Taken by Storm: Business Survival in the Aftermath of Hurricane Katrina*

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Abstract

We use the damage caused by the 2005 hurricane season in Louisiana and Mississippi as a natural experiment to study business survival in the aftermath of a cost shock. Our analysis uses establishment-level data on business activity in the retail, restaurant, and hotel sectors from the Census Bureau's Longitudinal Business Database (LBD) and Economic Census, combined with geo-spatial damage maps from the Federal Emergency Management Agency (FEMA) documenting the exact location of damaged structures by hurricanes Katrina and Rita. Difference-in-difference and triple-difference regressions reveal that, even after controlling for establishment-level productivity and inherent differences in survival rates between small and large firms, establishments in large chains were more likely to recover from catastrophic structural damage. Among establishments that belong to smaller firms, those located closer to banks were more likely to recover. We discuss various interpretations for these findings, including access to capital markets and both implicit and explicit forms of insurance.

JEL Codes: D22, L11, L81, L83, G33, Q54

Keywords: Retail, chain, credit constraints, hurricane, Katrina

*Preliminary and incomplete. Please do not cite or circulate without permission from the authors. Author contact: emek@missouri.edu, javier.miranda@census.gov. Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed. We thank Saku Aura, Randy Becker, Steve Fazzari, Teresa Fort, Lucia Foster, Ron Jarmin, Shawn Klimek, Traci Mach, Erika McEntarfer, Justin Pierce, Allison Plyer, Anne Polivka, Melissa Schigoda, and seminar participants at the U.S. Census Bureau, Iowa State University, and the 2011 Southern Economic Association meetings (Washington DC) for helpful comments and conversations. This research was started while Basker was an ASA/NSF/Census Bureau Fellow visiting the Center for Economic Studies (CES) at the U.S. Census Bureau. Basker thanks the funding agencies for their generous support and the economists at CES for their hospitality.

1 Introduction

Hurricane Katrina's landfall in the fall of 2005 famously breached levees, flooding New Orleans. It also unleashed wind gusts that destroyed hundreds of buildings in Louisiana and along the Mississippi gulf coast. Large-scale evacuations and out-migration in the aftermath of Katrina, and to a lesser extent Rita, and infrastructure damage that disrupted supply chains as well as access to customers, all affected the ability of area businesses to survive. In this paper, we study the effect of direct storm damage due to direct wind and flooding on business establishments' ability to recover, focusing on the effect of a firm's access to credit on its recovery prospects. We use data from the Census Bureau's Longitudinal Business Database (LBD) on approximately 10,000 business establishments in 14 counties and parishes with significant storm damage, all of which experienced common demand and infrastructure shocks, combined with precise information on the location, type, and extent of structure damage from the Federal Emergency Management Administration (FEMA). The FEMA data allow us to pinpoint which establishments were hit directly (e.g., flooded or destroyed by wind) and which were left intact in the same area. We focus on establishments in the retail, restaurant, and hotel sectors, whose locations are non-fungible. Our identification comes from the randomness of actual damage within this fairly limited geographic area.

We document several characteristics of surviving businesses. First, establishments that survive are more likely to belong to large chains than establishments that do not survive. *Ceteris paribus*, a doubling of the size of the chain to which an establishment belongs reduces the impact of extensive or catastrophic damage on the probability of exit between 2004 and 2006 by about 2 percentage points, or about 10%. One explanation for this differential survival rate by chain size is that larger chains tend to have more productive establishments (see, e.g., Foster, Haltiwanger, and Krizan, 2006, in the retail context). The pattern persists when we control in a flexible way for establishment productivity using data from the 2002 Economic Census, suggesting another force is also at work here. We speculate that larger chains' better liquidity positions, better access to capital markets, and better forms of insurance may explain this pattern.

Second, we use triple-difference regressions to show that the distance between an establishment's location and the nearest bank or bank branch is negatively correlated with the establishment's ability to survive storm damage, and that this is particularly true for establishments in small chains and stand-alone businesses. Of course, businesses in denser commercial areas may recover more easily from damage for reasons unrelated to access to credit, such as greater customer foot traffic. To test whether the differential recovery rates correlated with distance to the nearest bank are due to some omitted factor, we add a specification test using distance to the nearest dentist as an explanatory variable. Since we do not believe access to dentists has a causal effect on business survival, the difference in the explanatory power of distance to a bank and distance to a dentist provides us with a sense of the importance of banks relative to general commercial density. We find a relationship between distance to the nearest dentist and an establishment's ability to recover from storm damage, but, unlike in the case of distance to a bank, this effect does not vary with firm characteristics.

Finally, we observe that most short-run predictors of survival are significantly weakened in the longer run. By 2008, neither firm size nor distance to the bank is a significant predictor of an establishment's ability to survive after experiencing storm damage during the 2005 hurricane season. Some of this convergence in survival rates is due to the delayed return of establishments in smaller firms and those located further from banks, but the primary reason for convergence appears to be the late departures of establishments in large firms and those located near banks. We interpret this as evidence that firms with access to more resources are better able to withstand severe shocks but only for a short period of time if the shock is not reversed.

In work currently underway, we are refining our sample to include only sole proprietorships, for which we can link in the owners' demographic information. Using this smaller sample, we intend to test whether the owner's race and gender also play a role in a business's ability to recover from storm damage. Using the business owners' home addresses, we can also determine whether the home was significantly damaged and the role this played in business recovery.

The rest of the paper is organized as follows. Section 2 provides some background on hurricanes Katrina and Rita. Section 3 describes our data in detail. Section 4 presents some stylized facts derived from our data about the damaged areas before and after the storm. Our analysis of exits is in Sections 5, 6, and 7 (under construction). We discuss the wider implications of our findings in Section 8 and conclude with Section 9.

2 Timeline and Institutional Background

The 2005 Atlantic hurricane season was particularly active, with 27 named storms (breaking the previous record, set in 1933), including 15 hurricanes (breaking the previous record for hurricanes, set in 1969), four of which made U.S. landfall, also a record. Our paper focuses on the two most damaging storms of that season: Katrina and Rita. Jarmin and Miranda (2009) estimate a lower bound of the direct economic impact of the storms at $444 million in the first quarter after the storm, mostly due to Katrina. That figure is limited to lost payroll at business establishments that were directly hit by winds or storm surge, or were flooded as a result of the breached levees. The indirect impact, including the cost of rebuilding, repairs, and lost inventories, as well as lost revenue and payroll at establishments that were not physically damaged, and longer-term losses, are presumed to be much higher. The Federal Emergency Management Agency estimates the economic loss from Katrina at about $125 billion (Federal Emergency Management Agency, 2006).

Hurricane Katrina struck several locations in Florida before veering into the Gulf of Mexico and making landfall again in New Orleans on August 29, 2005 as a Category 3 hurricane. Storm surges of 24–28 feet along the Mississippi coast reached as far as 12 miles inland, causing severe flooding (Knabb, Rhome, and Brown, 2005, p. 9), and the storm spawned at least 24 tornados (Federal Emergency Management Agency, 2006). Flood waters did not completely recede for several weeks. Katrina caused damage in several states, including Alabama and Florida, but the most severe damage to businesses, which we focus on in this paper, was in Louisiana (primarily due to flooding) and along the Mississippi coast (primarily due to high winds). Later that season, Rita made landfall as a Category 3 storm along the Louisiana/Texas border, and caused both wind and flood damage due to storm surges in several states (Knabb, Rhome, and Brown, 2006). Rita's heaviest damage was concentrated in Louisiana.

Evacuation orders were in place in the immediate aftermath of Katrina and (to a lesser extent) Rita in many areas of Louisiana and Mississippi, and many residential areas remained uninhabitable for some time due to infrastructure damage. Entire Louisiana parishes were without power, for example; potable water was extremely limited; and many roads, highways, and bridges were severely damaged. Both the Louis Armstrong International Airport in New Orleans and the Gulfport-Biloxi International Airport in Mississippi were temporarily closed to all air traffic. Figure 1 shows the ten Louisiana parishes and four Mississippi counties that were most affected by hurricanes Katrina and Rita. The bulk of the analysis in our paper is limited to establishments in these fourteen areas.

Data on sales tax receipts shows the differential recovery in these areas from the initial shock.[1] Sales tax receipts in Jefferson, St. Charles, St. John, and St. Tammany parishes in Louisiana was sharply down relative to the same month in 2004 for only a month or two, after which it showed increases relative to the previous year; by August 2006, a year after the hurricane, sales tax receipts in these four parishes were 20–50% higher than in August 2004. Orleans and St. Bernard parishes saw deeper and more sustained losses; their tax receipts a year after the storm had reached approximately 80% of the pre-storm levels and their sales tax receipts did not recover to their pre-storm levels until 2010.

[1]We thank Allison Plyer for providing us with monthly sales tax receipts for six Louisiana parishes.

Recovery, as captured by the return of evacuees to the affected areas, was also uneven. Paxson and Rouse (2008) cite evidence that only 50% of New Orleans households received mail in August 2006, one year after the storm; two thirds were receiving mail by June 2007. Table 1 shows population counts from the 2000 and 2010 population censuses for the ten Louisiana parishes and four Mississippi counties that were most affected by Katrina and Rita. Three Louisiana parishes — St. Bernard, Cameron, and Orleans — lost more than a a third of their populations between 2000 and 2010. At the same time, several counties and parishes, including St. Tammany and Tangipahoa in Louisiana and Stone in Mississippi, experienced population gains exceeding 15 percent.

