Storms and Jobs: The Effect of Hurricanes on Individuals' Employment and Earnings over the Long Term

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Abstract

Hurricanes Katrina and Rita devastated the U.S. Gulf Coast in 2005. We use job-level data to compare the evolution of earnings for affected workers in four states with workers from matched control counties. We attribute short-term earnings losses to job separations and long-term gains to wage growth in the affected areas. Wages rose due to reduced labor supply and increased labor demand in the affected labor markets. Damage to a worker's residence or workplace accentuated short-term earnings losses. Effects varied by pre-storm industry, with larger gains for workers in sectors related to rebuilding.

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1. Introduction

The 2005 Atlantic hurricane season was one of the most active and costly on record (Nordhaus, 2010). It included two storms that reached Category 5 strength (the highest on the Saffir-Simpson Hurricane Wind Scale) and caused significant damage to the United States, primarily along the Gulf Coast. Hurricane Katrina, which made landfall on the Gulf Coast on August 29, was the costliest and one of the deadliest hurricanes in U.S. history with more than 1,800 deaths (Knabb et al., 2005; Blake et al., 2011). The massive hurricane caused catastrophic flooding in New Orleans and devastating damage along the Gulf coasts of Alabama, Mississippi, and Louisiana. Hurricane Rita made landfall on the Texas–Louisiana border on September 24, devastating coastal communities and causing additional flooding in New Orleans (Knabb et al., 2006).

These hurricanes disrupted people's lives and their ability to engage in gainful employment. Hurricane Katrina, in particular, caused one of the largest and most abrupt relocations of people in U.S. history, as approximately 1.5 million people aged 16 years and older evacuated from their homes (Groen and Polivka, 2008a). Unemployment and the number of mass-layoff events in Louisiana and Mississippi rose sharply in September 2005 following Katrina (Brown et al., 2006; Brown and Carey, 2006).[1] In the two months following Katrina, payroll employment declined by 35 percent in the New Orleans metropolitan area and by 12 percent in the entire state of Louisiana (Kosanovich, 2006). The effects of Katrina have been long-lasting and far-reaching, permanently reshaping some communities (Elliott and Pais, 2006; Vigdor, 2008; Groen and Polivka, 2010).

In the aftermath of the storms, many analysts expected a fast recovery. For example, the Congressional Budget Office (2005) expected recovery expenditures to revive the local economy within a year but cautioned that "some of the people who lost jobs may remain unemployed for some time" (p. 1). The objective of this paper is to estimate short- and long-term effects on earnings outcomes for affected workers and to understand the roles of damage to workers' homes and workplaces as well as a worker's pre-storm industry of employment in the pace of their

[1] See also, King, R. (October 26, 2005), "Katrina Blows Away 224,000 Local Jobs," *The Times Picayune*, p. A1.

recovery. Studying the effects of these storms on individuals could provide a reference point to policymakers and those providing assistance for other disasters.[2]

For our analysis, we combine damage data with U.S. Census Bureau data from household surveys and longitudinal administrative data on jobs and place of residence to build a sample of pre-storm workers in areas with greater and lesser direct impacts. The jobs data, compiled by the Longitudinal Employer-Household Dynamics (LEHD) program, allow us to track workers over time, even if they move across state lines, and avoids issues of recall bias that might affect post-storm surveys (e.g., Paxson and Rouse, 2008; Sastry, 2009; Gregory, 2014). Our approach is to compare the evolution of earnings before and after the storms for individuals who resided (at the time of the storms) in storm-affected areas in four states and individuals who resided in suitable control counties. For our preferred control group, the control counties are chosen to have worker characteristics, earnings trends, and economic conditions similar to those of the storm-affected areas prior to the storms. We present statistics demonstrating the alignment of the treatment and control samples in the pre-storm period, including parallel trends in quarterly earnings. We also repeat our analysis with alternate control groups and find similar results.

For workers who resided in storm-affected areas, we find a modest decline in quarterly earnings in the first year after the storms followed by a rise in earnings from 2006 to 2008 and sustained higher earnings through 2012. We attribute the earnings losses in the immediate aftermath of the storms to non-employment spells and the earnings gains in later years to higher pay within employment. Outcomes for workers vary by pre-storm industry, however, with substantial and immediate gains for construction workers and losses for workers in tourism, healthcare, and professional services. We also find losses to be concentrated among workers whose pre-storm homes or workplaces were in the most-devastated areas. We find that these workers were especially likely to migrate or separate from their jobs—transitions that were associated with the largest drops in earnings and the longest recoveries. Local data on employment and wages from the Census Bureau and the Bureau of Labor Statistics, along with our individual-level results, suggest that the long-term rise in earnings was due to an increase in labor demand and a drop in labor supply in the affected local labor markets, which led to higher wages. The story varies by industry, with construction workers benefiting from especially high

[2] Annual U.S. hurricane damages and related government spending are expected to increase over time due to climate change and an increase in the population of coastal areas (Nordhaus, 2010).

labor demand associated with rebuilding and workers whose jobs depend on tourism or the local population experiencing a slower recovery and no long-term earnings gains.

Our emphasis on the longer-term impacts of hurricanes on individuals' employment and earnings distinguishes this study from area-level analyses of hurricanes for the U.S. labor market and short-run analyses of the effects of Katrina on individuals. Most studies of disasters examine effects on geographic areas (e.g., Guimaraes et al., 1993; Brown et al., 2006; Clayton and Spletzer, 2006; Dolfman et al., 2007; Belasen and Polachek, 2008, 2009; Jarmin and Miranda, 2009; Strobl, 2011; Xiao, 2011; Coffman and Noy, 2012). Within a year or two of a disaster, these studies typically find that the affected area has lower employment but higher wages. Some studies also find gains in both employment and wages for the construction industry (e.g., Guimaraes et al. 1993; Dolfman et al. 2007; Belasen and Polachek, 2008). However, these outcomes cannot be ascribed entirely to the original affected residents because some of these residents may leave the area and migrants moving into the area may be the ones experiencing these outcomes (Strobl, 2011; Sisk and Bankston, 2014; Boustan et al., 2017). Given that a substantial portion of disaster aid is targeted directly to affected individuals and households, understanding individuals' outcomes (e.g., migration, job separation, and earnings) has important implications for assistance programs.

Of the few studies that have examined the effects of Katrina on individuals' employment and earnings, most have examined the impact only during the first year after the storm (Elliot and Pais, 2006; Vigdor, 2007; Groen and Polivka, 2008b; Zissimopoulos and Karoly, 2010).[3] An exception is the analysis of Deryugina et al. (2018), which developed concurrently with this paper and uses tax-return data to study a range of outcomes (e.g., earnings, unemployment-insurance receipt, marriage, and fertility) for households in New Orleans affected by Katrina. Our analysis is consistent with the finding of Deryugina et al. (2018) that, by a few years after Katrina, annual earnings of those who resided in a storm-affected area rose relative to those who resided elsewhere. In interpreting the overall real earnings trend, Deryugina et al. (2018) attribute increases partially to a higher cost of living but still find earnings gains for those staying

[3] Other examples of analysis of the longer-term impacts of Hurricanes Katrina and Rita on individual outcomes include Sacerdote (2012), the effect on schooling; Paxson et al. (2012), on mental health; and Gallagher and Hartley (2017), on debt. There have been studies for Indonesia of the long-run effects of earthquakes on workers' earnings (Gignoux and Menéndez, 2016; Kirchberger, 2017), but differences in the underlying economy and governmental context reduce the applicability of these studies to disasters in the U.S.

in New Orleans that are unexplained. With our quarterly data we are able to isolate the effects on (real) earnings of a change in workers' employment stability throughout the year versus higher earnings individuals receive when employed. We are also able to compare changes in workers' earnings by industrial sector. With this more complete picture of the labor market, we argue that higher earnings in our treatment area can be explained by shifts in labor supply and demand, which we show varied widely at the industry level.

In addition, unlike Deryugina et al. (2018) and other studies of the effects of Katrina that use New Orleans as a treatment area, our analysis covers affected counties and parishes from Texas to Alabama, which provides greater variation in damage and a more comprehensive perspective on affected labor markets. This larger area of study increases the applicability and generalizability of our results. We also are able to assess the effects of differences in the severity of damage to workers' homes and workplaces within our treatment area.

The remainder of this paper is organized as follows. Section 2 describes mechanisms for how storm damage, labor-market shifts, and rebuilding could translate into changes in employment and earnings for affected workers. Section 3 describes our data and defines our treatment and control samples. Section 4 explains our difference-in-differences methodology. Section 5 presents our estimation results. Section 6 gives our interpretation of how local labor-market shifts can explain worker outcomes. Section 7 concludes.

