each Census tract for each calendar year by averaging across the lender loan ratios associated with each mortgage originated in the census tract during the year. Each individual in our CCP sample is assigned an average local loan ratio based on the year of origination and Census tract of the property for the individual's largest home loan. The median resident with a home loan has a local loan ratio number of 0.21.[10]

Figure 5 shows the quarterly number of new mortgages originated by local and non-local lenders for homeowners located in the most flooded areas of New Orleans. In the figure, we consider a local lender to be one that made at least 21% of its home loans in the New Orleans CSA before Katrina. Following Katrina, there is a much larger drop in new loans to New Orleans by non-local lenders relative to the drop in such loans by local lenders. The drop is over twice as large for the non-local lenders than for the local lenders whether measured in levels or percentage terms. After Katrina, the number of new mortgages issued by local banks returns to near the pre-Katrina level around mid-2007. The number of new mortgages issued by non-local lenders remains much lower throughout the post-Katrina period.

Table 7 displays the results of investigating whether there were greater reductions in the propensity to have a home loan after Katrina among individuals who were likely to have their home loans originated by a non-local lender. We estimate five linear probability models, where the dependent variable in each regression is an indicator for an existing home loan. The sample is limited to individuals in our panel who had a home loan at the time of Katrina.

Column 1 of Table 7 estimates our preferred difference-in-differences specification (Table 3 column 7). Relative to the non-flooded group, the propensity to have a home loan drops after Katrina in places with flooding - and it drops more as the flood depth increases. Columns 2-5 of Table 7 show the local loan share associated with each homeowner's home loan interacted with the flood

[10]January 1997 is the earliest available date for the HMDA lender data with a consistent reporting requirement. Individuals with loans opened before 1997 are assigned the average Census tract local loan ratio for the January 1, 1997 - August 29, 2005 period. Please refer to the Appendix for details on the HMDA and FDIC Summary of Deposits data.

depth and post-Katrina indicators. Recall that a larger local loan share implies that the homeowner's loan is more likely to be originated by a lender with a higher concentration of lending activity in New Orleans (relative to other lenders). The mean and median local loan shares (across individuals) are 0.22 and 0.21, with a standard deviation of 0.06. The estimates in column 2 imply that a one standard deviation increase in the local loan share for a homeowner in the most-flooded group is associated with a 5.6 percentage point decrease in the likelihood of paying off a home loan (21% relative to the -0.263 estimate of the reduction in the propensity to have a home loan for the most-flooded group shown in column 1). Note also that the estimated reduction in the propensity to have a home loan in column 2 for the mean homeowner in the most-flooded group is -0.260 (calculated as $-0.467 + 0.22 * 0.941$). This estimate is very similar to the baseline estimate in column 1.

Columns 3-5 add controls for credit risk, share of African American residents, and flood insurance coverage. The estimates in Column 5 imply that a one standard deviation increase in the local share for a homeowner in the most-flooded group is associated with a 4.1 percentage point decrease in the likelihood of paying off a home loan (16% relative to the mean). After controlling for flood insurance coverage, there is no differential effect of paying off the mortgage in locations with the least amount of flooding. This is consistent with the evidence that flood insurance was the main mechanism that allowed non-local lenders to pressure homeowners to pay down their mortgages. Robustness checks that define a local lender based on the dollar value of loans or based on having a branch office in the CSA, only consider residents in our CCP sample who obtain a mortgage between 1997 and August 28, 2005, and cluster the standard errors at the Census tract level all confirm the same pattern of findings as in Table 7 (see Appendix).

6 Conclusion

We provide some of the first evidence for the effect that a large natural disaster in the United States has on levels of household debt and measures of financial

distress using a new panel data set that combines account-level credit and debt information with a heterogeneous measure of disaster damage. Overall, we find that Hurricane Katrina led to a large and immediate reduction in debt for residents living in the most flooded blocks. The reduction in debt is due to lower home loan debt and is mostly a consequence of homeowners using flood insurance claims to pay down mortgages. We also find that Hurricane Katrina had a modest negative effect on personal finances as indicated by increases in short-term debt and account delinquency and decreases in credit score. There is some evidence that credit constraints combined with a tightening credit market may help to explain the relatively low use of credit card debt after Katrina. One limitation of the study is that we do not observe the asset side of the household balance sheet. Households that spend savings, take on additional debt, or lose home equity are likely to incur some welfare loss from Katrina.

The composition of local versus non-local lenders in a region impacted by a natural disaster can effect household rebuilding decisions and overall regional redevelopment. The propensity to pay off and close mortgage accounts was especially high in those neighborhoods of the deepest flooded areas of New Orleans where mortgages were most likely to have been originated by a non-local lender. At the same time, new mortgage originations by non-local lenders fell sharply after Katrina relative to originations by local lenders. These differences in lending activity are likely to be driven by differences in the cost of information acquisition, business incentives, and the financial stability of local and non-local lenders after a large disaster.