There is no doubt that damage to homes, businesses, and infrastructure played a role in return rates. Using Current Population Survey data, Groen and Polivka (2010) find that residents of areas that experienced more severe damage were less likely to return after an initial evacuation, although they do not distinguish between general damage to the area and damage to an individual's home or business specifically. Paxson and Rouse (2008) find, in a sample of low-income African-American women, that those with water damage to their homes were more than 30 percentage points less likely to return to New Orleans. We are not aware of any studies specific to business owners, but given evidence that homeowners' return probabilities were 20 points higher than renters' (Paxson and Rouse, 2008) we believe that business owners' rates of return would have been higher than average.

A web of government programs was mobilized to provide post-storm support to residents and business owners affected by the storms. The most substantial program directed at business owners was a loan program administered by the Small Business Administration (SBA). Unlike other SBA programs, eligibility in this program is not restricted to small businesses. General Accounting Office (2010) reports that SBA disaster loans related to hurricanes Katrina and Rita totaled about $1.2 billion. From September 2005 through July 2008, almost $300 million in physical damage loans were distributed to retailers, restaurants, and hotels damaged by Katrina, along with an additional $15 in Economic Impact Disaster

Loans (EIDLs). EIDLs may be conferred on a business that was not damaged but whose supply chain or customer base was affected by the storm. The figures for Rita are lower, at $43 million and $3 million, respectively.

Despite this and sundry other programs, the General Accounting Office (GAO) concluded that some small businesses experienced credit- and funding-related difficulties recovering from the disasters. This was due in some cases because their financial documents were lost in the disaster, limiting their ability to apply for SBA and other loans, and in other cases because of increased costs of doing business due to insurance payments and the need to repay recovery-related debts (General Accounting Office, 2010).

3 Data

For our analysis we use data from the Census Bureau's Longitudinal Business Database (LBD). The LBD is a longitudinal database covering all employer establishments and firms in the U.S. non farm private economy. The series starts in 1976 and currently runs through 2009. We use data from the LBD to track the activity and outcomes of all retail stores, restaurants, and hotels operating in Louisiana and Mississippi, the two states most affected by the 2005 hurricane season. We follow establishments in these industries between 2002 and 2008. Hurricane damage is typically narrowly localized with some areas devastated while other in close proximity are spared the impact. We use FEMA's geospatial damage maps to determine which establishments were directly affected by the hurricanes, which were not, as well as the type of damage inflicted by the storms.

We limit our analysis to retail and restaurant businesses and hotels and other accommodation facilities for several reasons. First, they represent a very large share of the local economies in the affected counties, approximately ten times as large as manufacturing. This is important since affected areas are often small and we need sectors with enough data to conduct the analysis. Second, unlike many other service industries and some non-service industries (e.g., construction), the location of the business is non-fungible. Whereas a lawyer may continue to provide legal services and a janitorial firm may continue to provide cleaning services even if the main office is destroyed, stores, restaurants, and hotels provide their services at the business address and cannot survive otherwise.[2] Third, selected retail and services serve local demand. The hurricanes produced a severe long-term displacement of population that would have similar effects on nearby businesses serving local demand. Demand for products in other sectors such as manufacturing may extend beyond the local area in ways that we do not observe, making it hard to determine the relative effect of demand and supply shocks for these businesses.

The LBD is an establishment-level dataset that includes firm characteristics. An establishment is the physical location where business is conducted and a firm is the legal entity with operational control. Establishments that belong to the same firm are linked in the data via a firm identifier. Firms in the LBD can and often do have very complex and dynamic structures. The LBD tracks the activity of these firms over time, i.e., establishments that open or close as well as any acquisitions and divestitures of pre-existing establishments. In the retail and hospitality context, a multi-establishment firm is usually a chain, although it can also be a firm operating, say, one retail outlet and one or more non-retail outlets (manufacturing facilities, warehouses, etc.). We use the firm identifier on each record to compute firm characteristics including the firm's age and its size.[3]

The LBD is constructed from several sources, of which the most important for our purposes are administrative business filings.[4] These filings are processed by the Census Bureau on a flow basis as they are received. Establishments in the LBD are defined to be

[2]For this reason, we omit from the data non-store retailers such as catalog companies and vending-machine operators, as well as caterers and mobile food service providers.

[3]Firm age is computed using the same methodology as in Haltiwnager, Jarmin, and Miranda (forthcoming). It is also the same methodology used in the construction of the Business Dynamics Statistics (BDS); see `http://www.ces.census.gov/index.php/bds`.

[4]There records are enhanced with Census collections to identify meaningful economic units of interest such as establishments and firms.

"active" if the tax-reporting unit to which they are attached, the Employer Identification Number (EIN), reports positive payroll to the IRS at any point during the year. Following Katrina, the IRS several times postponed the tax filing deadlines, including waiving penalties and late fees, of individuals and businesses in affected areas. The original relief order, IRS News Release IR-2005-84, extended the filing deadlines by 45 days to taxpayers in 31 Louisiana parishes, 15 Mississippi counties, and three Alabama counties; later revisions increased the number of counties and parishes relieved and ultimately extended the deadline by another full year. Further extensions to April 2007 were also available. These filing extensions naturally cause disruptions in the flow of transactions recorded by the Census in a given year and could lead us to attribute an establishment exit when none exists. However, late filings are recorded by the Census Bureau as amendments to prior year records when they are reported by the IRS. These amendments are recorded up to two years after the original filing year. We rely on these late filings and amendments to fill in reporting gaps and to identify late-filers from temporary exits and permanent exits. However, because some businesses filed even later (or perhaps not at all), we expect some reporting gaps for establishments that were otherwise active for at least part of this year. To ensure that we correctly measure exits against the true population of businesses, we use 2004 data as our baseline, and compare 2004 to 2006 for our short-run analysis and 2004 to 2008 for the longer-run analysis.

We geocode establishments using Geographic Information System (GIS) tools to assign latitude and longitude based on the business's address.[5] The Census Bureau spends considerable resources ensuring that the business address on file corresponds to the physical address. It requires businesses responding to a census or a survey form to provide the physical address of all their establishments. Establishments never covered by a census or a survey are assigned their mailing address as identified through their administrative filing forms.In

[5]We follow the methodology developed in Jarmin and Miranda (2009). They use geographic information tools to combine geospatial digitized maps with establishments latitude/longitude locations.

a small number of cases the business address may represent the address of an accountant or other hired provider who assists the business with those forms. To minimize this problem, we removed 230 businesses whose addresses were identical to addresses provided by accounting or bookkeeping firms.

Despite these efforts not all addresses are of the necessary quality to be able to geocode down to the latitude and longitude successfully. Incomplete addresses and non standard addresses (e.g. rural routes and PO Box) are main reasons for failures. Rural areas are known to be particularly problematic in this regard. For 2004, across the 14 counties and parishes that experienced Katrina or Rita storm damage, our lowest success rate was in St. Charles Parish (population density 172/square mile), where only 61% of approximately 180 establishments were successfully geocoded; the highest rate was in Orleans Parish (population density 1,965/square mile), with 93% of approximately 2,920 establishments geocoded. Combined, the 14 counties and parishes accounted for over 12,000 stores, restaurants, and hotels prior to the storm, of which we geocoded 87%, or 10,480. Table 2 lists the 14 counties and parishes and the number of geo-coded establishments in each. Table 3 compares summary statistics of establishment and firm characteristics for geocoded and non-geocoded establishments in both 2002 and 2004. Non-geocoded establishments tend to be slightly larger and older and to belong to larger firms; among restaurants only, the non-geocoded establishments appear to be much more productive. Almost none of these are statistically different in 2004, but several are significant in 2002.

Figure 2 shows close-up maps of the counties affected by hurricanes Katrina and Rita, with the damage areas shaded. Damage from Katrina was widespread, with areas of flooding abutting those with wind damage. Rita's damage was more scattered.

In addition to establishments in the retail, restaurant, and hotel sectors, we also geocoded all banks (NAICS 5221) and dentists (NAICS 6212) in Louisiana and Mississippi. We use this information to calculate the distance, as the crow flies, between each store, restaurant, and hotel in our data set and the nearest bank lending institution and the nearest dental office. In 2004, the median distance to a bank in our data was approximately a quarter mile and the mean half a mile. The 99th percentile was about 5 miles from a bank, and all establishments were within 20 miles of a bank. Distance to the nearest dentist was on average about 50% further than distance to the nearest bank.

Storm damage information comes from FEMA and is described in detail in Jarmin and Miranda (2009). FEMA uses a four-tier system to designate the level of wind damage: limited, moderate, extensive, and catastrophic. We reduce this to a two-tier system, combining "extensive" and "catastrophic" into one category (defined as "extensive" from here on), and combining the "limited" and "moderate" into a second category ("limited" from here on). In practice, there was very little extensive damage, with almost all of the extensive/catastrophic damage being catastrophic. We also have an indicator for flood damage, which has a single level. Most of the extensive and catastrophic wind damage was in Mississippi, and most of the flooding in Louisiana.[6] Damage designations are based on a combination of remote sensing data collected shortly after each hurricane as well as reports from the ground. Hurricane Katrina data were collected between August 30 and September 10, 2005, for example. Critically, damage designations are not based on insurance claims. In some cases, FEMA released alternative damage estimates for the same areas; following Jarmin and Miranda (2009), we use the more conservative estimates whenever multiple sets are available. Also following Jarmin and Miranda (2009), we add the FEMA damage information to the geocoded LBD to obtain, for each geocoded establishment, the FEMA classification of the location containing that establishment.