2. Mechanisms for Effects on Employment and Earnings

In this section we briefly outline anticipated effects of the storms on workers' earnings through changes in workers' wages and hours. These changes will be the result of workers' and employers' responses to the destruction caused by the storms and the interplay of these responses within local labor markets. While having some common features across time, these effects may differ depending on the length of time after the storms. Consequently, we divide our discussion into two parts: an examination of effects in the immediate aftermath of the storms, and an examination of medium- and longer-term effects.

2.1. Immediate Aftermath and Short-Term Disruptions

In the immediate aftermath of the storms, it is anticipated that the earnings of workers who remain in the area will decline as residents and employers spend time cleaning up, rebuilding, filing insurance forms, and generally taking stock of the situation. Infrastructure and

vehicle damage that prevents workers from getting to their jobs and business from being able to open or obtain supplies also would serve to reduce residents' earnings in the short term. These effects, although potentially more severe in some industries, would be expected to exist for all workers who remained in the area regardless of their industry of employment. The magnitude of the drop in earnings and the length of time over which earnings are suppressed is expected to be greater the more severe the damage to workers' homes and employers' facilities.

Evacuees' earnings are expected to decline in the short term because of a reduction in their willingness and ability to work. Rather than working, evacuees are spending time finding temporary housing, obtaining aid, and dealing with the psychological impacts of being dislocated and having experienced a hurricane (Paxson et al., 2012).

2.2. Medium- and Longer-Term Effects

In the medium and longer term, changes in workers' earnings in the affected areas will depend on the industry in which workers were employed (or switch to) along with the interaction in the local labor market of labor supply and labor demand. These local labor-market dynamics will depend on the relative magnitude of shifts in labor supply and labor demand along with the elasticities of these curves in the aggregate and within industries.

In the construction industry, demand for workers will unambiguously increase. If there is not a large influx of workers to the storm-affected areas and relatively few residents switch industries, this increase in demand will raise the earnings of workers in construction and related industries by increasing their wages and hours (both in terms of steadier employment and hours on the job). It is anticipated that effects on construction workers' earnings will precede recoveries in other sectors and extend at least as long as it takes for the storm-affected areas to rebuild.

The effect on workers in non-tradeable industries reliant on the size of the local population and non-residents who visit the area (e.g., education, retail trade, and tourism) will depend on the shift in labor supply relative to the shift in labor demand. Declines in the local population and tourism will decrease the demand for workers in these sectors. Out-migration will reduce labor supply in the affected area. However, remaining workers wanting more hours to counteract a decrease in wealth or an increase in indebtedness could mitigate the reduction in labor supply. If labor demand falls more than the supply of workers falls, wages will decrease.

Workers' average earnings will correspondingly fall if employed workers' average hours remain at or below pre-storm levels.

If, however, the decline in the local population is sufficiently large or enough people switch to other industries, the reduction in labor supply could be larger than the reduction in labor demand—resulting in an increase in wages. The effect on workers' average earnings will then depend on what happens to workers' hours. If workers' average hours increase or remain at pre-storm levels (probably the most likely scenario), workers average earnings will unambiguously rise. If workers' average hours decrease, average earnings could increase, decrease, or remain the same depending on the relative increase in wages versus the decrease in hours per worker.

Among these non-tradable sectors, factors beyond the size of the local population will affect the magnitude of the drop in demand, which in turn would be expected to affect workers' earnings. Demand for workers in the tourism sector is least tied to the size of the resident population and thus the trajectory of workers' earnings in this sector is the most uncertain. If infrastructure is restored quickly and hotels, places of entertainment, and meeting places are rebuilt before residential buildings, it is likely that labor demand will increase prior to labor supply. If, however, tourists remain reluctant to visit the area or national economic factors depress people's willingness to travel, labor demand in the tourism sector could remain depressed for an extended period. The effect of a smaller resident population on the demand for workers in sectors involved in selling goods to residents could be counteracted by people replacing goods destroyed by the storms or residents whose earnings have risen purchasing more goods. In contrast, the demand for workers such as teachers or hospital staff would have few countervailing influences and thus the demand for these workers would be almost completely tied to the size of the resident population.

In the tradable sector, workers' wages would be expected to return to pre-storm levels and then follow national trends. However, even at the pre-storm wage, workers in the tradable sector may experience earnings gains if the reduction in local labor supply due to migration and workers switching industries caused workers in the tradable sector to obtain more hours of work within a week or more steady employment across weeks.

In addition to the effects on workers' wages caused by the interaction of changes in labor supply and labor demand, the earnings of workers who remain in the storm-affected area could

also be influenced by several factors that directly alter workers' marginal productivity. These possible factors include selectivity in which businesses decide to continue operating, adoption of more-modern technology by businesses that rebuild, and the loss of firm-specific human capital among workers who are separated from their pre-storm employers.

The influence of local labor-market dynamics on workers who relocated to new areas are expected to be muted compared to the effect of local labor-market dynamics for those who did not permanently leave storm-affected areas. Nevertheless, the large influx of migrants to some areas (e.g., Houston) may have reduced wages in non-tradable sectors due to an increase in labor supply (McIntosh, 2008; De Silva et al., 2010), which would also depress migrant wages. Because migrants will mostly have separated from their pre-storm employers, they would be expected to have depressed earnings due to the loss of firm-specific human capital.

3. Data

In this section, we outline our worker and earnings data, damage data, and how the treatment and control groups are defined, with additional details in the Appendix. We draw on a wide range of public-use and confidential data assembled at the Census Bureau.[4]

3.1. Worker Data

The sample of individuals for our analysis is composed of respondents to the 2000 Census long-form and the American Community Survey (ACS) from January 2003 through July 2005, before Hurricane Katrina struck. These surveys provide information on demographics and educational attainment. We limit the survey responses to persons aged 25–59 in 2005, ages where labor force participation is uniformly high. We use an annual address file based on federal administrative records to determine a 2005 residential location (county and Census block) for each person. Because the majority of these records are sourced from the addresses on federal income-tax returns (which are typically filed in the first four months of the year), the locations are a good representation of pre-storm place of residence.

We use unique person identifiers to match the survey records for this sample to earnings records from the LEHD Infrastructure Files. We track earnings from two years prior to the storms (2003 quarter 3, or 2003:3, the first quarter with data for all the states in our study area) to

[4] Researchers may apply to the U.S. Census Bureau for access at Federal Statistical Research Data Centers.

seven years after the storms (2012:3). LEHD is a national employer-employee matched database of jobs, with each record consisting of the unemployment insurance (UI) covered earnings for a worker at an employer in a quarter (Abowd et al., 2009). For most states, LEHD does not include hours or an hourly wage. We convert earnings into constant dollars as of 2005:2 using the Consumer Price Index. LEHD earnings records cover approximately 96 percent of wage-and-salary civilian jobs.[5] The national collection of earnings records is crucial for our approach because it allows us to follow workers over time, even if they move across state lines.

Given our focus on the labor market, our sample from the survey and administrative records consists of workers employed just prior to the storms. We require that individuals had a job that spanned July 1, 2005 (the beginning of the quarter in which the storms occurred), with earnings in both 2005:2 and 2005:3. For these jobs (or the highest-earning one in 2005:2 if a worker had multiple such jobs), we link to the employer's industry (NAICS code) and establishment location to examine differential effects of the storms on workers.[6] We compute sample weights that account for differences in the match rate of Census/ACS respondents (by age, sex, and race/ethnicity categories) to administrative data, so that our summary statistics and estimates are representative of the population of workers residing in our analysis areas in 2005.

3.2. Damage Data

We use two sources of damage data in the analysis. The first is a county-level measure of storm-damage assessments from Federal Emergency Management Agency (FEMA) inspections, indicating the share of housing units in the county with substantial damage, estimated as being in excess of $5,200 (HUD, 2006). The second is a more spatially-detailed measure based on remote-sensing observations that provides the degree of damage in neighborhoods for the most heavily damaged counties (FEMA, 2005).[7] The detailed damage data allows us to assign Census blocks (the most-granular unit of Census tabulation geography) to what we term major damage (long-term flooding, most structures destroyed or interiors exposed) or minor damage (short-term

[5] Our data exclude federal workers and some states are not available for the complete time series. Some sectors and worker classes not included are self-employed, unpaid family, and some agricultural workers (see Appendix 9.1).
[6] Most states' UI earnings records for employers with multiple establishments within the state do not specify the establishment to which a worker is associated. For such multi-unit employers, we use the first establishment draw from a multiple-imputation model developed by the LEHD program to assign establishments to workers (Abowd et al., 2009). The model attempts to replicate the establishment-size distribution within an employer and the observed distribution of commute distances.
[7] See Jarmin and Miranda (2009), Basker and Miranda (2018), and Appendix 9.2 for other studies using these data.

flooding, superficial or exterior damage) areas. The FEMA data cover 72.5 percent of occupied housing units in our defined treatment area and 93.0 percent of those with substantial damage as indicated in the HUD (2006) data.