The paper contributes to a growing literature on the impact of natural disasters on subsequent economic growth highlights the role of investment in capital and how lenders facilitate that investment (e.g. Morse [2011] and Hornbeck and Naidu [2014]). The location of a lender in relation to the location of the natural disaster can have an impact on the lender's response (Hosono et al. [2012]; Chavaz [2014]). Our results suggest that a higher relative proportion of local lending at the time of a disaster can increase the amount of post-disaster rebuilding. Local lenders are both more likely to make new loans and more

likely to continue existing lending relationships after Katrina.

A property owner's decision about how to spend insurance money after a disaster - that is, whether to use it to rebuild or to pay down existing mortgage debt - can affect the overall economic recovery of the neighborhood and the city. In the case of post-Katrina New Orleans, the individual homeowner's decision not to rebuild could be costly in terms of forgone regional development, especially if New Orleans' residents are more likely to return when their neighbors return (Paxson and Rouse [2008]). Moreover, the overall level of immediate post-Katrina rebuilding could affect which, of the possibly many, future equilibria the city converges to when there are economies of agglomeration (e.g. Bleakley and Lin [2012]).

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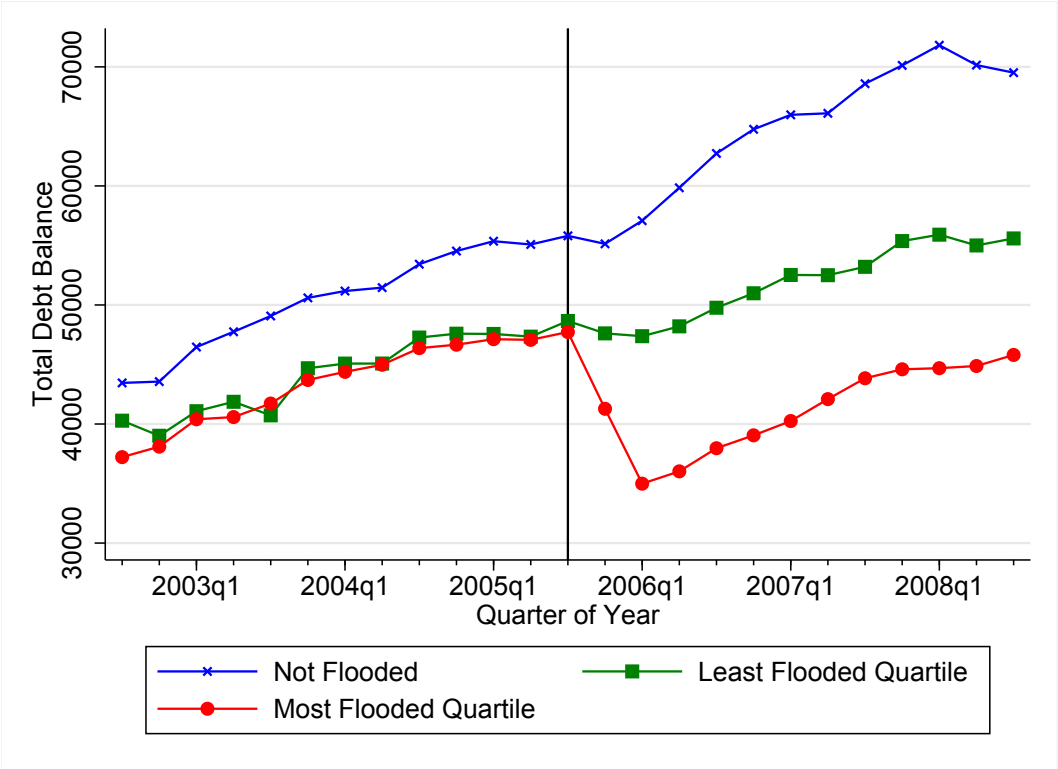
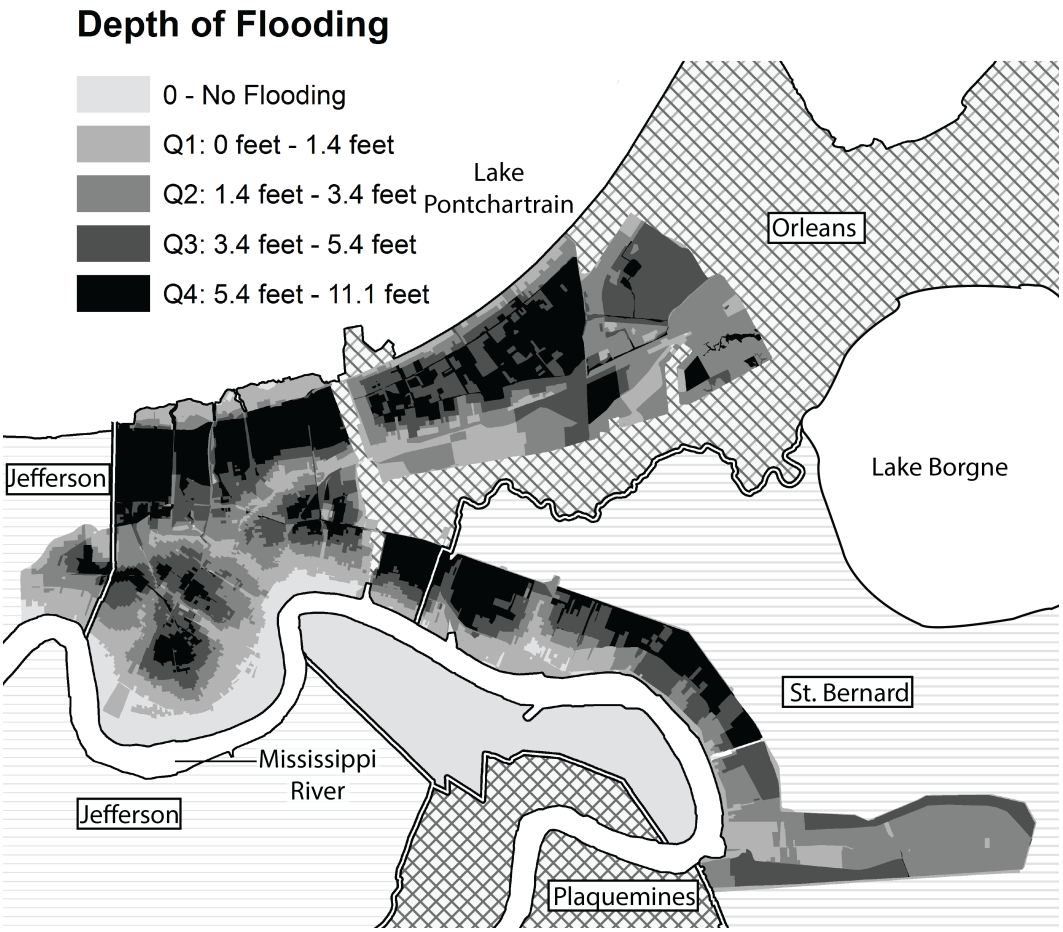
8 Figures and Tables