Figure 3 shows an area on the border of Harrison and Hancock counties in Mississippi in which storm damage was widespread and highly variable. Each grey dot on the map rep-

[6]Texas and Florida also experienced storm damage due to hurricanes Rita (in Texas) and Wilma (in Florida), but the damage in those states was almost exclusively limited or moderate. A small number of business establishments in Alabama were also damaged by the storms. We do not include these in our analysis.

resents a single business establishment.[7] Establishments in red (diagonally cross-hatched) areas were extensively or catastrophically damaged, those in blue (diagonally lined) areas were flooded, and those in green (horizontal and vertical cross-hatched) areas were limitedly or moderately damaged by winds. Establishments in the white areas were physically undamaged.

Table 2 provides summary statistics for establishments in the 14 affected counties in 2004. Approximately 470 establishments were in areas later designated by FEMA as having endured extensive or catastrophic wind damage. Another 3,500 establishments were in areas later designated as flooded, and 820 were in areas later designated as having suffered limited or moderate damage. (All numbers are rounded to the nearest ten.) We refer to all of these establishments as “damaged.” The final three columns in Table 2 provide the approximate percentage of establishments in each of the designated areas. Cells representing fewer than ten observations are omitted, but they are included in the total. Counties or parishes with no listed damage areas, such as Cameron parish and Stone county, have fewer than ten establishments in each of the three designated damage zones, but at least one establishment that was damaged.

Productivity measures used as control variables in some of our regressions are derived from the 2002 Census of Retail Trade (CRT) and the 2002 Census of Accommodation and Food Services (CFS), which provide revenue information at the establishment level. In the absence of information on other inputs, such as cost of materials and capital, we calculate productivity as the log of the ratio of annual revenue to annual payroll at the establishment level.[8]

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[7]These dots were “jittered” in compliance with Census Bureau disclosure procedures to prevent identification of particular establishments.

[8]Revenue information is not available in annual data sets, but only in the quinquennial Economic Censuses. Our ratio measure is also used in Basker (forthcoming). Other papers using Census data, including Foster, Haltiwanger, and Krizan (2002) and Doms, Jarmin, and Klimek (2004) have used the ratio of annual revenue to March employment, but this measure is sensitive to part-time employment, which is common in these industries. See Foster, Haltiwanger, and Krizan (2002), Haskel and Sadun (2009), Basker (forthcoming), and Betancourt (2005) for further discussion.

Table 4 shows pre-storm summary statistics for the 2002 and 2004 cross-sections of establishments in our data. We show the average value for establishments located in areas that were later damaged and those located in areas that were undamaged. With the exception of the number of establishments in the firm in 2004, the only variables whose mean differs statistically between the damaged and undamaged sample are the distance variables: damaged establishments closer to both the nearest bank and the nearest dentist by three tenths of a mile. This difference reflects the fact that New Orleans, where much of the flood damage was concentrated, is denser than any other area in our dataset and therefore characterized by shorter distances.

Most of the establishments in our dataset, as in the U.S. as a whole, are owned by corporations and partnerships. Sole proprietorships operating in the 14 counties and parishes in our sample constituted approximately 13% of firms and accounted for 10% of establishments in these counties and parishes in 2004.

Although sole proprietorships form a relatively small sample, they have the advantage that we have additional information about their owners, something unavailable for other legal forms of organization (LFOs). We obtain the owner's race and gender from the 2000 Population Census 100% ("short-form") file. The 2000 Census, for the first time, allowed respondents to choose more than one racial category. We code respondents as "white" if they selected only white and as "non-white" if they selected one or more non-white categories. Of the approximately 1,000 sole proprietors in our dataset each year, we are able to link approximately 80% to their individual Census records. The remaining sole proprietors were not matched due to validation problems due to common, incomplete or name changes that make it hard to match to the 2000 population census. We plan to bring in these data in the future.

4 Stylized Facts

In this section we provide basic facts regarding the effect of the hurricanes on the economic activity of the region. We divide establishments in the sectors under analysis and for each state into three categories, based on their location: "damaged" refers to establishments in areas that were damaged by Katrina and/or Rita in the fall of 2005 as identified through FEMA's geospacial maps. "Undamaged" refers to establishments that were located in counties in which there was at least some such damage but were not damaged themselves. Finally, "undamaged county" or "undamaged parish" refers to the rest of the state; that is, counties that did not receive any such damage. Figure 4 shows the log change in the number of restaurants, stores, and hotels with positive payroll activity in each of these categories in Louisiana and Mississippi, relative to 2002. The immediate effect of the 2005 hurricane season was a nearly 30% reduction in the number of payroll active establishments in the damaged areas of Louisiana, where most damage was due to flooding, and an approximately 35% decline in Mississippi, where most damage was due to wind. By 2008, there was some recovery in Louisiana, but not in Mississippi. The number of establishments in undamaged areas continued the positive trend growth through 2008 with a small dip for establishments located close to the damaged areas.

Figure 5 repeats the above analysis using higher frequency quarterly data. These data are only available for single-unit firms, because quarterly filings are made at the firm/employer level and it is not possible to definitively allocate them among establishments in the case of multi-establishment firms. The pattern is qualitatively similar, with a few differences. First, the decline between the third and fourth quarters of 2005 is much larger, reaching nearly 70% in Louisiana and 75% in Mississippi. This is partly because single-establishment firms were hit harder than chains (as we will show later), but mostly because the quarterly data are finer and pick up on very short-term fluctuations in activity. The implication is that many of the establishments in the damaged areas were able to resume activity soon after the storm hit. By the fourth quarter of 2006, the establishment count in Louisiana is down only 30% relative to pre-storm levels, and in Mississippi it is down by 50%, close to the 2006 annual measure in Figure 4.

The other difference we observe in the quarterly data is a very short-term "sympathy slump" in the establishment activity count in areas of the county or parish that were not directly damaged by the storms.[9] This slump may be due to a combination of two factors; demand and supply disruptions and measurement error. Disruptions include the departure and relocation of many customers as well as possible damage to suppliers, communications infrastructure, as well as business owners' own temporary abandonment of the area. Measurement error may be of two sorts. The first is measurement of the damage areas by FEMA. We have no way to verify these designations and have to take them as given. The second is error in the measurement of payroll activity. Tax-filing deadlines in the affected counties were extended by over a year, and despite our best efforts to track late and amended filings, we may have missed some establishments.[10]

The regressions in the next section focus on the cross-section of establishments that existed in 2004. Before we turn to those regressions, Figure 6 shows the survival pattern of those establishments between 2005 and 2008, again by damage status. Unlike the graphs in Figure 4, these graphs all trend down, about 10% per year, because they do not include new entrants that replenish the stock of establishments, replacing exiting establishments. The break in the establishment count in the damaged areas, and to a lesser extent in the undamaged sections of damaged counties and parishes, can be seen here too. Our regressions, which include only establishments in damaged counties and parishes, exploit the differential survival (exit) rates of damaged and undamaged establishments and ask to what extent these were influenced by access to credit markets.

[9]This was also evident in the annual data but to a lesser degree.

[10]Establishments in counties not affected by the storms did not show these declines despite also being able to delay their filings. By contrast demand and supply disruptions both in LA and MS were considerable in counties/parishes affected by the storms. This suggests the drops observed in the data are likely predominantly real.

5 The Role of Firm Size

5.1 Difference-in-Difference Estimates

We now test whether damage differentially affects exits by establishments in small and large firms. Letting business establishment i be in county or parish $j(i)$ and in 6-digit NAICS $n(i)$, we estimate a cross-sectional linear probability model as follows:

$$\text{Exit}_i = \alpha_{j(i)} + \gamma_{n(i)} + \sigma \ln(\text{Firm Size})_i + \delta \text{Damage}_i + \beta \ln(\text{Firm Size})_i \cdot \text{Damage}_i + \text{Establishment controls} + \varepsilon_i \quad (1)$$

where **Exit** is a binary variable defined over a two-year ("short-run") horizon and a four-year ("long-run") horizon. In the short run, **Exit** is an indicator that equals 1 if the establishment, having had payroll in year t, had no payroll at $t+2$; in the long run, **Exit** equals 1 if the establishment had no payroll in $t+4$. We capture the effect of the 2005 hurricane season by estimating short-run and long-run regressions on the full set of retail, restaurant, and hotel establishments that were active (had positive payroll) in 2004 in damaged counties in Louisiana and Mississippi.

On the right-hand side, $\boldsymbol{\alpha}$ is a county or parish fixed effect intended to capture different area-wide exit probabilities due to overall demand and infrastructure shocks. The 6-digit NAICS fixed effect $\boldsymbol{\gamma}$ captures differences in exit and reentry rates across 110 types of businesses, for example due to the fact that some types of businesses, such as building-material stores, fared better than others in the immediate aftermath of the storm (Pearson, Hickman, and Lawrence, 2011) due to the changing demographics and type of activity of the affected areas (Groen and Polivka, 2010). All establishment- and firm-level control variables are evaluated in 2004. **Firm Size** is measured by the number of establishments operated by the firm that owns establishment i.[11] **Damage** is a vector of three damage indicators:

[11] Results are qualitatively similar when we use two alternative measures of firm size: the number of states in

limited or moderate wind damage; extensive or catastrophic wind damage; and flood damage as described in section 3. The interaction between **Firm Size** and **Damage** captures the differential exit rates for establishments in damaged areas by chain size. Establishment-level controls are log age, an age equal to zero indicator for new establishments, log establishment employment, and a zero-employment indicator for establishments with zero March 12 employment. These controls are designed to capture different exit rates by size and age (Haltiwnager, Jarmin, and Miranda, forthcoming). The error term ε is clustered at the county (or parish) level. Among other things, this clustering accounts for the fact that business survival is interdependent across the county, especially following a large demand shock as in the case of the hurricanes.