We use the county-level measure to define a treatment area composed of counties and the spatially detailed measure to assign a degree of damage to individuals' residences and workplaces (see Appendix 9.2 for detailed explanations and maps). One concern with using damage measures, as opposed to an exposure measure such as wind speed, might be that the degree of structural damage may reflect pre-storm risk-mitigation efforts that could be correlated with individuals' earnings. As a precaution, we use the HUD measure only to indicate whether storm damage to a county surpassed a minimal threshold. The more-detailed FEMA measure is largely based on either physical measures or near proxies. Much of this damage was widespread across large areas (see Figure A3), so we would not expect that it would be sensitive to localized mitigation efforts. The primary contributor of damage was flooding, which was remotely observed and was extensive both in New Orleans and other areas. As another example, the extent of the storm surge is evident in the near-universal destruction across a broad swath of coastal land from Mississippi to Alabama.

3.3. Treatment Group

In order to examine the effect of the storms on individuals' earnings, we define a treatment group and a control group. The treatment group is defined as individuals who meet our employment criterion and resided, in 2005, in a county that experienced substantial damage from either Katrina or Rita. Specifically, the treatment area is the set of 63 counties (or parishes) with HUD (2006) reporting substantial damage for at least 1 percent of the housing units or FEMA (2005) reporting any damage. These counties (shown in Figure 1 in light shading) stretch from Texas to Alabama and included 1.8 million occupied housing units, of which 15.8 percent had substantial damage.

3.4. Propensity-Score Matched Control Group

We use a propensity-score methodology to identify a set of control counties similar to the treatment counties prior to the storms (see Appendix 9.3 for details). Our methodology follows the approach taken by Sommers et al. (2014). For our matching model, we use our worker data to construct county-level level demographic characteristics, industry composition, and pre-storm quarterly earnings; we augment these with county-level measures of economic and population

trends. We build a synthetic (or matched) control (e.g., Abadie et al. 2010) by selecting, from the potential control counties, a set with pre-storm characteristics most similar to the treatment counties.

For the county-level dataset used to estimate our propensity-score model, we restrict the set of counties to the 63 counties in the treatment area and 2,393 other counties in the continental United States. We estimate a logit model with a binary outcome, where counties in the treatment area have the indicator 1 and all other counties have the indicator 0. This method estimates the association between county characteristics and the treatment area. To select the control sample, we use the parameter estimates to predict (within sample) the probability that each county might be a treatment county. We sort the control candidates by propensity score in descending order and select the top 5 percent of counties (computed using sample weights aggregated by county). Our control area includes 287 counties in 28 states. Figure 1 displays the control counties (in dark shading), which are concentrated in the coastal Southeast and Mid-Atlantic, Appalachia, and along the Mississippi river, with a scattering across northern Michigan, the Great Plains, and western mountain regions. The Gulf Coast is culturally unique in many respects, so it is not surprising that no area of the country dominates the matching. Rather, the selected areas have differing contributions, with the southeastern coastal plain being most similar in demographics, Appalachia being most similar in terms of educational attainment, and some western counties being most similar in terms of oil and gas extraction.

To examine the robustness of our main results, we also consider three alternate control groups, described in Appendix 9.8. The results using the alternate control groups are qualitatively similar to our main results using the matched control group.

3.5. Summary Statistics

For our sample of Census/ACS respondents linked to LEHD earnings records, Table 1 provides the resulting sample sizes and summary statistics (percentages and means) of variables prior to the storms describing worker characteristics, earnings, and local economic conditions for the treatment sample, potential control sample, and matched control sample. Our sample contains approximately 544,000 workers, including 138,000 workers in the treatment sample and 406,000 workers in the matched control sample.[8] For comparison, we also include summary

[8] Observation counts are rounded to the nearest 1,000 persons.

statistics for the potential control sample, which consists of the 8.1 million workers who resided in counties that were eligible for inclusion in the matched control sample.

The matched control sample is much more similar to the treatment sample than is the potential control sample (see standardized differences in Appendix 9.4). For example, average quarterly earnings prior to the storms (2005:2) are $9,916 for the treatment sample, $11,523 for the potential control sample, and $10,388 for the matched control sample. The matched control sample and the treatment sample also align closely on local economic conditions, although the treatment sample has somewhat lower labor-force attachment and population growth.

In our results, we disaggregate earnings effects by the intensity of home and workplace damage. Before the storms, 5.6 percent of our treatment sample lived in a Census block receiving major damage and 12.2 percent lived in a block receiving minor damage. Likewise, 7.1 percent worked in a block receiving major damage and 18.3 percent worked in a block receiving minor damage. The higher incidence of workplace damage is partially attributable to the concentration of employment in urban areas near the coast, which was more affected.[9]

The high out-migration rate for our sample is evidence of the storms' impact and also highlights the need to follow earnings outcomes for workers who move across state lines. In 2006, we observe 8 percent of our treatment sample living in a different commuting zone (or local labor market) than in 2005, compared with only 3.5 percent of the matched control sample. This difference is all the more remarkable given the lower pre-storm mobility of the treatment sample. The excess out-migration for the treatment sample eased over time as some workers returned to their pre-storm locations (documented in Groen and Polivka, 2010), with 11.8 and 10.6 percent of the treatment and control samples, respectively, living in a different commuting zone in 2010 than in 2005. (For alternative definitions of migration as well as pre-storm and long-term trends, see Table A3 and Appendix 9.2.)

4. Methodology

We identify the effect of the storms on earnings by comparing the evolution of earnings before and after the storms of individuals in the treatment sample with individuals in the control sample. Our econometric framework exploits the panel nature of our earnings data to control for

[9] For 29.9 percent of residences and 19.8 percent of workplaces, damage is uncertain, though expected to be low due to FEMA focusing its surveying on counties with the most damage. See Table A2 and Appendix 9.2.

both time effects and individual fixed effects. The individual fixed effects control for permanent differences between workers related to observable and unobservable characteristics. Our econometric approach is based on the specification that is standard in the job-displacement literature (e.g., Jacobson et al., 1993), with storm-affected individuals playing the role of displaced workers. Although our general approach is standard, our decomposition of earnings effects into effects due to shifts in employment and changes in earnings for those who are employed is novel.

Our primary outcome variable is quarterly earnings. For each quarter from 2003:3 to 2012:3, we either observe earnings from one or more jobs for a worker in our sample or interpret zero earnings as the absence of any job in the quarter. Including observations with zero earnings allows us to consistently use a balanced panel of individuals for our analysis.

Our baseline specification is:

$$Y_{it} = \alpha_i + \gamma_t + \sum_k D_{ik}\delta_k + \varepsilon_{it}. \tag{1}$$

The dependent variable Y_{it} is earnings of individual i in quarter t. The α_i terms are individual fixed effects. The γ_t terms are the coefficients on a set of quarterly dummy variables that capture the general time pattern of average earnings for the entire sample. The dummy variables D_{ik} are equal to 1 if individual i is in the treatment sample and the quarter is k quarters before or after 2005:3, when the storms struck. The coefficients on these variables, δ_k, capture the average difference between individuals in the treatment and control samples as of the kth quarter before/after the storms, relative to this difference in the first quarter before the storms (2005:2).[10] The estimation runs from 2003:3 (k = -8) through 2012:3 (k = 28). We cluster the standard errors at the county level (based on 2005 residence location) to account for serial correlation (Angrist and Pischke, 2009; Cameron and Miller, 2015).

We define two additional earnings variables in order to decompose the earnings effects from our baseline specification into two sources: (1) changes in earnings within employment and (2) shifts between employment and non-employment. Note that our main earnings variable, Y_{it}, includes zeros for person-quarter observations in which individuals do not have an earnings record. The first new variable, Y_{it}^e, replaces any zeros with the individual's earnings in the reference quarter, 2005:2 (denoted Y_{i*}); otherwise, $Y_{it}^e = Y_{it}$. This variable isolates changes in

[10] Because 2005:2 (k = -1) is the reference quarter, the D_{ik} variable for this quarter is excluded from the regression.

earnings within employment. The second new variable is the difference between the other two earnings variables: $Y_{it}^{n} = Y_{it} - Y_{it}^{e}$. This variable, which is $-Y_{i*}$ for quarters in which $Y_{it} = 0$ and zero otherwise, isolates earnings losses due to shifts from employment to non-employment. We estimate our earnings model separately for each dependent variable (Y_{it}, Y_{it}^{e}, Y_{it}^{n}) and obtain coefficients of interest (δ_k, δ_k^e, δ_k^n). Because $Y_{it} = Y_{it}^{e} + Y_{it}^{n}$, it can be shown that $\delta_k = \delta_k^e + \delta_k^n$; that is, the total effect of the storms on earnings is decomposed into (1) a part from earnings changes within employment and (2) a part from earnings losses due to shifts from employment to non-employment.