Figure 1: Total Debt Balance for New Orleans Area Residents from 2002-2008 by Post Hurricane Katrina Flood Intensity



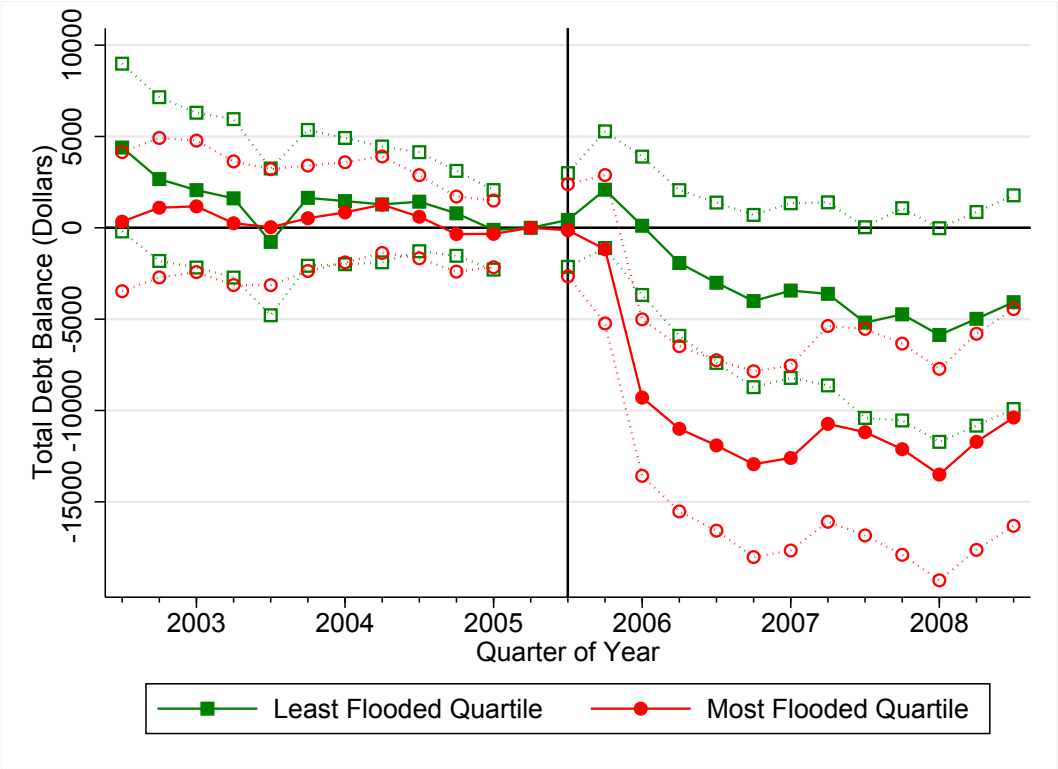
The figure plots quarterly individual debt balances for residents living in New Orleans at the time of Hurricane Katrina. Average debt balances are shown separately for residents living in non-flooded, the least flooded, and the most flooded census blocks. The least flooded blocks are defined as being those with average maximum flood depths of less than the 25th percentile (1.4 feet) among all flooded blocks. The most flooded blocks are those greater than the 75th percentile (5.4 feet). Debt information is from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax (CCP).