Our data permit more than one transition between the two states (in operation and not in operation). In the aftermath of Katrina and Rita in particular, we are interested not only in who exited but in who returned to operation. For this purpose we estimate a probability model, with varying time horizons. We define an "exit" between 2004 and 2006, for example, not as a permanent state change but as a (potentially) temporarily one; and we revisit the same establishments in 2008 to see which of them is, at that point, no longer in operation (whether or not it was in operation in 2006). The choice of a linear probability model over a nonlinear model such as a probit or logit is due to the large number of fixed effects: there are 110 six-digit NAICS codes ($\{\gamma_{n(i)} : n = 1, \ldots, 110\}$) alone.[12] The tradeoff is that a linear model can produce predicted values that fall outside the unit interval. For each regression in this paper, we report the percentage of predicted values outside the unit interval; this value ranges from 1% to 8%, depending on the regression.

which the firm operates, following Foster, Haltiwanger, and Krizan (2007), and total firm-level employment, following Jarmin, Klimek, and Miranda (2004). We do not have access to revenue-based measures of firm size in non-census years.

[12]For a discussion of the incidental-parameters problem in nonlinear models with a large number of fixed effects, see Greene (2004). We chose a linear probability model over a conditional logit model for computational convenience, but we intend to check robustness using a conditional logit model in a future version of the paper.

The identifying assumption in our analysis is that, at least within the counties and parishes affected by Katrina and Rita, the precise path of the storm and therefore the damage inflicted was random. While businesses were clearly not damaged *due to* any underlying characteristics such as size, productivity, profitability, etc. (the hypothesis of God's wrath notwithstanding), it could still be that damage was assigned non-randomly, that is, in a way that is correlated with underlying characteristics (both observable and unobservable).[13] Table 4 in Section 3 provides both a comfort and a caution, in that many, but not all, observables are distributed similarly in the treated (damaged) and control (undamaged) samples. We also assume that demand shocks following the storms — due to temporary and permanent out-migration and a drastic reduction in tourism — are accounted for with county/parish and detailed-industry fixed effects. The remaining differences between damaged and undamaged establishments can then be attributed to their differential recovery costs.

To address the fact that not all variables are distributed similarly in the two samples, we also estimate all our regressions on a pre-storm period, for which we analyze exits between 2002 and 2004. Exits over this period should not have been affected by the 2005 storms, so any relationship we find between future storm damage and exit over this period must reflect location-specific unobserved variables that influence survival rates. These estimates therefore establish a baseline against which we can compare the post-storm regression coefficients to make causal interpretations.

Although the setting is cross-sectional and not a panel, the estimates of the impact of the storm can be interpreted as difference-in-difference estimates in that we focus on the estimate of impact of the interaction of firm size and damage while controlling for the two effects separately. Comparing our estimates for the post-storm period, particularly 2004–2006, to the pre-storm estimates from 2002–2004 provides an indirect third difference.

[13] A similar issue having to do with using geographic variation to identify the impact of Wal-Mart is discussed in some detail in Basker (2006) and Basker and Noel (2009).

Results from estimating this regression are presented in the first three columns of Table 5. We estimate three regressions, each of which defines "exits" over a different time period or horizon. The first uses 2002 as the baseline and uses a two-year horizon to define exits. This is our pre-storm baseline. The second uses 2004 data with a two-year horizon (post-storm short run), and the third uses 2004 data with a four-year horizon (post-storm long run). The first regression may be viewed as a falsification exercise, since we do not expect differential exit rates over the pre-storm period to be correlated with 2005 storm damage, except to the extent that storm damage is correlated with unobserved factors.

To conserve space, we do not report all the coefficients but only the ones related to damage and firm size. However, the coefficients on establishment-level employment are consistently negative and often significantly so, suggesting that larger establishments were less likely to exit even after controlling for firm characteristics.

Looking at column (1) we see no relationship between wind damage in the 2005 hurricane season and exits in the pre-storm period. However, we do see marginally significant higher exit rates in the flooded area in the pre-storm period, indicating unobserved differences between the areas that later flooded and the rest of the counties and parishes in which they were located. Recall that the Katrina flooding occurred mostly in high density urban areas of New Orleans, which probably explains this effect (Jarmin, Klimek, and Miranda, 2009). We find establishments belonging to larger firms have lower exit rates. This is true consistently across size specifications and time periods and is consistent with previous findings (see, for example Foster, Haltiwanger, and Krizan, 2006). The coefficient on the interaction of flood damage and firm size is also statistically signifiant. The gap in exit rates between establishments that belong to large and small firms narrows down, but does not disappear, in flooded areas. This suggests that the flood zone was different from undamaged areas and also from other storm-damaged areas even before the storm hit.

Turning to columns (2) and (3), as expected, the probability of exit increased by more than 20 percentage points following the storms in areas that experienced extensive or catastrophic wind damage. Smaller and statistically insignificant increases in exit probabilities occurred in areas with flooding and limited or moderate wind damage. The point estimate of the impact of limited or moderate wind damage is particularly small. In the case of flooding, the point estimate is quite large, nearly eight percentage points in the short run and 5.5 points in the long run, but the standard errors on these estimates are quite large. We suspect this is due to a colinearity problem; as Table 2 shows, flooding was extremely concentrated in a small number of parishes, and those parishes were essentially entirely under water. (More than three quarters of the businesses in Orleans parish were flooded, as were 97% of those in St. Bernard.) Since we already include county/parish fixed effects, these are likely to absorb most of the effect of the flooding. In a future version of this paper we will incorporate finer data on water depth from Paxson and Rouse (2008) to overcome this colinearity problem.

Within the heavily damage areas, the probability of exit increased the least for establishments belonging to large chains: a doubling of the size of the chain, *ceteris paribus*, reduces the impact of extensive or catastrophic damage on the probability of exit by 2.4 percentage points in the short run, and by 1.3 percentage points in the longer run. These estimates imply that for a large enough chain, the impact of wind damage would have been negligible; an establishment in a hypothetical chain with approximately 7,000 establishments would have almost no increased exit probability between 2004 and 2006 as a result of extensive or catastrophic wind damage.

These interaction effects persist in the longer time horizon, but their magnitude falls by approximately half. As a matter of accounting, the convergence in damage-induced exit between establishments in small and large chains could be due to increased exits of establishments in large chains over time, or to delayed returns to operation by establishments in small firms. While both occur in the data, it is increased exit rather than reentry that drives these results. Our estimates imply, for example, that a single-unit establishment that experiences extensive or catastrophic wind damage is only one percentage point more likely to exit by 2008, three years after the storms, than by 2006. That differential is up to six percentage points for an establishment in a 100-establishment chain and eight and a half percentage points for an establishment in a 1,000-establishment chain.

We also estimate a version of Equation (1) in which we broaden the definition of "exit" to include not only the exit of an establishment but also the exit of a firm (even if the establishment survives under different ownership) and the severing of the owner-establishment tie (due to divestiture or the sale of an entire firm).[14] These results, not shown, are qualitatively similar to the ones presented in Table 5, with coefficients on the size and damage interaction terms generally larger in absolute value, and standard errors slightly smaller. We do not have enough observations to separately estimate exits and sales/divestitures.

What accounts, first, for small firms' disproportionate early exit, and second, for large firms' disproportionate late exit?

Our preferred interpretation of these results is that large firms have some combination of more liquidity, better access to credit markets, and better forms of explicit and implicit insurance. These firms can make use of these resources to weather a temporary negative shock as well as one with a more uncertain time duration in expectation of better times.

Alternatively, the observed differences may be due to omitted variables such as productivity differences or differences in labor hoarding. In the first explanation, larger firms, operating more productive establishments, are better able to weather cost and demand shocks in the short run. In the second explanation, larger businesses are more likely to hold on to a few workers (at least in the short run) as insurance if their future plans are uncertain, to facilitate orderly shutdown, or as a reward for past service. Since we use a payroll-based measure of economic activity rather than a revenue-based measure, we may be mis-classifying these establishments as "active" when they are, in fact, not open for business. We investigate both

[14] The LBD allows us to track ownership through a firm identifier. One caveat is that the firm identifier changes automatically if a single-unit firm acquires a second unit or if a multi-unit firm closes or divests of all but one of its establishments. Therefore, we only code a change in the firm identifier in conjunction with a change in the multi-unit identifier in the case where (1) the new firm identifier has already been in use for other establishments, or (2) the old firm identifier continues to be in use for other establishments.

these possibilities next.

5.2 Productivity

As noted above, more productive establishments may be able to better withstand shocks, as well as have better reasons to return to operation after a negative shock. In the retail context, Foster, Haltiwanger, and Krizan (2006) document a large productivity advantage of large firms over small ones. The correlation between firm size and productivity could cause us to attribute a firms' differential ability to withstand shocks to their size and resources when, in fact, it is due to differences in productivity.