To examine how storm effects vary with the extent of hurricane damage, we distinguish individuals in the treatment sample by the damage category of their 2005 residence or workplace and compare individuals in a given damage category to the entire control sample. For these estimates, we use a variation on Equation (1) where the storm effects are estimated separately for each damage category. We also use this approach to examine how storm effects vary according to whether individuals in the treatment sample separated from a job or migrated to another area after the storms. To estimate how storm effects vary across different groups of individuals according to pre-storm industry or demographic characteristics, we estimate Equation (1) separately for each subgroup, restricting both the treatment and control samples. In addition to estimating the storm effects for each quarter, we also report estimates for three time periods after the storms: 2005:4–2006:3 ("short term"), 2007:4–2008:3 ("medium term"), and 2011:4–2012:3 ("long term"). We also estimate an average quarterly effect over the entire post-storm period (2005:4–2012:3) in order to assess aggregate impacts of the storms on individuals' earnings. This effect combines the short-term, medium-term, and long-term effects as well as effects for intervening periods into a total effect.

5. Results

5.1. Effects on Earnings and Employment

Table 2 reports estimates of the effect of the storms on earnings in the short, medium, and long term as well as over the entire post-storm period. In the short term (first year after the storms), we find that the storms reduced the earnings of affected individuals, though not with statistical significance. The effect during these four quarters is a loss of $298 per quarter, which is 3.0 percent of average pre-storm quarterly earnings in the treatment sample. In the medium

term (third year after the storms), the pattern is reversed: instead of earnings losses, the storms are associated with earnings gains, with an average earnings gain of $343 per quarter (3.5%). The magnitude of earnings gains increases over time, so that by the long term (seventh year after the storms) the estimated earnings gain is $792 per quarter (8.0%). Over the entire post-storm period, we find that the storms led to a net increase in earnings of affected individuals of $404 per quarter (4.1%), or $11,312 in total.

We find a similar pattern of earnings loss and recovery across all pre-storm earnings subgroups (earnings changes as a share of pre-storm earnings, see Table A9). As such, we find no indication that our results are driven by differential financial exposure before the storms, risk-mitigation efforts that may be tied to pre-storm earnings, or by divergent earnings paths by pre-storm earnings strata. We also show in Appendix 9.8 that our estimates of earnings effects using the matched control sample are generally similar to estimates we obtain from using three alternate control samples.

Figure 2 shows the quarterly estimates of storm effects on earnings and decomposes the total effect in each quarter into earnings changes within employment and earnings changes due to shifts from employment to non-employment.[11] The estimates indicate that the short-term losses in earnings over the first year after the storms are primarily the result of reductions in earnings due to shifts from employment to non-employment. This source accounts for 97 percent of the total (negative) effect on earnings in the short term. The estimated earnings losses due to shifts to non-employment continue through the fourth year after the storms, but by the third year after the storms these earnings losses are eclipsed by the estimated earnings gains due to earnings changes within employment. As a result, the total effect on earnings is positive by the third year after the storms and the effect is driven primarily by increased earnings within employment. In the fifth, sixth, and seventh years after the storms, the estimated earnings losses due to shifts to non-employment are modest and the total effect on earnings comes primarily from increased earnings within employment. These results imply that by the third year after the storms those who were employed were experiencing earnings gains.

[11] Figure A6 reports the quarterly estimates of the total effect with confidence intervals. Table A4 reports the decomposition estimates for the short, medium, and long term.

5.2. Effects by Damage Type

As noted in Section 2, we expect the effect on earnings (at least in the short term) to vary by the degree of damage individuals and businesses experienced. When we estimate storm effects separately by type of residence damage, we find more severe damage to be associated with more negative effects of the storms on earnings (Table 2 and Figure 3). Individuals that experienced major damage had the largest negative effects. These earnings losses are primarily in the short term, though they lasted for approximately two years after the storms. Specifically, those with major residential damage had an average quarterly earnings loss of $1,710 (-17.2%) during the first year after the storms. Individuals who experienced minor damage also experienced short-term earnings losses, though these losses were smaller in magnitude and less persistent than the losses for those with major damage. After the initial negative shock, average earnings of individuals in each damage type improved relative to the control group. In the long term, our estimates of storm effects are positive and statistically significant for individuals in each damage type. The overall net effect of the storms (combining short-term earnings losses and long-term earnings gains) is positive for those with minor damage or no damage but negative for those with major damage.

When we measure damage according to workplace rather than residence, the general pattern is similar (Table 2 and Figure A7).[12] Notably, the negative short-term effect for those with major workplace damage is about the same as the effect for those with major residence damage. In addition, the long-term effect on earnings is positive for all categories of workplace damage, as it is for residence damage.

5.3. Effects by Industry Sector

In Table 3, we examine storm effects on earnings by industry sector (based on a worker's pre-storm employer). These estimates are consistent with shifts in the demand for tradable and non-tradable goods associated with the immediate impact of the storms and the subsequent recovery. We find that short-term earnings losses are large for individuals employed in healthcare (-9.3%) and in leisure and accommodations (-8.5%)—both non-traded sectors unrelated to rebuilding. For individuals in healthcare, the earnings losses moderated after the

[12] In a specification (results not presented here) including both residence damage and workplace damage, we find that both factors appear to have independent and additive effects on earnings in the short run. In other words, there is no interactive effect of having both residence and workplace damage.

short term but continued to exist in the long term, at -2.2 percent of pre-storm earnings. For those in leisure and accommodations, the earnings losses persisted into the medium term.

The effects by industry are most positive for individuals in construction and in agriculture and natural resources. Those in construction experienced an earnings gain even in the short term (4.8%), and in the long term they experienced strong earnings gains (22.7%); these gains are presumably tied to the increased demand for construction services related to post-storm cleanup and rebuilding. In the long term, our estimates indicate that workers experienced earnings gains in every industry except healthcare. In addition to construction, the long-term gains were large for agriculture and natural resources (18.3%); public and education (9.1%); and trade, transportation, and utilities (9.0%).

We report effects by pre-storm attachment to employment and by demographic subgroups in the Appendix 9.5. Although there are differences across demographic groups in the short-term and long-term earnings effects of the storms, the long-term earnings gains are widespread: affected individuals in all demographic groups have increased earnings (relative to the control group) by the seventh year after the storms.

5.4. Role of Job Separations

To further explore the mechanisms at work in our main results, we investigate how the earnings effects of the storms vary with short-term job separations. Recall that the earnings losses over the first year after the storms are primarily the result of reductions in earnings due to shifts from employment to non-employment. Therefore, we investigate specifically the earnings effects for those who separated from their pre-storm employer. For individuals in the treatment sample, we define a job separation as the loss of earnings from one's main, pre-storm employer for at least the first four quarters after the storms. Though we do not know the reason for job separation, those workers assigned to establishments in major-damage locations had almost double the mean separation rate, even when controlling for residential damage (Table A6).

These year-long separations almost completely account for the earnings losses we observe in the first year after the storms, as those not separated in this way have negligible earnings loss (Figure 4 and Table A7). While earnings losses may reflect, in part, frictions

associated with migration, only 28.1 percent of separators moved from 2005 to 2006.[13] The estimated earnings losses for separators lasted through the third year after the storms, but the earnings of separators and non-separators converged in the long term, with similar earnings gains for both relative to the control sample. Notably, the earnings losses of separators do not last as long as the losses typically experienced by displaced workers (Jacobson et al., 1993; Fallick, 1996). This faster recovery could reflect that, unlike typical displaced workers, many of those who were separated due to the storms lost their jobs for reasons unrelated to declining demand for their specific job skills. The economic activity that arose in the wake of the storms provided opportunities not available to typical displaced workers.

5.5. Discussion

Our results indicate that in the immediate aftermath of the storms and for the first year thereafter, affected individuals experienced earnings losses largely due to job loss. The increase in shifts to non-employment in the immediate aftermath of the storms is consistent with various short-term disruptions and evident in the subgroup results. Short-term earnings losses were greatest among those individuals in sectors with severe negative demand shocks, such as those tied to tourism (leisure and accommodations) or the size of the local population (healthcare). Individuals who were separated from their pre-storm jobs experienced large short-term earnings losses, and their earnings losses persisted through the third year after the storms. Individuals whose residence or workplace suffered major damage experienced larger short-term earnings losses than did those who experienced minor damage or no damage.

In the medium and longer term, our results indicate that those affected by the storms earned comparatively more than those not affected. Our finding of a long-term increase in earnings is consistent with the aggregate finding of Deryugina et al. (2018) using a different source of earnings data (federal tax returns). In an exploration of why these aggregate changes occurred, our earnings decomposition indicates that the long-term earnings gains were due to higher earnings among those employed rather than increases in the share of individuals who are

[13] We also investigate how the earnings effects of the storm vary with short-term migration status (relocating to a different commuting zone from 2005 to 2006). We find that movers had larger earnings losses than non-movers in the short term (Figure A8 and Table A7). Later, the earnings of movers and non-movers converged; in the long term, we estimate that both movers and non-movers experienced earnings gains. Of short-term movers, only 38.8 percent separated.

employed in a quarter (relative to the control sample). Our analysis also highlights the crucial importance of differences by industry in explaining the aggregate effects.