Figure 2: Mean Census Block Flooding Depth on August 31, 2005



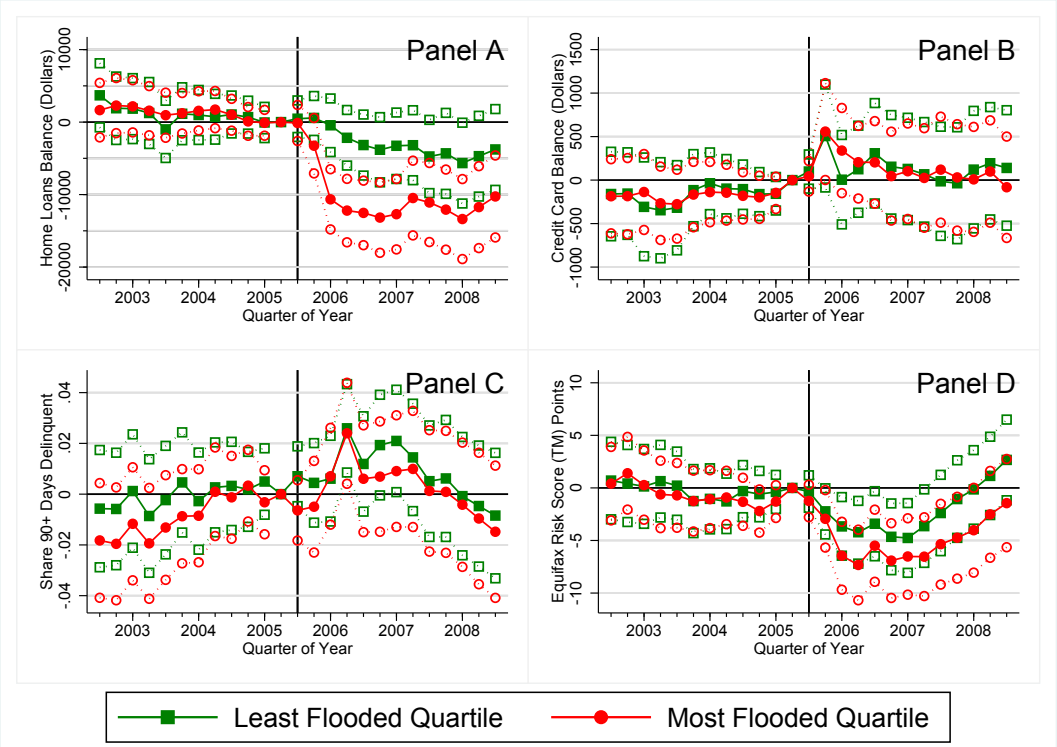
The figure shows mean census block flood depths on August 31, 2005 for New Orleans. Census blocks are divided into five groups: those with no flooding and four flooded quartiles (conditional on having a positive flood depth). The flood depth map covers portions of three Louisiana Parishes: Jefferson, St. Bernard, and Orleans. The number of individuals in our sample in the non-flooded group is approximately one fifth of our sample. The source of the flood depth data is National Oceanic and Atmospheric Administration (NOAA).