To test the importance of this explanation we calculate an establishment-level productivity measure. The LBD does not have output data at the establishment level, so we use the 2002 Census of Retail Trade and 2002 Census of Accommodation and Food Services to obtain revenue data for all establishments in the affected areas in 2002. Productivity varies significantly across industries, as shown in Table 4, so we define separate productivity measures for each of the three sectors in our data: hotels, restaurants, and stores.

Only a subset of the observations used to estimate Equation (1) have productivity information. A small number (approximately 200) did not provide the revenue data needed to calculate this information. A larger number, approximately 2,000, do not have this information because they did not exist in 2002 and were not included in that census. The timing of the productivity measurement causes an asymmetry between the pre-storm sample on the one hand and the short- and long-run storm samples on the other. Because productivity is measured in 2002, almost all observations in the 2002 sample have productivity information, but only about 80% of establishments in the 2004 sample have productivity information; the remaining 20% started up after the 2002 census. Thus, the later sample consists of older establishments. Older establishments are likely to be more productive due to selection, and they may also differ on other observable and unobservable dimensions. To remove this asymmetry, we restrict the 2002 as well as the 2004 samples to establishments that are at least two years old. This method sacrifices some sample size in the pre-storm analysis in favor of consistency across samples.

We augment Equation (1) by adding not only these three productivity variables but also a full set of interaction terms of the productivity variables with the damage vector, to allow productivity to differentially affect an establishment's ability to withstand the storm shock. The extended probability model is:

$$\begin{aligned}\text{Exit}_i = \alpha_{j(i)} + \gamma_{n(i)} + \sigma \ln(\text{Establishments})_i + \delta \text{Damage}_i + \beta \ln(\text{Establishments})_i \cdot \text{Damage}_i \\ + \pi_{s(i)} \cdot \ln(\text{Prod})_i + \phi_{s(i)} \cdot \ln(\text{Prod})_i \cdot \text{Damage}_i + \text{Establishment controls}_i + \varepsilon_i, \quad (2)\end{aligned}$$

where $s(i)$ is the sector (retail, restaurant, hotel) of establishment i.

The last three columns in Table 5 show the coefficients on the damage variables, firm size, and their interactions, estimated from Equation (2). To conserve space, we do not show the three productivity effects or the nine productivity-damage interactions. The direct productivity effects are consistently negative, as expected: more productive establishments are less likely to exit, *ceteris paribus.* The interaction effects vary in sign, but generally they are positive for extensive and catastrophic damage in the post-storm period: all else equal and once we add the level effect, we find the exit gap between less productive and more productive establishments narrows in the damaged areas. In this regard the damage caused by the hurricanes had the effect of equalizing exit probabilities across establishment types.

Turning to the coefficients, results show that once we condition on productivity the size of the firm becomes a much weaker predictor of establishment exit. The results are qualitatively similar when we omit the productivity controls and interactions but limit the sample to establishments aged two and above in unreported regressions. In other words, this effect is due less to the correlation between firm size and establishment productivity, and more to the correlation between establishment age and exit.

The coefficients on the three damage variables in the post-storm regressions (columns

(5) and (6)) are qualitatively similar to, but generally smaller than, those estimated when productivity controls were omitted. In the case of extensive or catastrophic wind damage we find lower exit rates of establishments in the *pre-damage period*, so we can interpret the full effect of the storm as the difference between the 2002–04 coefficients and the 2004–06 and 2004–08 coefficients. Interpreted this way, the effect of severe wind damage is almost identical to our previous estimates. The estimated effect of limited or moderate wind damage is now negative, statistically so in the short run. The coefficients on flood damage are much smaller, although as noted earlier we hope to use finer flood data in the future to estimate this effect more precisely.

We still find large and statistically significant differentials in the impact of extensive or catastrophic wind damage by firm size on the probability that an establishment exits between 2004 and 2006. The coefficients on the interaction term with extensive and catastrophic damage are only approximately 10% lower than our previous estimates for the short horizon. In the longer run, however, the estimated effects shrink considerably and are no longer statistically distinguishable from zero. Once again, the convergence result is due to excess exit rates of establishments in large firms in the 2006–2008 period.

5.3 Robustness Checks: Labor Hoarding and Labor Depletion

5.3.1 Labor Hoarding

In the absence of revenue data we are constrained to use payroll data to measure business activity. However, the "zero payroll" threshold we use to designate business activity may be problematic for two reasons. First, some businesses may have held on to a few key employees— possibly a manager or a small number of employees regardless of whether the store is operational. There may be multiple reasons for this; for instance, the business may retain good employees in expectation that the business will resume operations; to reward long-term employees at a time of hardship, even if the business is not generating any revenue and possibly even if it does not expect to resume operation; to keep the business operating at a skeletal level in order to gain an advantage when business returns; to help with cleanup and construction, or, conversely, with the orderly shutdown of the establishment. If this type of response, which we term "labor hoarding," was more common in large firms than in small ones, our above results could be biased. In particular, our finding that large firms are more likely to remain in operation or resume operation within a year of the storm could simply indicate that large firms are more likely to "hoard" labor.

To test for this possibility we redefine "exit" to include any case in which the establishment's payroll fell by 90% or more, and re-estimate Equations (1) and (2) using the redefined LHS variable. Coefficient estimates, which we suppress to conserve space, are qualitatively unchanged and continue to be statistically significant at similar levels.

5.3.2 Non-Employer Businesses

A related concern is that businesses may eliminate all paid employment without actually going out of business. An example may be a bed-and-breakfast operation that hires an employee to work as a maid during good times, but continues operations with the owner doing the maid service during bad times. Since our measure of activity is defined using payroll, we incorrectly identify these contractions as exits. Moreover, if small firms are more likely to transition to non-employment, which seems likely, then our results are biased.

This issue cannot be addressed with the LBD, which, as noted, contains only information about establishments with payroll. We hope to incorporate analysis using the Integrated Longitudinal Business Database (ILBD) in the future. The ILBD is described in some detail in Davis, Haltiwanger, Jarmin, Krizan, Miranda, Nucci, and Sandusky (2009). Essentially, we plan to search for all exiting establishments in the ILBD to determine whether they have actually exited or remained in operation without employees.

6 The Role of Establishment Location

Up until this point our analysis has not shown a direct link between exit rates and financing constraints. As stated in Section 5.1, large and small firms may differ in the types of constraints they face along multiple dimensions. In this section we use distance to a bank as a proxy for the ability of firms to obtain financing. Research in this area has shown that distance from a bank is negatively correlated with the probability that a business receives a small commercial business loan Brevoort and Hannan (2004); Petersen and Rajan (2002). [Add references here.]

We estimate a triple-difference regression to allow the effect of damage on an establishment's probability of exit to differ by firm size, as above, and also by its distance to the nearest bank, as well as by the interaction of the two. For completeness, we also allow an interaction of distance to the nearest bank with firm size. The probability model is extended as follows:

$$\begin{aligned}\text{Exit}_i &= \alpha_{j(i)} + \gamma_{n(i)} + \sigma \ln(\text{Size})_i + \tau \ln(\text{Distance})_i + \delta \text{Damage}_i + \beta \ln(\text{Size})_i \cdot \text{Damage}_i \\ &+ \eta \ln(\text{Distance})_i \cdot \text{Damage}_i + \mu \ln(\text{Size})_i \cdot \ln(\text{Distance})_i + \psi \ln(\text{Size})_i \cdot \ln(\text{Distance})_i \cdot \text{Damage}_i \\ &+ \pi_{s(i)} \cdot \ln(\text{Prod})_i + \phi_{s(i)} \cdot \ln(\text{Prod})_i \cdot \text{Damage}_i + \text{Establishment controls}_i + \varepsilon_i \quad (3)\end{aligned}$$

where **Distance** is the distance between establishment i and the nearest bank lending institution. This regression includes, in addition to all the variables from Equation (2), our new sets of variables: log distance; log distance interacted with the vector of damage indicators; log distance interacted with log firm size; and the three-way interaction of log distance, log firm size, and the vector of damage indicators.

The results are reported in the first three columns of Table 6. To conserve space, we omit the flood and limited and moderate damage variables and focus on establishments in the areas characterized by extensive and catastrophic wind damage.[15]

The second column shows the effect of these variables on exits between 2004 and 2006. Establishments in the extensive-and-catastrophic-damage area were nearly 16 percentage points more likely to exit than other establishments over this time period. The direct effects of firm size and distance, and on the interaction of the two, are very small and not statistically significant, suggesting this proxy for access to credit does not affecting firms of different sizes differentially prior to the storms. As in the previous analyses, the coefficient on the interaction of firm size and extensive or catastrophic damage is negative and significant: *ceteris paribus*, establishments belonging to larger firms are less likely to exit conditional on experiencing severe structural damage. The coefficient on the interaction of distance and extensive or catastrophic damage is positive and significant: *ceteris paribus*, establishments further from a bank are more likely to exit after experiencing severe damage. The coefficient on the three-way interaction term, however, is negative and significant. In other words, while establishments that are close to a bank are less likely to exit as a result of severe damage, this effect diminishes with firm size.