6. Local Labor-Market Dynamics

Higher earnings for storm-affected individuals who were employed could arise because their wages were higher, their hours were higher, or both. The pattern of estimated storm effects by type of residence damage does not support the explanation that workers with larger wealth losses increased their hours to recoup savings, pay off debts, or rebuild. Notably, those who suffered major damage had markedly lower earnings in the short term and had no higher earnings in the long term than those who suffered no damage.

Rather than an increase in hours, it seems more plausible that workers' earnings increased because the wages of affected individuals rose relative to the wages of individuals in the control sample, which could be explained by increased demand for labor. The storms prompted over $100 billion in federal spending over ten years as well as $46.3 billion in insured property losses and a $16.8 billion payment from the National Flood Insurance Program, all of which would be expected to increase demand in at least some sectors.[14] Contemporary reporting on the storm-affected areas noted labor shortages and boosts in wages, especially for experienced positions in manufacturing and construction.[15] In the first few months after the storms, employers reported offering wages much higher than pre-storm wages. During the Great Recession, rebuilding helped to sustain the affected area's construction sector and manufacturing related to construction. In this section, we evaluate empirical evidence consistent with these local labor-market dynamics by examining area-level data on population, employment, and wages.

6.1. Area-Level Trends

[14] The Congressional Budget Office (2007) reported that by July 2007, emergency supplemental spending bills had allocated $94.8 billion on cleanup, rebuilding, and mitigation for Hurricanes Katrina, Rita, and Wilma, with additional spending from agencies' annual appropriations. The CBO reports that 93 percent of appropriations were spent by 2013, with the majority of spending from 2006 to 2008. See Hoople, D. (September 23, 2013), "The Budgetary Impact of the Federal Government's Response to Disasters." https://www.cbo.gov/publication/44601 (accessed June 29, 2017). Insured property losses (in 2005 dollars) reported by the Insurance Information Institute (Hartwig and Wilkinson, 2010). Payment from the National Flood Insurance Program reported by FEMA, "Significant Flood Events (as of May 31, 2015)," http://www.fema.gov/significant-flood-events (accessed August 14, 2015).

[15] Rivlin, G. (November 11, 2005), "Wooing Workers for New Orleans," *The New York Times*. Quillen, K. (August 31, 2008), "Labor Shortages Persist in the Metro New Orleans Area," *The Times Picayune*. Quillen, K. (November 29, 2008), "As Labor Markets Crash Nationwide, New Orleans is Holding onto its Jobs," *The Times Picayune*.

We compare the evolution of employment and wages in treatment and control areas, which requires us to supplement our individual-level results with area-level data (LEHD does not have hours or wages for most states). We evaluate whether changes in average wages in treatment and control areas over time can explain the long-term increases in earnings of individuals in the treatment sample relative to the control sample. We then interpret our individual and area-level evidence in the context of shifts of labor supply and labor demand, both overall and by industry. Most of the individuals in our treatment and control samples remained in their 2005 labor markets, with the treatment and control samples having roughly equal long-term out-migration rates (see Table A3). Therefore, we expect labor-market dynamics to have first-order effects on long-term earnings differences.

As an indicator of trends in labor supply, we use population estimates over time. Figure 5 shows the population of the treatment and control areas from 2000 to 2012 as a percent of 2005 population. Population growth in the treatment and control areas was similar prior to the storms. During the first year after the storms, population fell by 6.8 percent in the treatment area and increased by 1.8 percent in the control area, a difference of 8.6 percentage points. After 2006, the treatment and control areas grew at roughly similar rates. As a result, 86 percent of the relative population loss in the first year after the storms persisted until 2012.

To help us infer trends in labor demand, we construct estimates of quarterly employment in the treatment and control areas from LEHD's Quarterly Workforce Indicators. As shown in Figure 5, employment (as a percent of pre-storm employment) in the treatment area fell sharply in the aftermath of the storms and remained below employment in the control areas until the middle of 2009. After that point, employment growth was similar in the treatment and control areas; by the end of 2012, employment was at the pre-storm level in both the treatment and control areas.

The narrowing of the employment gap during the Great Recession, in spite of reduced population in the storm-affected area, is suggestive of a relative increase in labor demand. In construction, employment in the treatment area grew sharply through early 2008. It declined during the Great Recession, though not nearly as much as in the control area; by 2012, construction employment in the treatment area was above its pre-storm level while the control

area remained depressed.[16] Manufacturing employment also grew in the treatment area, relative to the control area, between 2005 and 2012, though manufacturing employment was below its pre-storm level in both areas starting in 2009.

In contrast to those sectors, the negative effects of the storms on employment were quite severe and prolonged in non-tradable services unrelated to construction, including healthcare and leisure/accommodations. In leisure and accommodations, employment in the treatment area fell by over 25 percent in the aftermath of the storms (consistent with a decrease in tourism) and it did not recover to its pre-storm level until 2012.[17] In healthcare, the short-term decline in employment was not as severe; however, it remained below the control area through 2012. The decline in employment is consistent with a decrease in both capacity and the demand for local services (due to migration of a portion of the resident population).[18] A comparison of the charts for population and healthcare employment suggests that the population decline in the treatment area was a key factor in the long-term decline in healthcare employment.[19]

To understand the combined effect of changes in labor supply and demand, we examine area-level wages in Table 4. We use the Occupational Employment Statistics survey for May 2005, 2008, and 2012 to construct estimates of average wages (in 2005:2 dollars) for the treatment and control areas (see Appendix 9.7 for details). Prior to the storms, average wages were lower in the treatment area by $1.90 per hour. After the storms, wage growth was greater in the treatment area, with relative growth of 3.2 percentage points from 2005 to 2008 and 6.0 percentage points from 2005 to 2012.

6.2. Using Area-Level Trends to Interpret Individual-Level Estimates

The relative growth of wages in the treatment area after the storms is similar in magnitude to the earnings gains experienced by affected individuals in our individual-level analysis. In that analysis (see Table 2), affected individuals experienced earnings gains of 3.5

[16] One indicator of demand for construction work is the issuance of residential building permits. See Appendix 9.7 for a description of trends in permits, which show a relative increase for the treatment area.
[17] Passenger-arrival data from the Bureau of Transportation Statistics provide some indication of a fall in tourism demand. See Appendix 9.7 for a description of trends in arrival statistics for airports in the treatment area.
[18] For New Orleans, the GAO reports a reduction in staffed beds from 4,083 before Katrina to 1,984 on Feb. 22, 2006, reflecting both closings due to storm damage and staff shortages, as well as uncertainty regarding the recovery of the population. See Government Accountability Office, "Status of the Health Care System in New Orleans" (GAO-06-576R), March 28, 2006, https://www.gao.gov/new.items/d06576r.pdf (accessed January 7, 2019).
[19] Another indicator of local demand for services is the number of students enrolled in public elementary and secondary schools, which showed a relative decrease for the treatment area. See Appendix 9.7 for a description of enrollment trends in the treatment and control areas.

percent of pre-storm earnings over the medium term (2005–2008) and 8.0 percent of pre-storm earnings over the long term (2005−2012). This alignment suggests that long-term earnings gains reflect higher hourly wages. This interpretation is also consistent with our decomposition estimates, which demonstrate that earnings gains are explained primarily by within-employment shifts. This overall result extends to our industry-level analysis. We disaggregate the area wage changes by industry sector and find a general correspondence of industry wage growth in the treatment area (relative to the control area) and earnings growth in the treatment sample (relative to the control sample) from 2005 to 2012 (see Appendix 9.7 and Figure A9). Stated another way, the sectors with stronger growth in relative wages (e.g., construction and manufacturing) tend to be the sectors with stronger earnings gains in our individual-level analysis.

Putting our individual- and area-level results together and using the framework developed in Section 2, we summarize our local labor-market interpretation as follows. After the initial disruptive period of 2005–2006, where damage intensity and sector shocks led to job separations and earnings losses, we find evidence of long-term earnings gains across all subgroups. We interpret the overall earnings gains for the treatment sample, relative to the control sample, as an increase in wages resulting from reduced labor supply and increased labor demand in the treatment area. By 2008, the narrowing of the employment gap and the attenuation of earnings losses due to non-employment suggest that the increase in labor demand was at least as important as the reduction in labor supply. Demand growth was concentrated in sectors related to rebuilding, so the wage and earnings gains were greatest for workers in those sectors. In contrast, workers with experience in non-tradable sectors reliant on tourism or the size of the population had less-robust gains.