Figure 3: Effect of Flooding on Total Debt Balance



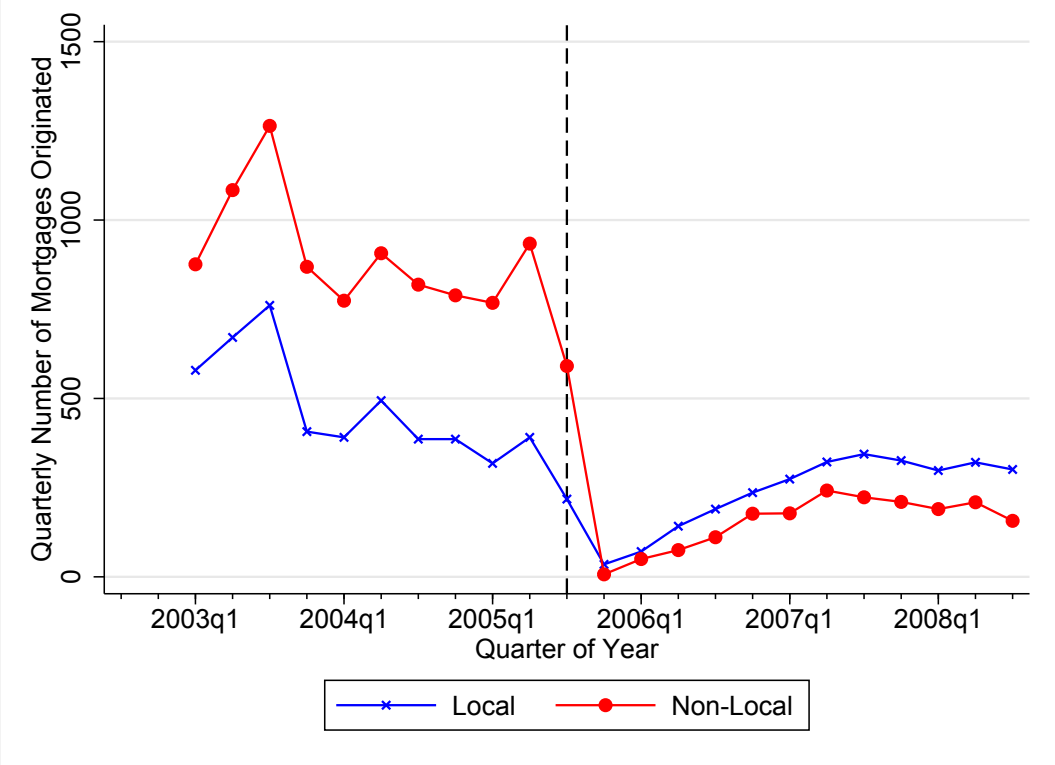
The figure plots difference-in-differences event time coefficients and 95% confidence intervals from the estimation of a version of Equation (2) that replaces the pre-/post- Katrina indicator with quarterly indicators. The dependent variable in the model is total debt balance in dollars. All coefficients can be interpreted as the change in debt balances for New Orleans residents living in flooded blocks, as compared with this change for residents in non-flooded blocks, relative to the quarter before Hurricane Katrina. The squares are point estimates for residents living in the least flooded blocks, where the mean maximum block flood depth was less than 1.4 feet. The circles are point estimates for residents living in the most flooded blocks, where the mean maximum block flood depth was greater than 5.4 feet. Standard errors are robust to heteroskedasticity and clustered by the Census block of residence in 2005Q3.

Figure 4: The Effect of Flooding on Home Loan Balance, Credit Card Balance, 90-Day Delinquency Rates, and Credit Score



The figure plots difference-in-differences event time coefficients and 95% confidence intervals from the estimation of a version of Equation (2) that replaces the pre-/post- Katrina indicator with quarterly indicators. The only difference between the four panels is the dependent variable used in the model. The dependent variable in Panel A is total home loan balance. The dependent variable in Panel B is total credit card balance. The dependent variable in Panel C is the share of residents with at least one account that is 90 or more days delinquent. The dependent variable in Panel D is the Equifax Risk Score (TM). All coefficients can be interpreted as the change in debt balances for New Orleans residents living in a flooded block, as compared with this change for residents in non-flooded blocks, relative to the quarter before Hurricane Katrina. Standard errors are robust to heteroskedasticity and clustered by the Census block of residence in 2005Q3.

Figure 5: The Number of New Mortgages Originated by Local and Non-Local Lenders



The figure shows the total number of loans by quarter made in the most flooded quartile of Census tracts split by whether the lender does a high share of its mortgage lending locally. We define "local" as lenders that made 21% or more of their loans from 1997Q1 to 2005Q2 in the New Orleans CSA. "Non-local" is defined as lenders that made less than 21% of their loans from 1997Q1 to 2005Q2 in the New Orleans CSA. The series begin in 2003Q1 because 2003 is the first year the HMDA data were reported using the 2000 Census tract boundaries. Conversion of HMDA data between 1990 and 2000 tract boundaries is discussed in the Appendix.

Table 1: Characteristics of Blocks by Degree of Flooding

Flood Depth Quartile	No Flooding	1	2	3	4
Number of Blocks	2,541	2,215	2,214	2,214	2,214
Depth	0.00	0.54	2.37	4.48	6.86
Elevation	2.06	2.04	1.39	0.96	1.08
Proportion in Flood Plain	47.9%	53.0%	78.9%	93.2%	97.6%
Median Household Income	$40,282	$39,079	$32,123	$34,364	$39,582
Poverty Rate	25.3%	26.5%	28.4%	27.8%	21.8%
Median Home Value	$149,006	$156,710	$105,618	$97,006	$123,605
Proportion Owner Occupied	46.6%	48.4%	48.3%	50.9%	59.7%
Proportion College Degree	31.5%	26.0%	17.6%	17.2%	22.7%
Proportion 65 or Older	11.8%	12.9%	11.7%	10.8%	13.2%
Proportion African American	46.7%	50.9%	65.1%	68.0%	61.5%
Proportion Hispanic	4.3%	3.3%	2.7%	3.1%	3.3%
Equifax Risk Score (TM)	653	646	636	628	648
Total Debt Balance	$55,083	$47,342	$38,388	$39,641	$47,072
Have a Home Loan	30.5%	26.8%	29.3%	33.2%	33.9%
Have a 90+ Day Delinquency	23.4%	24.6%	27.2%	28.2%	25.9%

The top panel of the table compares the engineering data for five groups of Census blocks: those with no flooding and quartiles of blocks as determined by mean level of flooding for the block on August 31, 2005. The middle panel of the table compares block-group-level characteristics from the 2000 Census for the five groups. The bottom panel compares the five groups' means for various credit indicators in the quarter before Hurricane Katrina (2005Q2) computed from Federal Reserve Bank of New York Consumer Credit Panel / Equifax (CCP) data.