To interpret these coefficients, consider first two single-establishment firms that are located, respectively, one tenth of a mile from a bank (approximately the 25th percentile of distance) and 0.55 miles from a bank (approximately the 75th percentile of distance), but are otherwise identical. For the first of these, experiencing extensive or catastrophic damage would have increased its exit probability between 2004 and 2006 by 5.4 percentage points; for the second, the increase would have been 13.1 percentage points. The effect of the additional 0.45 mile distance between the second establishment and the nearest bank is correlated, then, with an increased exit probability of 7.7 percentage points.

Compare the above two establishments with two establishments that are otherwise identical but part of a 100-establishment chains. For these establishments, the differential in-

[15]We hope to revisit these other interaction results once we have the finer flood data from Paxson and Rouse (2008) described in the previous section.

creased exit probabilities due to extensive or catastrophic wind damage is only 3.8 percentage points. In other words, the impact of the additional 0.45 of a mile in distance increases the exit probability of a single-establishment firm by 4 points *more* than it increases the exit probability of an establishment in a 100-establishment chain.

In contrast to this evidence on the relevance of bank proximity for short-term post-storm exits, there is no such evidence for either the longer-term period, from 2004 to 2008, or the pre-storm period from 2002 to 2004. This, too, is consistent with the results in Table 5 showing that the impact of credit constraints on exits appears to have dissipated in the longer run.

One caution with the causal interpretation of these results is that the distance to the nearest bank may be correlated with a host of unobservable variables that have independent effects on an establishment's ability to survive a shock; for example, distance to the central business district, customer base, etc. Locations near other retail and service establishments may benefit from externalities due to foot traffic, similar to the effect of locating in a mall with other retailers (see Gould, Pashigian, and Prendergast, 2005). Another possibility is that businesses that locate far from banks cater to different populations from those located closer to banks. If these populations were differentially affected by the storm (e.g., displaced at greater rates) then the establishments supplying them would have experienced different (greater) demand shocks.

To address these concerns, we repeated the regressions replacing distance to the nearest bank with distance to the nearest dental office. The number of bank outlets and dental offices in the U.S. is very similar; the 2007 Economic Census counted approximately 125,000 banks and 127,000 dental offices with employees. Unlike banks, however, dental offices should not have any causal effect on the exit probability of a store, restaurant, or hotel. The last three columns of Table 6 show these results. With the exception of two distance interactions in the pre-storm period, none of the coefficients on distance to the nearest dental office are statistically significant.

7 The Role of Owner Demographics

In this section we zoom in on the subset of establishments in our data that are organized as sole proprietorships. As explained in Section 3, we have owner characteristics for (a subset of) sole proprietorships. These sole proprietorships are uniformly small (more than 99% have a single establishment, and all operate in just one state), so they all fall into the set of financially vulnerable businesses based on our earlier results.

We plan to do several analyses in this section. First, we will repeat the difference-in-difference analysis of Section 5 to test whether firm size matters for sole proprietorships. We do not expect to find statistically significant results, however, because there is very little variation in firm size for sole proprietorships. Second, we will test whether distance to a bank and/or dentist matters for sole proprietorships, as we did in Section 6. Third, and perhaps most interesting, we will test for an interaction between storm damage and owner demographics; specifically, whether female- or minority-owned sole proprietorships were more likely to exit following significant storm damage than sole proprietorships owned by white males.

The motivation for the last point is existing evidence that businesses owned by women and minorities may be especially vulnerable to credit constraints. Historically, black entrepreneurs in the U.S. were more likely to use credit cards than other forms of finance. Chatterji and Seamans (2011) present evidence that black entrepreneurs are particularly vulnerable to limits on credit-card lending in the 1970s and 1980s, and Blanchflower, Levine, and Zimmerman (2003) show that in the 1990s, black-owned small businesses were twice as likely to be turned down for bank loans even after controlling for credit risk. More recently, Robb, Fairlie, and Robinson (2009) provide evidence from the Kauffman Firm Survey that suggests that black-owned businesses' access to capital has not improved in the 2000s. There is also evidence of gender-related credit constraints, although it is generally weaker (Blanchflower, Levine, and Zimmerman, 2003; Cole and Mehran, 2001).

8 Discussion

In this section we raise issues of interpretation, some of which we plan to address as we continue to develop this paper.

One critical issue in interpreting our estimates as causal is whether the control group we use, namely undamaged establishments in the counties in which damage occurred, is valid. A concern is that these establishments not only suffered some of the same demand and cost shocks associated with infrastructure damage and population relocation, but may have actually benefited from the demise of some of the damaged establishments. In that case, the undamaged establishments would have fared particularly well, causing us to over-estimate the negative effect of the damage. Worse in terms of the focus of our paper is the (albeit unlikely) possibility that, among undamaged establishments, those belonging to larger chains were for some reason less able to take advantage of their increased demand and market power. In this case, relative to undamaged establishments, damaged chain stores would appear to be doing better than damaged single-establishment firms. Alternatively, if undamaged chain stores were *more* able to take advantage of the change in conditions, our regression results underestimate the true differential response to storm damage by firm size. To address these issue, we plan to analyze changes in the size distribution of firms and establishments in the undamaged portions of the counties and parishes hit by Katrina and Rita.

An alternative approach would be to replace the nearby control group with a control group that was not affected by the storms at all, possibly located in other states. The problem with this approach is that the control group may have experienced an altogether different set of shocks and may not be comparable to the damaged establishments, even if we make efforts to match on pre-damage observables.

Another reason our results may be understated is government assistance. The political fallout from, particularly, hurricane Katrina, led to the mobilization of a web of government programs to help residents and home- and business owners recover from the storm. As noted in Section 2, these programs provided grants, loans, and other forms of assistance such as temporary housing. Of the myriad programs employed to help storm survivors, the most relevant from our perspective is the Small Business Administration's Disaster Loan program. One implication of a liquidity- or credit-based interpretation of our results is that small businesses that received SBA support behave more like large businesses than like small businesses without financial support.

We obtained SBA loan lists, including the name of the borrower, the business NAICS code, and the amount of the loan, from the National Institute for Computer-Assisted Reporting (NICAR), a program of Investigative Reporters and Editors, Inc. and the Missouri School of Journalism, which obtained the data from SBA through a Freedom of Information Act (FOIA) request. The data includes loans approved through September 2009, although the vast majority were approved by the early months of 2006. In all, we have identified 2,626 loans to businesses in the retail, restaurant, and hotel sectors, due to Katrina and/or Rita. The vast majority (89%) of these are physical damage loans, with the remainder EIDLs.

Unfortunately, linking the SBA data to the LBD is impossible. Many loans are issued in the name of the business owner, rather than the name of the business, and an inconsequential number of these owners had relocated at the time of the loan request. Katrina loans were issued to addresses in Kansas, Ohio, Oregon, and Wisconsin, among many other states. With both the name and the address links broken in the vast majority of cases, the only information we can use is the disaster (Katrina or Rita) and the business's NAICS code, which is often reported with some noise. These are not sufficient to link observations across the two data sets.

Finally, we should note that our analysis does not allow us to identify the underlying source of the constraints facing small business. There are many possibilities here, ranging from informational constraints — e.g., small business owners may not be as adept at handling the logistics of returning to operation — to liquidity constraints and lack of insurance. Lack of insurance may itself be an due to misinformation, inattention, different risk tolerance, or discriminatory practices in the insurance market. Ideally, we would like to tease out these issues, but the data we have are probably insufficient for this purpose.

9 Concluding Remarks

The aftermath of Katrina was associated with a high degree of uncertainty about the recovery process, especially in New Orleans: How long would it take? How complete would it be? Would residents and tourists return to the damaged areas at their former levels? How much government assistance would be provided for the rebuilding? At the time, some prominent economists suggested that rebuilding New Orleans was a bad policy choice (see, most notably, Glaeser, 2005). For business owners, waiting to find out whether the customers would return was potentially very costly, especially in cases in which the option of waiting depended on extensive repairs to the business.

The fact that we find that small businesses were disproportionately likely to exit in the short run suggests that for these businesses, either the option value was lower or the cost of resuming operations was higher. The former could be true if these small businesses were already only marginally profitable, or if smaller businesses expected to be disproportionately hurt in the recovery process (i.e., lose more customers), perhaps because returning customers have different tastes from those who did not return. The latter may have been due to liquidity constraints or a higher cost of credit faced by small businesses.