6.3. Alternative Explanations

Having presented evidence in support of local labor-market effects, we briefly discuss (and put aside) two other reasons that workers' wages could increase. First, the marginal product of labor could rise in the storm-affected areas due to the adoption of new technology and more capital-intensive means of production when establishments rebuild (Okuyama, 2003; Hallegatte and Dumas, 2008) or due to selection in the survival of damaged establishments (Caballero and Hammour, 1994; Basker and Miranda, 2018). This rise in marginal productivity would lead to an increase in wages. However, our finding that earnings increased for affected workers employed at workplaces that experienced no damage combined with the estimate that only about

25 percent of establishments experienced any damage suggests that any wage increases due to productivity increases at damaged establishments are probably of secondary importance.

A second reason that average wages of affected individuals could increase is that people in our sample shift to different employers and industries in response to relative differences in post-storm industry wages. In our individual-level data, we find that individuals in the treatment sample became more concentrated over time (relative to the change over time for the control sample) in sectors that experienced earnings gains; however, the magnitude of these shifts does not appear large enough to explain the long-term earnings gains in the aggregate (Table A8).

7. Conclusion

This study contributes to our knowledge of mass disasters by examining the employment and earnings of individuals affected by Hurricanes Katrina and Rita. We find that these hurricanes reduced the earnings of affected individuals over the first year after the storms. The earnings losses, which were due primarily to shifts to non-employment, reflect various short-term disruptions caused by the hurricanes. Our results indicate that individuals whose residence or workplace suffered damage experienced larger earnings losses in the short term, which may be attributed to migration or business closings. Almost all of the earnings losses in the first year can be attributed to those who separated from their pre-storm jobs after the storms.

We find that the affected individuals experienced earnings gains relative to the control sample in the medium and long term, primarily due to earnings gains within employment. Over the entire post-storm period, we find that the storms led to a net increase in the average quarterly earnings of affected individuals. For some subgroups, however, the storms led to a net decrease in average quarterly earnings (or no net change): those who separated from their pre-storm employer during the first year after the storms, those whose residence or workplace experienced damage, and those who worked in sectors closely tied to tourism or the size of the local population.

We provide evidence that the long-term earnings gains experienced by affected individuals were the result of differences in local labor-market dynamics between the affected areas and the control areas. Area-level data on population, employment, and average wages suggest that, in the affected areas, labor supply decreased and labor demand increased—producing an increase in relative wages. Our results show significant differences in the

trajectory of earnings by industry—with those employed in sectors related to rebuilding experiencing some of the largest gains and those employed in local services, education, and healthcare experiencing modest gains (or even losses). Our local labor-market interpretation provides an alternative to the cost-of-living explanation put forth by Deryugina et al. (2018), that increases in housing costs due the storms' destruction of residences is the primary cause of the increase in workers' earnings. Furthermore, our labor-market analysis provides an explanation of how employers could afford to pay higher wages to accommodate a higher cost of living.

Construction expenditures may have contributed to the sequencing and intensity of the recovery for other sectors. By generating demand for local products and services and providing earnings to local construction workers, construction spending may have boosted hiring in other sectors. We find that workers in manufacturing, local services, and trade, transportation, and utilities all had medium-term earnings gains. In contrast, we find no such medium-term gains for workers in the leisure and accommodations, healthcare, and professional services sectors. These sectors are more closely tied to the size of the local population or non-residents' perception of the degree to which storm-affected areas are "open for business" and desirable places to visit; as such, these sectors are less influenced by spillover from increased earnings in other sectors supported by the area's recovery.

The differences we observe by industry emphasize the importance of not treating storm-affected areas as a single entity. The heterogeneity of results by industry also suggests that policymakers contemplating the design of assistance programs for storm-affected areas may want to pay particular attention to those who were employed in sectors related to the size of the local population. The results further suggest that if a storm-affected area's economy is particularly tied to tourism, policymakers' efforts to restore non-residents' confidence in and desire to visit the area may be important to the area's recovery.

In a broader context, our results have implications for the literature on local labor-market shocks (e.g., Blanchard and Katz, 1992; Autor et al., 2013) and mass-layoff events (e.g., Jacobson et al., 1993; Fallick, 1996). In addition, our study demonstrates that localized disasters may have both direct and indirect effects on individuals. Direct effects include the damages to residences and workplaces as well as impacts on individuals' physical and mental health. Indirect effects include changes in wages and prices that are caused by disasters and rebuilding through changes in labor, product, and housing markets. Although the direct effects are more

obvious in the immediate aftermath of a disaster, the indirect effects ultimately may have greater overall economic impact.

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Table 1. Summary Statistics for Treatment and Control Samples

Variable	Treatment	Potential Control	Matched Control
Gender:			
Male	50.1	50.9	49.0
Female	49.9	49.1	51.0
Age:			
25–29	12.9	14.0	12.5
30–39	29.4	29.0	30.3
40–49	33.6	32.8	33.1
50–59	24.1	24.2	24.1
Race/ethnicity:			
White, not Hispanic	64.7	72.5	64.9
Black, not Hispanic	27.1	9.9	26.9
Hispanic	5.3	11.0	4.5
Other race, not Hispanic	2.9	6.6	3.7
Education:			
Less than high school	12.4	9.5	11.0
High school	32.3	27.6	31.3
Some college	32.9	32.7	32.0
College	22.3	30.2	25.7
Annual earnings:			
Low (< $23,000)	36.7	28.9	34.8
Middle ($23,000–$43,499)	33.5	34.7	35.6
High (≥ $43,500)	29.8	36.5	29.7
Industry:			
Agriculture and resources	3.0	1.2	1.8
Construction	6.8	5.3	6.0
Manufacturing	12.7	15.1	13.8
Leisure, accommodations	7.5	5.4	6.2
Healthcare	14.5	13.4	13.8
Professional services	12.7	17.0	14.1
Local services	17.0	16.6	17.4
Trade, transport, utilities	9.6	9.6	10.6
Public, education	16.2	16.3	16.3
Quarterly earnings:			
2003:3	8,706	10,187	9,214
2003:4	9,428	11,228	10,001
2004:1	9,104	10,952	9,821
2004:2	9,040	10,721	9,620
2004:3	9,161	10,797	9,701
2004:4	10,015	12,021	10,618
2005:1	9,698	11,456	10,361
2005:2	9,916	11,523	10,388
County characteristics:			
Percent employed, 2005:2	50.7	58.0	53.3
Unemployment rate, 2004	6.2	5.6	6.1
Housing-price change, 2000:2–2005:2	23.8	37.4	22.7
Population change, 2000–2005	3.7	3.7	5.2
Observations	138,000	8,124,000	406,000

Note: Person records are drawn from the 2000 Census and ACS microdata and matched to LEHD quarterly earnings records. Demographic variables including sex, age (in 2005), race, ethnicity, and educational attainment are derived from the survey data. Earnings (in 2005:2 dollars) and industry variables are derived from LEHD earnings and employer records. Annual earnings are based on the eight quarters before the storms, 2003:3–2005:2. Statistics on attachment, unemployment, housing prices, and population change are for the pre-storm county of residence. See Appendix 9.1 for industry definitions.

Table 2. Effects on Earnings, Overall and by Damage Type

	Effects by Time Period after the Storms			
Model	Short	Medium	Long	Full
Overall	-298.4	343.0*	792.3*	403.8*
	(191.4)	(125.4)	(141.8)	(127.9)
	[-3.0]	[3.5]	[8.0]	[4.1]
Residence damage:				
Major	-1,710.3*	-302.6	535.2*	-295.8*
	(322.2)	(159.8)	(181.0)	(141.7)
	[-17.2]	[-3.1]	[5.4]	[-3.0]
Minor	-631.9*	295.0*	772.1*	258.8
	(167.9)	(120.3)	(258.9)	(134.9)
	[-6.4]	[3.0]	[7.8]	[2.6]
Workplace damage:				
Major	-1,444.0*	-2.7	835.9*	41.4
	(252.9)	(121.9)	(226.5)	(129.1)
	[-14.6]	[0.0]	[8.4]	[0.4]
Minor	-755.3*	286.1	754.7*	218.7
	(298.2)	(171.9)	(189.6)	(181.6)
	[-7.6]	[2.9]	[7.6]	[2.2]

Note: The estimates for overall treatment effects, residence damage, and workplace damage are based on separate regressions. Numbers in parentheses are standard errors clustered at the county level (based on 2005 residence location). Numbers in brackets are effects as a percent of average earnings in 2005:2 for the treatment sample as a whole. Short term is 2005:4–2006:3 (k=1–4), medium term is 2007:4–2008:3 (k=9–12), long term is 2011:4–2012:3 (k=25–28), and full is 2005:4–2012:3 (k=1–28). See Table A2 for distribution of FEMA (2005) damage and Table A5 for estimates associated with damage categorized as Uncertain (not assessed by FEMA), None, or (for workplace damage) Outside of treatment area.
* $p<0.05$.