Table 2: Correlates of Flooding Depth

	(1)	(2)	(3)	(4)	(5)
Elevation and Flood Risk	X	X		X	X
Cubic and Interaction of Elevation and Flood Risk		X		X	X
Log Median Home Value of Block Group			X	X	X
Other Demographics of Block Group					X
N	11,283	11,283	11,283	11,283	11,283
R^2	0.327	0.399	0.036	0.399	0.445

This table presents statistics from OLS regressions of mean flood depth on August 31, 2005, by Census block on covariates that could be correlated with flooding depth. Elevation and flood risk variables are the mean, minimum, and maximum elevation within the Census block and the proportion of the Census block that lies within the the 100-year flood plain as of 1999. Cubic and interaction of elevation and flood risk variables are a squared and cubed term of each of the previously mentioned variables as well as an interaction of the mean elevation and the proportion of the Census block in the 100-year flood plain. Log median home value is from the 2000 US Census and measured at the block group level. Other demographics of the block group, also from the 2000 Census are as follows: log median household income, poverty rate, proportion of housing units that are owner-occupied, proportion of residents that have a college degree or higher, proportion of residents that are 65 and older, proportion of residents that are African American, and proportion of residents that are Hispanic.

Table 3: Impact of Flooding on Total Debt Balance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1st Quartile * Post Flood	-6,781***	-5,552***	-4,013*	-4,067*	-3,937*	-4,086*	-4,489**
	(1,999)	(2,081)	(2,156)	(2,138)	(2,144)	(2,164)	(2,191)
2nd Quartile * Post Flood	-12,510***	-10,394***	-7,242***	-6,781***	-6,622***	-6,709***	-6,677***
	(1,790)	(1,889)	(2,004)	(1,970)	(1,976)	(2,010)	(2,029)
3rd Quartile * Post Flood	-16,280***	-13,319***	-9,915***	-9,536***	-9,463***	-9,703***	-9,736***
	(1,682)	(1,964)	(2,022)	(1,985)	(1,988)	(2,020)	(2,045)
4th Quartile * Post Flood	-16,861***	-13,826***	-11,282***	-10,999***	-10,954***	-11,002***	-11,092***
	(1,892)	(2,178)	(2,226)	(2,188)	(2,191)	(2,218)	(2,249)
1st Quartile	-5,858*	-3,263	1,463	1,377	540		
	(3,162)	(3,140)	(2,824)	(2,731)	(8,573)		
2nd Quartile	-13,952***	-7,786***	1,498	1,257	3,655		
	(2,801)	(2,946)	(2,612)	(2,529)	(8,940)		
3rd Quartile	-12,858***	-2,985	1,807	1,367	5,794		
	(2,546)	(3,022)	(2,557)	(2,475)	(9,051)		
4th Quartile	-7,062**	3,066	-176	-353	5,335		
	(2,782)	(3,358)	(2,900)	(2,775)	(9,318)		
Post	14,603***	10,666***	-30,688	-36,584	-37,800	-33,053	-33,192
	(1,365)	(3,800)	(48,041)	(47,827)	(47,964)	(48,282)	(49,081)
Elevation and Flood Risk		X	X	X	X	X	X
Log Median Home Value of Block Group			X	X	X	X	X
Other Demographics of Block Group			X	X	X	X	X
Cubic of Age				X	X	X	X
Census Tract FE					X		
Census Block FE						X	
Individual FE							X
N	390,714	390,714	390,714	390,714	390,714	390,714	390,714
R^2	0.007	0.026	0.082	0.115	0.128	0.382	0.731

This table presents a number of different specifications of OLS regressions of total debt balance (from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax (CCP)) on depth of flooding quartiles. Observations are at the individual level and contain all CCP primary individuals that were living in our flood depth coverage area in 2005Q3 and are continuously in the sample from 2002Q3 through 2008Q3 (16,573 individuals). Census-block-group variables correspond to the block group of residence in 2005Q3 and are described in the previous table note. Census-tract and Census-block fixed effects use the tract or block of residence in 2005Q3. Elevation and flood risk enter the specification in levels, squared, cubed, and interacted. All elevation, flood risk, and Census block group characteristics are entered both alone and interacted with a post-Katrina indicator. Robust standard errors clustered by Census block of residence in 2005Q3 are shown in parentheses. Significance level: *** 1%, ** 5%, * 10%.