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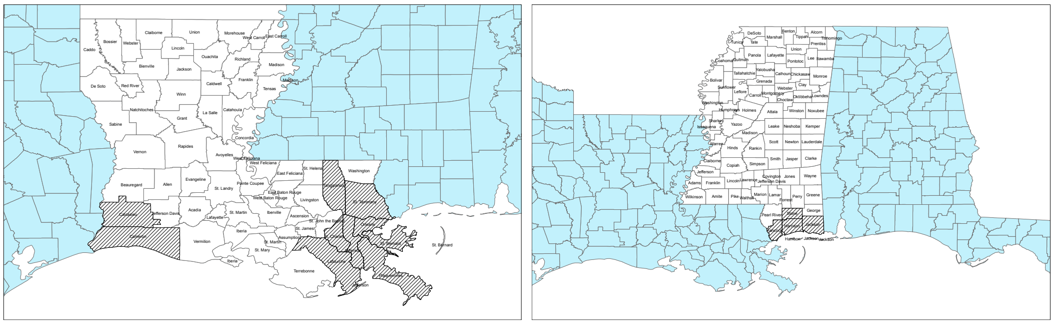
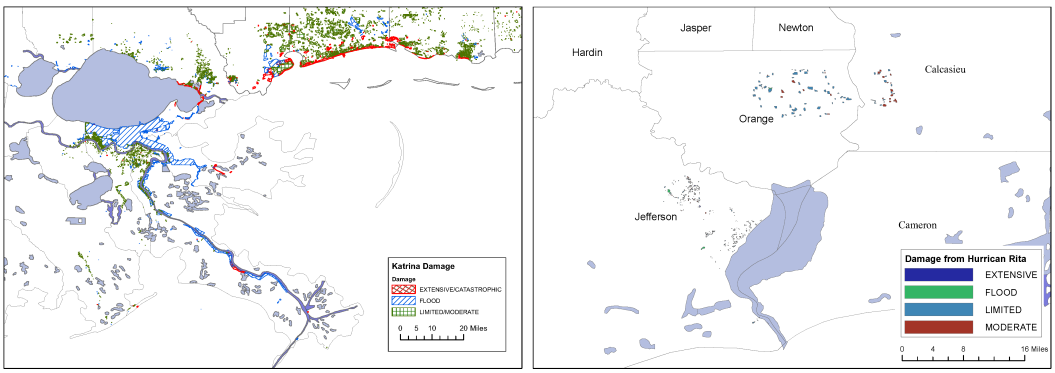


(a) Louisiana (b) Mississippi

Figure 1. Louisiana Parishes and Mississippi Counties Most Affected by Katrina and Rita



(a) Katrina (b) Rita

Figure 2. Damage Area Overview

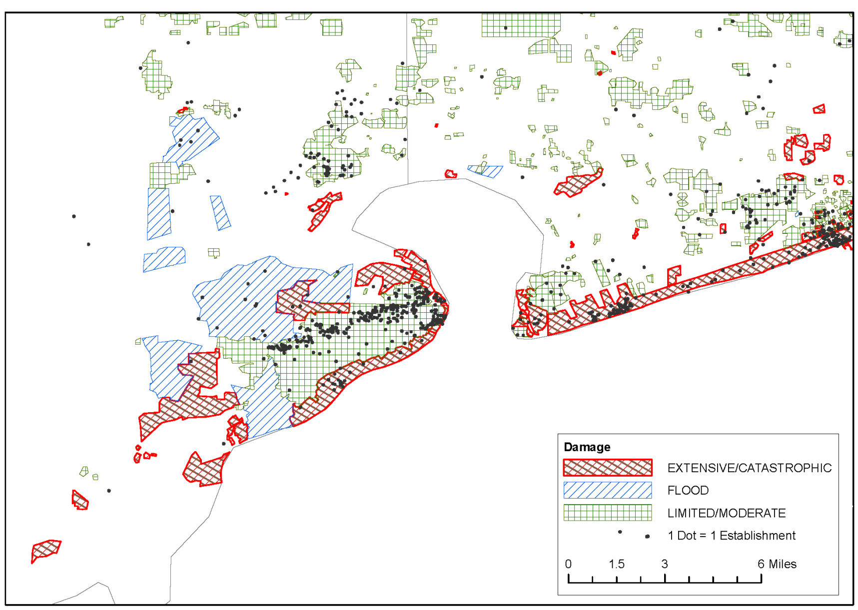
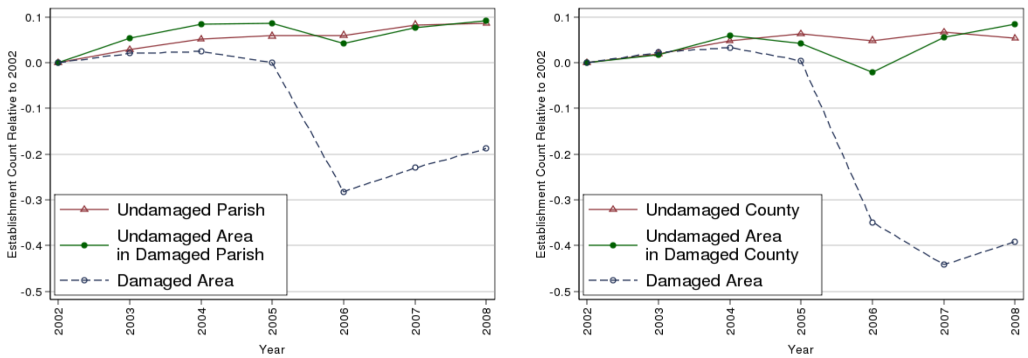
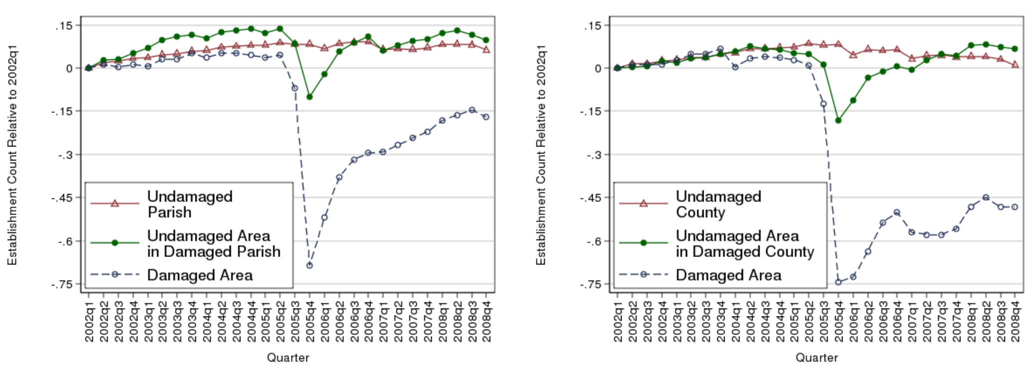


Figure 3. Damage Area Closeup: Harrison and Hancock Counties, MS



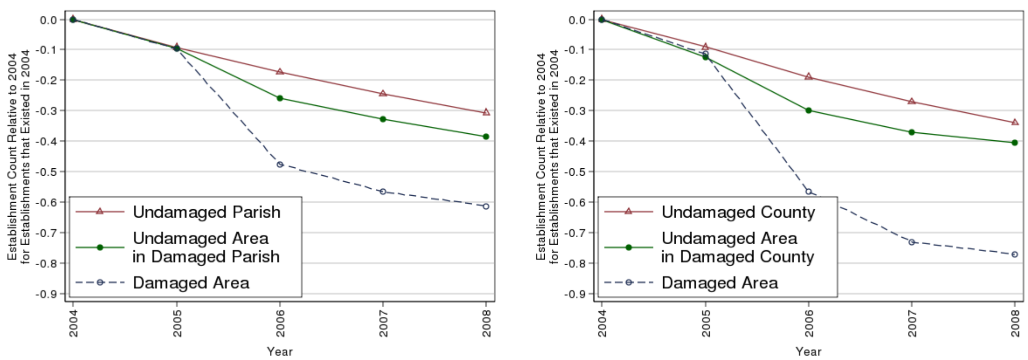
(a) Louisiana (b) Mississippi

Figure 4. Log Change, since 2002, in Stores, Restaurants and Hotels by County/Parish and Establishment Damage Status



(a) Louisiana (b) Mississippi

Figure 5. Log Change, since 2002q1, in Single-Unit Stores, Restaurants and Hotels by County/Parish and Establishment Damage Status



(a) Louisiana (b) Mississippi

Figure 6. Log Change, since 2004, in Stores, Restaurants and Hotels that Existed in 2004 by County/Parish and Establishment Damage Status

Table 1. Population of Selected Counties and Parishes 2000–2010

State	County/Parish	2000 Population	2010 Population	Log Change
LA	Calcasieu	183,577	192,768	+ 4.9%
LA	Cameron	9,991	6,839	−37.9%
LA	Jefferson	455,466	432,552	− 5.2%
LA	Lafourche	89,974	96,318	+ 6.8%
LA	Orleans	484,674	343,829	−34.3%
LA	Plaquemines	26,757	23,042	−14.9%
LA	St. Bernard	67,229	35,897	−62.7%
LA	St. Charles	48,072	52,780	+ 9.3%
LA	St. Tammany	191,268	233,740	+20.1%
LA	Tangipahoa	100,588	121,097	+18.6%
MS	Hancock	42,967	43,929	+ 2.2%
MS	Harrison	189,601	187,105	− 1.3%
MS	Jackson	131,420	139,668	+ 6.1%
MS	Stone	13,622	17,786	+26.7%

Source: Population Census

Table 2. County and Parish Summary Statistics, 2004

State	County/Parish	Estabs[a]	Geo-Coded[a]	Extensive or Catastrophic Wind Damage	Flood Damage	Limited or Moderate Wind Damage
LA	Calcasieu	1,090	980			4.6%
LA	Cameron	40	30			
LA	Jefferson	2,840	2,330		49.4%	9.3%
LA	Lafourche	460	370			
LA	Orleans	2,920	2,720		75.5%	1.0%
LA	Plaquemines	140	110		34.9%	
LA	St. Bernard	310	280		97.2%	
LA	St. Charles	180	110			
LA	St. Tammany	1,260	1,070			7.0%
LA	Tangipahoa	590	490			
MS	Hancock	230	210	11.4%	5.2%	61.9%
MS	Harrison	1,300	1,130	34.7%		18.3%
MS	Jackson	670	580	6.0%		18.1%
MS	Stone	80	70			
Total[b]		12,100	10,480	4.5%	33.8%	7.8%