Table 3. Effects on Earnings by Subgroup based on Industry

Industry	Pre-storm earnings	Effects by Time Period after the Storms			
		Short	Medium	Long	Full
All	9,916	-298.4	343.0*	792.3*	403.8*
		(191.4)	(125.4)	(141.8)	(127.9)
		[-3.0]	[3.5]	[8.0]	[4.1]
Agriculture and resources	14,921	740.5	2,048.3*	2,730.4*	1,847.5*
		(273.4)	(464.5)	(684.4)	(422.7)
		[5.0]	[13.7]	[18.3]	[12.4]
Construction	10,461	503.4*	1,384.7*	2,376.8*	1,706.1*
		(180.8)	(194.8)	(268.0)	(201.2)
		[4.8]	[13.2]	[22.7]	[16.3]
Manufacturing	13,375	10.7	894.8*	1,128.3*	888.1*
		(148.0)	(170.6)	(172.6)	(150.9)
		[0.1]	[6.7]	[8.4]	[6.6]
Leisure, accommodations	5,825	-495.3*	-131.8	158.8	-60.9
		(214.5)	(164.4)	(137.3)	(123.1)
		[-8.5]	[-2.3]	[2.7]	[-1.0]
Healthcare	9,220	-855.6*	-300.8	-205.1	-418.4
		(309.6)	(197.0)	(271.7)	(226.3)
		[-9.3]	[-3.3]	[-2.2]	[-4.5]
Professional services	11,531	-1,181.3*	-295.4	754.0	-84.2
		(494.9)	(333.0)	(502.8)	(375.3)
		[-10.2]	[-2.6]	[6.5]	[-0.7]
Local services	7,400	30.7	314.0*	506.4*	352.3*
		(131.7)	(88.0)	(126.1)	(80.3)
		[0.4]	[4.2]	[6.8]	[4.8]
Trade, transportation, utilities	11,801	-178.5	682.6*	1,059.2*	646.3*
		(182.0)	(182.0)	(210.0)	(182.0)
		[-1.5]	[5.8]	[9.0]	[5.5]
Public, education	8,833	-97.2	258.4	802.8*	437.6*
		(285.6)	(273.2)	(193.8)	(211.7)
		[-1.1]	[2.9]	[9.1]	[5.0]

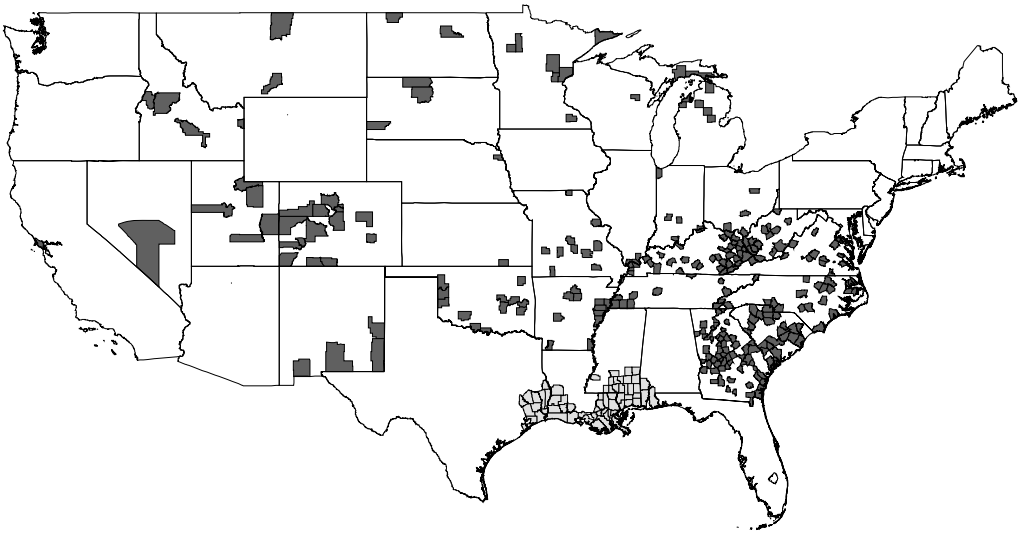
Note: The estimates in each row are based on a separate regression. Pre-storm earnings are average earnings in 2005:2 for the treatment sample. Numbers in parentheses are standard errors clustered at the county level (based on 2005 residence location). Numbers in brackets are effects as a percent of average pre-storm earnings for each group. Short term is 2005:4–2006:3 (k=1–4), medium term is 2007:4–2008:3 (k=9–12), long term is 2011:4–2012:3 (k=25–28), and full is 2005:4–2012:3 (k=1–28).
* $p<0.05$.

Table 4. Average Wages in Treatment and Control Areas, 2005–2012

	Treatment	Control	Treatment – Control
Levels ($)			
May 2005	15.68	17.58	-1.90
May 2008	16.08	17.46	-1.38
May 2012	16.76	17.74	-0.98
Changes (%)			
2005 to 2008	2.53	-0.70	3.23
2005 to 2012	6.91	0.88	6.03

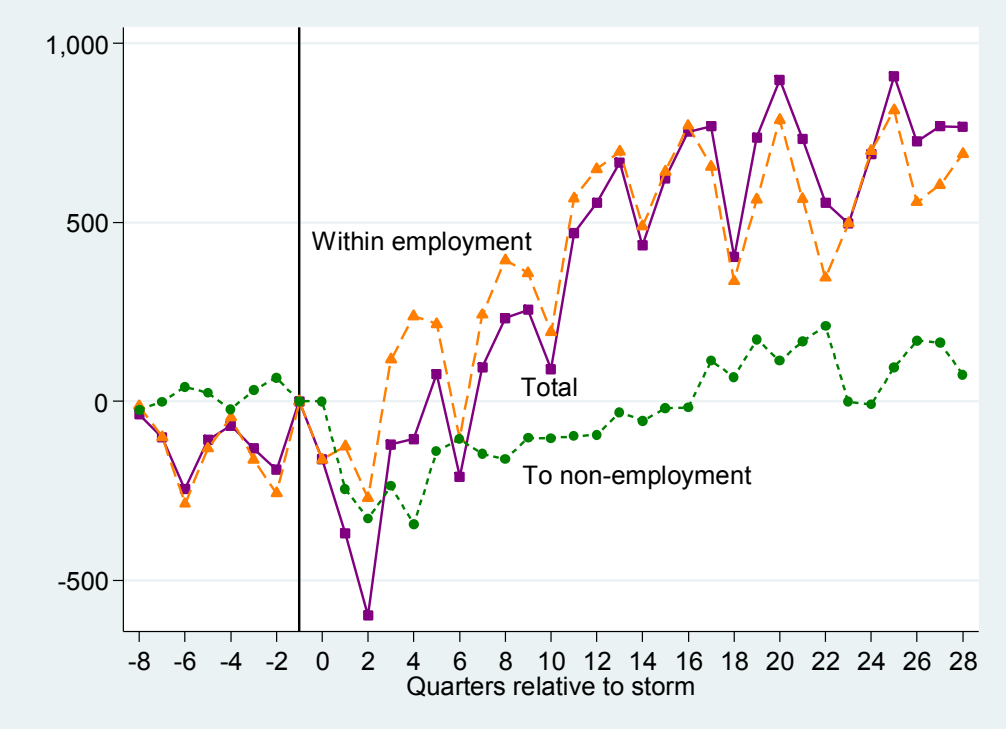
Source: Occupational Employment Statistics survey (authors' calculations; see Appendix 9.7).
Note: Estimates of average wages are in 2005:2 dollars.

Figure 1. Treatment and Control Areas



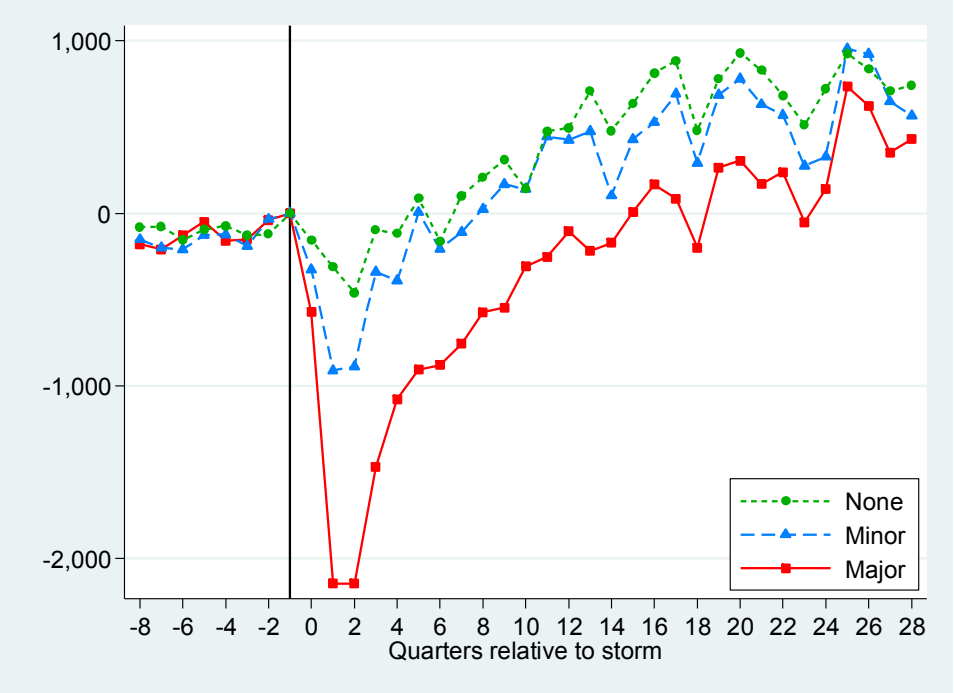
Note: The estimation sample consists of workers who resided in treatment or control counties before the Hurricanes Katrina and Rita. Treatment counties (shaded lighter) are 63 counties in Texas, Louisiana, Mississippi, and Alabama. Control counties (shaded darker) are 287 counties in 28 states.