Table 4: Impact of Flooding on Composition of Debt, Delinquency, Credit Score, and Migration

Dependent Variable:	Home Loan (1)	Credit Card (2)	Auto (3)	Delinquency (4)	Credit Score (5)	Migration (6)
1st Quartile * Post Flood	-4,179**	285	-29	0.008	-2.0	0.002
	(2,085)	(236)	(200)	(0.008)	(1.4)	(0.002)
2nd Quartile * Post Flood	-7,377***	-89	181	0.013	-5.3***	0.006***
	(1,862)	(228)	(240)	(0.009)	(1.4)	(0.002)
3rd Quartile * Post Flood	-10,637***	112	530**	0.008	-3.6**	0.011***
	(1,917)	(224)	(245)	(0.009)	(1.5)	(0.002)
4th Quartile * Post Flood	-12,181***	292	172	0.011	-4.4***	0.012***
	(2,106)	(272)	(243)	(0.010)	(1.6)	(0.002)
N	390,714	390,714	390,714	390,714	384,368	415,913
R^2	0.707	0.604	0.402	0.571	0.852	0.195

This table estimates six different OLS regressions using our preferred difference-in-differences specification (Table 3 column 7). The table (only) displays the point estimate and robust standard error for the difference-in-differences treatment effect for the four flooded groups. See the notes to Table 3 for more details regarding the exact specification. Columns 1-3 consider three major subcategories of debt balance (home loan, credit card, auto). We do not consider student loans, the 4th major subcategory, as the manner in which student loans is classified in the CCP changed in 2005 during the middle of our panel. The dependent variable for column 4 is an indicator of whether there is at least one account that is 90 or more days delinquent. The dependent variable for column 5 is the Equifax Risk Score (TM). There are fewer observations in the credit score regression as there are a small number of individuals with missing credit scores. Column 6 measures the quarterly migration rate. We define migration as leaving New Orleans and not returning to the New Orleans CSA for at least three years. Note that the sample used for the migration analysis differs from the sample used for the rest of the paper in that we include individuals who are in New Orleans at some point during the three years before Katrina, but move before the flood. This is necessary to calculate a pre-Katrina quarterly migration rate. Robust standard errors clustered by Census block of residence in 2005Q3 are shown in parentheses. Significance level: *** 1%, ** 5%, * 10%.

Table 5: Flood Insurance Claims, Foreclosure Rates, and Property Sales

	Not Flooded	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Panel A: Flood Insurance Claims					
Ratio of 2005 Flood Insurance Claims to Outstanding Mortgage 2005Q2	0.09	0.77	0.87	0.81	0.80
Panel B: Property Sales					
Ratio of Property Sales for 6 Months After Katrina to Outstanding Mortgage 2005Q2	0.03	0.02	0.01	0.01	0.01
Panel C: Foreclosures					
Difference in Foreclosure Start Rate 6 Months Before/After Katrina	-0.0030**	-0.0018	-0.0031***	-0.0025***	-0.0037***
	(0.0012)	(0.0020)	(0.0011)	(0.0009)	(0.0011)

Panel A reports statistics indicating how much of the collective mortgage debt could have been paid off if all flood insurance claims paid out were applied toward home loan balances. The statistics reported in Panel A show the ratio of 2005 flood insurance claims paid out to 2005Q2 mortgage balances for New Orleans residents living in each flood group. The flood insurance claims data are from administrative records provided by the National Flood Insurance Program. The foreclosure rates and mortgage balances are from the CCP. Mortgage balances are multiplied by 20 to account for the 5% random sample. Panel B reports a similar statistic as in Panel A, except that the numerator of the ratio is the total dollar value of home sales for the six months after Katrina. Panel B limits analysis to New Orleans Parish and for reasons of data availability excludes townships in our sample from the Parishes of St. Bernard and Jefferson. The home sales data are from the Orleans Parish Assessor's Office records and include information on 86% of the parcels in the Parish. Panel C reports coefficients and robust standard errors from five univariate regressions (one for each flood group) of a foreclosure start indicator on a post-Katrina indicator variable. Significance level: *** 1%, ** 5%, * 10%.

Table 6: New Orleans Neighborhood Housing Characteristics Pre- and Post-Katrina

Neighborhood:	(1) New Orleans East	(2) 9th Ward	(3) Lake View, Gentilly	(4) Algiers	(5) Uptown, Carrollton, Garden Dist.	(6) CBD, Mid-City, French Quarter	(7) Arabi (St. Bernard Parish)	(8) Metairie (Jefferson Parish)
Panel A: Pre-Katrina Housing Variables								
Flood Policies per Housing Unit	0.53	0.27	0.56	0.38	0.34	0.28	0.60	0.54
Median Home Value	93,749	64,306	134,955	105,657	144,524	85,633	95,983	153,908
Proportion with Mortgage	0.38	0.22	0.37	0.34	0.26	0.18	0.39	0.31
Avg Mortgage Balance	27,771	10,786	41,533	34,085	38,308	15,681	30,283	60,760
Avg Mortgage Balance Cond'l on Having Mortgage	76,712	54,126	116,510	100,826	156,183	94,164	80,765	193,375
Panel B: Post-Katrina Housing Variables								
Avg Flood Depth	4.14	3.34	5.20	0.00	2.05	2.45	3.60	1.07
Proportion Properties w/ Severe Damage	0.78	0.48	0.40	0.00	0.03	0.21	0.30	-
Avg Flood Insurance Claim Cond'l on Having a Claim	119,248	76,457	136,157	14,336	81,312	79,068	136,647	63,121
Ratio Avg Cond'l Claim to Median Value	1.27	1.19	1.07	0.16	0.59	0.93	1.43	0.39
Same Census Block 3 Yrs After Katrina	0.46	0.46	0.40	0.69	0.63	0.60	0.31	0.68
Severely Damaged Properties Rebuilt	0.87	0.73	0.85	0.70	0.53	0.85	0.43	-
Number of Zip Codes	4	1	2	2	4	4	5	3
CCP Population	3,127	1,431	2,192	1,678	3,283	1,942	2,160	530
Number of Assessed Parcels	15,733	3,835	12,530	7,926	15,928	7,388	3,050	-