[a] Counts rounded to nearest ten

[b] Total rounded separately, may differ from sum due to rounding

Damage counts are percentages of geo-coded establishments

Blank cells indicate fewer than ten establishments in damage zone

Table 3. Establishment Summary Statistics: All Establishments, 2002 and 2004

		2002 Mean for:			
Variable	Obs[a]	All	Non-Geocoded	Geocoded	T-test[b]
Establishments in firm	11,990	449.6	568.5	424.2	0.000
States with operations by firm	11,990	9.1	12.7	8.3	0.000
Firm employment	11,990	10,837.9	12,660.1	10,449.2	0.104
Establishment employment	11,990	17.1	17.6	17.0	0.630
Establishment age	12,010	9.6	10.4	9.5	0.000
Productivity: all[c]	11,880	10.2	12.8	9.6	0.580
Retail productivity[c]	7,740	12.4	12.3	12.4	0.957
Restaurant productivity[c]	3,620	6.0	15.1	4.6	0.130
Hotel productivity[c]	520	6.0	5.7	6.1	0.534

		2004 Mean for:			
Variable	Obs[a]	All	Non-Geocoded	Geocoded	T-test[b]
Establishments in firm	12,120	473.7	537.3	463.2	0.310
States with operations by firm	12,120	8.9	12.3	8.4	0.000
Firm employment	12,120	11,119.6	12,631.5	10,871.0	0.290
Establishment employment	12,120	16.8	19.5	16.4	0.380
Establishment age	12,170	9.7	9.5	9.7	0.392
Productivity: all[c]	9,740	10.2	13.8	9.6	0.620
Retail productivity[c]	6,350	12.4	11.9	12.4	0.838
Restaurant productivity[c]	2,950	6.2	20.4	4.4	0.500
Hotel productivity[c]	440	5.9	5.7	6.0	0.666

[a] Counts rounded to nearest 10 observations

[b] p-value from t-test for equality of the means

[c] Ratio of revenue to payroll in 2002 for establishments that survived to 2004

Table 4. Establishment Summary Statistics: Geocoded Establishments, 2002 and 2004

		2002 Mean for:			
Variable	Obs[a]	All	Undamaged	Damaged	T-test[b]
Establishments in firm	9,930	424.3	453.7	391.0	0.800
States with operations by firm	9,930	8.4	8.2	8.5	0.258
Firm employment	9,930	10,390.9	11,636.3	8,984.8	0.200
Establishment employment	9,930	17.1	16.2	18.0	0.850
Establishment age	9,930	9.5	9.3	9.6	0.320
Distance to nearest bank	9,860	0.5	0.6	0.3	0.000
Distance to nearest dentist	9,860	0.7	0.9	0.6	0.000
Productivity: all[c]	9,790	9.6	9.7	9.6	0.921
Retail productivity[c]	6,210	12.4	12.2	12.7	0.760
Restaurant productivity[c]	3,120	4.6	4.5	4.6	0.239
Hotel productivity[c]	450	6.1	6.4	5.9	0.246

		2004 Mean for:			
Variable	Obs[a]	All	Undamaged	Damaged	T-test[b]
Establishments in firm	10,470	460.8	508.9	404.6	0.000
States with operations by firm	10,470	8.3	8.2	8.4	0.504
Firm employment	10,470	10,756.8	12,150.2	9,127.5	0.150
Establishment employment	10,470	17.0	16.1	18.0	0.570
Establishment age	10,470	9.8	9.5	10.1	0.000
Distance to nearest bank	10,410	0.5	0.6	0.3	0.000
Distance to nearest dentist	10,410	0.7	0.8	0.5	0.000
Productivity: all[c]	8,430	9.6	9.7	9.6	0.960
Retail productivity[c]	5,410	12.4	12.2	12.8	0.737
Restaurant productivity[c]	2,620	4.4	4.4	4.5	0.386
Hotel productivity[c]	390	6.0	6.4	5.7	0.193

[a] Counts rounded to nearest 10 observations

[b] p-value from t-test for equality of the means

[c] Ratio of revenue to payroll in 2002 for establishments that survived to 2004

Table 5. Difference-in-Difference Exit Regressions: Chain Size and Damage

	No Productivity Controls			Productivity Controls		
	2002–04	2004–06	2004–08	2002–04	2004–06	2004–08
Extensive/Catastrophic	-0.0149	0.2122***	0.2217***	-0.0825***	0.1050**	0.1600**
Wind Damage	(0.0100)	(0.0406)	(0.0508)	(0.0238)	(0.0358)	(0.0573)
Limited/Moderate	-0.0180	0.0021	0.0061	0.0446	-0.1086**	-0.0653
Wind Damage	(0.0135)	(0.0258)	(0.0255)	(0.0413)	(0.0392)	(0.0588)
Flood Damage	0.0094*	0.0784	0.0555	0.0027	0.0164	0.0169
	(0.0047)	(0.0467)	(0.0422)	(0.0205)	(0.0281)	(0.0449)
ln(Establishments)	-0.0100***	-0.0084**	-0.0128**	-0.0053*	-0.0041	-0.0070
	(0.0030)	(0.0038)	(0.0048)	(0.0033)	(0.0036)	(0.0048)
Extensive/Catastrophic	-0.0003	-0.0238***	-0.0129**	-0.0030	-0.0214***	-0.0085
× ln(Estabs)	(0.0027)	(0.0041)	(0.0047)	(0.0034)	(0.0042)	(0.0052)
Flood× ln(Estabs)	0.0054**	0.0051	0.0193	0.0055**	0.0043	0.0166
	(0.0019)	(0.0079)	(0.0126)	(0.0023)	(0.0078)	(0.0124)
Limited/Moderate	0.0012	-0.0045	-0.0039	0.0009	-0.0043	-0.0054
× ln(Estabs)	(0.0046)	(0.0052)	(0.0047)	(0.0047)	(0.0061)	(0.0075)
County/Parish FE	✓	✓	✓	✓	✓	✓
NAICS FE (6 digit)	✓	✓	✓	✓	✓	✓
Establishment controls[a]	✓	✓	✓	✓	✓	✓
Productivity×Sector				✓	✓	✓
Productivity×Sector×Damage				✓	✓	✓
Observations	9,925	10,471	10,471	7,929	8,375	8,375
Percent predicted outside [0, 1]	7%	2%	1%	7%	2%	1%

Robust standard errors in parentheses, clustered by county or parish.

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] Log establishment age, age zero indicator, log establishment employment, and zero employment indicator

Table 6. Triple-Difference Exit Regressions: Chain Size, Establishment Location, and Damage

	Distance to Nearest Bank			Distance to Nearest Dentist		
	2002–04	2004–06	2004–08	2002–04	2004–06	2004–08
Extensive/Catastrophic	-0.0565	0.1580***	0.2537***	-0.0682**	0.0916**	0.1561**
Wind Damage[a]	(0.0344)	(0.0450)	(0.0788)	(0.0288)	(0.0344)	(0.0569)
ln(Establishments)	-0.0075**	-0.0035	-0.0036	-0.0080***	-0.0054	-0.0073
	(0.0032)	(0.0051)	(0.0068)	(0.0029)	(0.0035)	(0.0043)
ln(Distance)[b]	0.0085*	0.0058	0.0023	0.0084	0.0029	-0.0038
	(0.0048)	(0.0074)	(0.0060)	(0.0061)	(0.0061)	(0.0059)
Extensive/Catastrophic	0.0019	-0.0283***	0.0011	-0.0044	-0.0215***	-0.0008
× ln(Establishments)	(0.0078)	(0.0055)	(0.0089)	(0.0042)	(0.0050)	(0.0059)
Extensive/Catastrophic	0.0154	0.0452**	0.0677**	0.0204**	0.0122	0.0113
× ln(Distance)	(0.0151)	(0.0161)	(0.0258)	(0.0162)	(0.0254)	(0.0355)
ln(Establishments) × ln(Distance)	-0.0017*	0.0004	0.0023	-0.0024	-0.0010	0.0000
	(0.0009)	(0.0012)	(0.0013)	(0.0014)	(0.0011)	(0.0015)
Extensive/Catastrophic	0.0000	-0.0057**	0.0007	-0.0025	-0.0015	0.0042
× ln(Estabs) × ln(Distance)	(0.0030)	(0.0022)	(0.0031)	(0.0025)	(0.0026)	(0.0036)
County/Parish FE	✓	✓	✓	✓	✓	✓
NAICS FE (6 digit)	✓	✓	✓	✓	✓	✓
Establishment controls[c]	✓	✓	✓	✓	✓	✓
Productivity×Sector	✓	✓	✓	✓	✓	✓
Productivity×Sector×Damage	✓	✓	✓	✓	✓	✓
Observations	7,867	8,365	8,365	7,867	8,365	8,365
Percent predicted outside [0, 1]	7%	2%	1%	7%	2%	1%

Robust standard errors in parentheses, clustered by county or parish

* significant at 10%; ** significant at 5%; *** significant at 1%

[a] The full vector of damage indicators with all interactions is included in the regression. For brevity, we show only coefficient estimates for extensive/catastrophic damage and its interactions

[b] Distance is measured to the nearest bank or dental office in operation in 2002

[c] Log establishment age, age zero indicator, log establishment employment, and zero employment indicator