Figure 2. Decomposition of Effects on Earnings



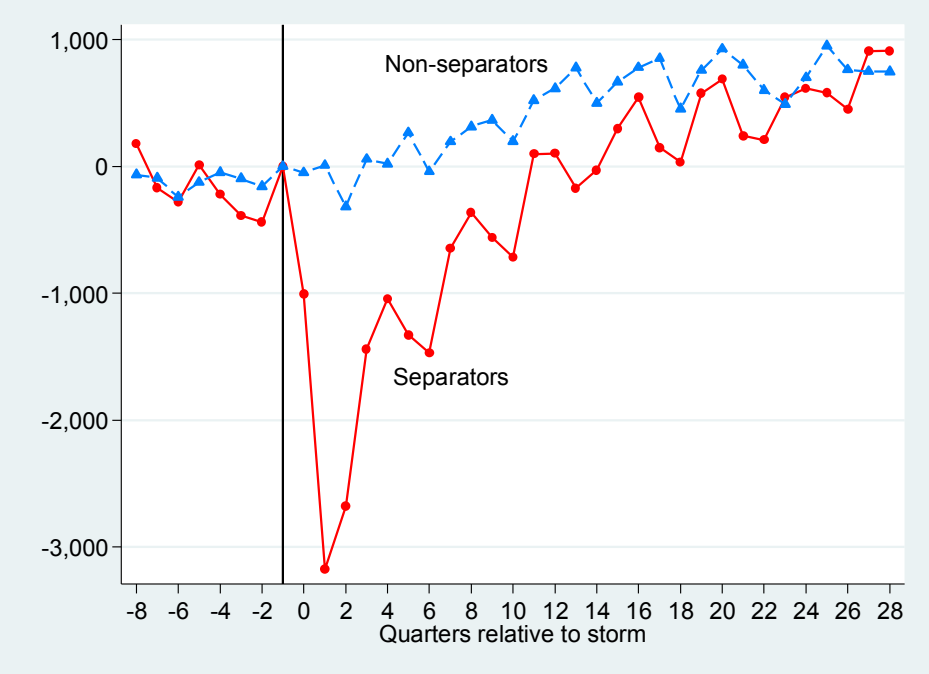
Note: Earnings calculated from LEHD quarterly earnings records spanning 2003:3 to 2012:3. The storms struck in 2005:3, labeled zero. All earnings are adjusted to 2005:2 using the Consumer Price Index. All workers held a job at the beginning of 2005:2. Sample includes 138,000 workers in the treatment sample and 406,000 in the control sample. The reference quarter in the model is 2005:2 (k = -1); the D_{ik} variable for this quarter is excluded from the regression and this quarter is marked by the vertical line. "Total" estimates are for Equation (1). The "within employment" and "to non-employment" estimates substitute alternate dependent variables that sum to total earnings. The "within employment" estimates isolate earnings changes for those employed in a quarter, while the "to non-employment" estimates isolate changes due to shifts to non-employment.

Figure 3. Effects by Type of Damage to a Worker's Residence



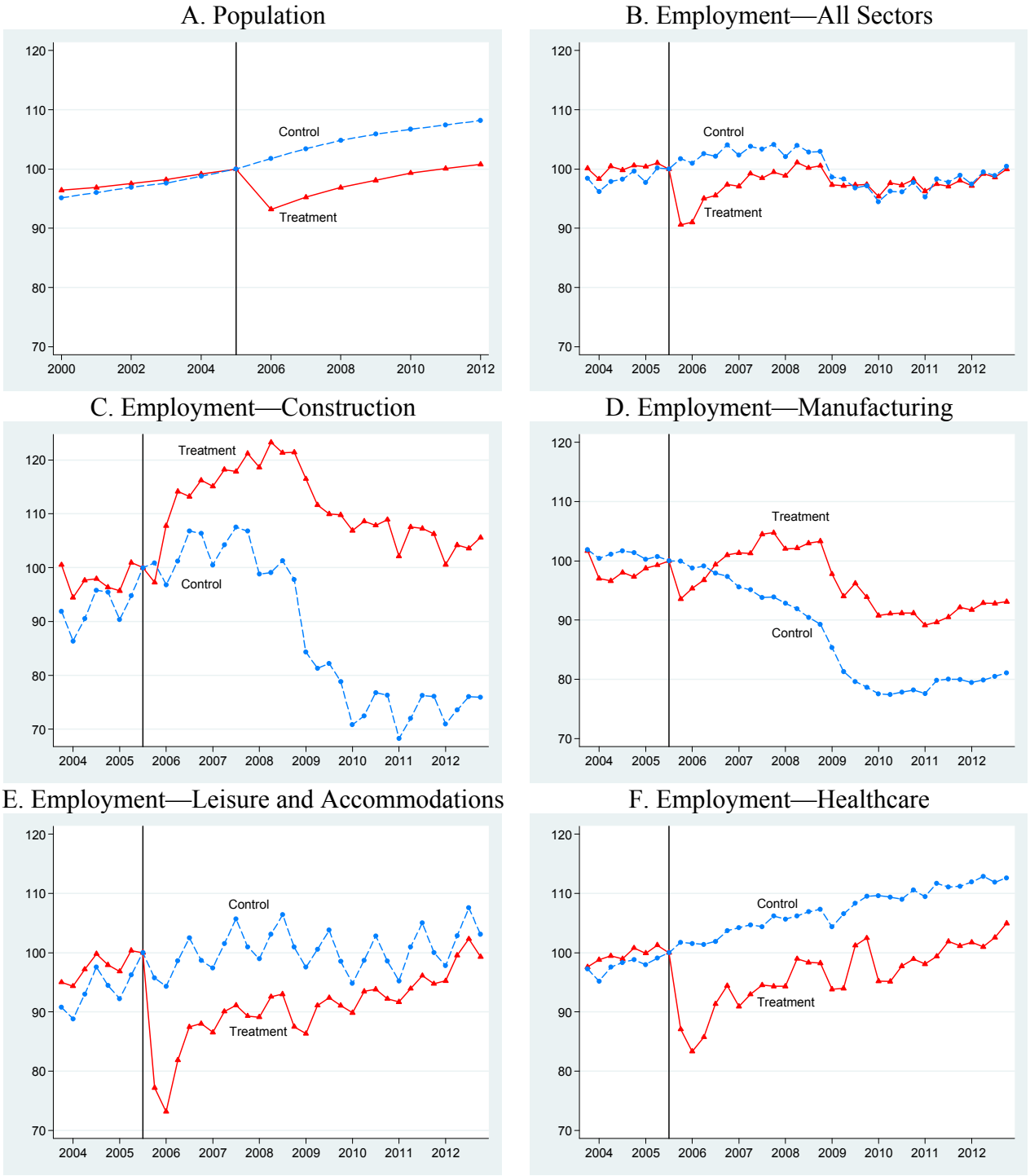
Note: The reference quarter in the model is 2005:2 (k = -1); this quarter is marked by the vertical line. For simplicity, the figure does not display estimates for uncertain damage (expected to be of lower frequency and intensity). See Table A2 for distribution of damage in the treatment sample. See Figure 2 for description of the earnings data.

Figure 4. Effects on Earnings by Subgroups based on Job Separation



Note: The reference quarter in the model is 2005:2 (k = -1); this quarter is marked by the vertical line. Separators are those in the treatment sample who were not working for their pre-storm employer in the first four quarters after the storms; non-separators are the remainder of the treatment sample. See Figure 2 for description of the earnings data.

Figure 5. Population and Employment in Treatment and Control Areas (% of pre-storm level)



Note: The vertical line marks the last pre-storm time period: the year 2005 for the population figure or the quarter 2005:3 for the employment figures.
Source: Census Bureau County Population Estimates (public-use data; reference date is July 1) and Quarterly Workforce Indicators (authors' calculations; reference date is beginning of quarter, see Appendix 9.7).