This table shows how key housing variables vary by geography within New Orleans. The table uses zip-code-level data to calculate housing statistics for eight geographic areas, or "neighborhoods." The table combines information from several sources: NOAA flood depth data, flood insurance data from the NFIP, mortgage and migration data from the CCP, tax assessor data provided by CoreLogic, and 2000 US Census information. The neighborhood statistics in the table are weighted by the CCP population when combining data from multiple zip codes (except for the proportion of properties with severe damage and severely damaged properties rebuilt variables, which are created from the tax assessor data and are weighted by the number of assessed parcels). We define the variable the same census block 3 years after Katrina as the proportion of CCP residents who are living in the same census block in 2008Q3 as they were in 2005Q3. Refer to Section 5.1 of the text and the Appendix for more details.

Table 7: Non-local Lender Share and Reductions in Mortgages

	(1)	(2)	(3)	(4)	(5)
1st Quartile * Post Flood	-0.086***	-0.293***	-0.282***	-0.250***	-0.123
	(0.022)	(0.080)	(0.079)	(0.082)	(0.087)
2nd Quartile * Post Flood	-0.154***	-0.346***	-0.332***	-0.293***	-0.201***
	(0.021)	(0.074)	(0.073)	(0.076)	(0.080)
3rd Quartile * Post Flood	-0.218***	-0.445***	-0.435***	-0.413***	-0.324***
	(0.023)	(0.071)	(0.071)	(0.074)	(0.077)
4th Quartile * Post Flood	-0.263***	-0.467***	-0.455***	-0.443***	-0.356***
	(0.024)	(0.082)	(0.082)	(0.086)	(0.089)
1st Quartile * Post Flood * Local Share		0.925***	0.875***	0.778**	0.454
		(0.323)	(0.322)	(0.328)	(0.335)
2nd Quartile * Post Flood * Local Share		0.873***	0.804**	0.729**	0.583*
		(0.323)	(0.322)	(0.328)	(0.328)
3rd Quartile * Post Flood * Local Share		1.067***	1.011***	0.917***	0.786**
		(0.315)	(0.314)	(0.319)	(0.319)
4th Quartile * Post Flood * Local Share		0.941***	0.876**	0.813**	0.686*
		(0.362)	(0.360)	(0.369)	(0.370)
Pre-Katrina Equifax Risk Score (TM)			X	X	X
High Share African American Blocks				X	X
Flood Insurance Coverage					X
N	113,909	113,909	113,883	113,883	113,883
R^2	0.379	0.380	0.381	0.382	0.383

This table presents five different OLS regressions of an indicator of whether an individual has any mortgage accounts on depth of flooding quartiles and interactions of those quartiles with the local loan share variable associated with each homeowner's home loan. A larger local loan share implies that the homeowner's loan is likely to be originated by a lender with a higher concentration of lending activity in New Orleans (relative to other lenders). The mean local loan share is 0.22 with a standard deviation of 0.06. The loan share variable is calculated using HMDA loan origination data from January 1, 1997 through August 28, 2005. Observations are at the individual level and contain all CCP primary individuals that had any type of mortgage, were living in our flood depth coverage area in 2005Q3, and are continuously in the sample from 2002Q3 through 2008Q3 (4,588 individuals). Standard errors clustered by Census block of residence in 2005Q3 are shown in parentheses. Significance level: *** 1%, ** 5%, * 10%. An indicator for post Katrina (2005Q3 and after), a cubic function of age, and individual fixed effects are included in all specifications. Column 1 estimates our preferred difference-in-differences model. Column 2 adds the non-local lender triple interaction variable. The specifications in columns 3, 4, and 5 include the interaction of a post-Katrina indicator and a cubic function of the mean of the individual's Equifax Risk Score (TM) during the pre-Katrina period (2002Q3-2005Q2). The specifications in column 4 and 5 include a three-way interaction variable between an indicator for whether an individual's 2005Q3 block is over 95% African American and flood depth and post-Katrina (and all two-way interactions of those variables). Column 5 adds a control for the flood insurance coverage rate of the block by interacting the ratio of 2005 flood insurance claims to outstanding mortgage balances in 2005Q2 and a post-Katrina indicator (see Panel A of Table 5 for the mean of this variable by flood group).