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

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Abstract

We use Hurricane Katrina's damage to the Mississippi coast in 2005 as a natural experiment to study business survival in the aftermath of a cost shock. Our analysis combines establishment-level data on business activity from the Census Bureau with geo-spatial maps from FEMA documenting the exact location and extent of damage. We find 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.

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

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

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*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 Please do not cite or circulate without permission from the authors.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, Jeff Brown, Jeff Czajkowski, Steve Fazzari, Teresa Fort, Lucia Foster, Jeff Groen, Hanna Halaburda, 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, Tel-Aviv University, Dartmouth College, the 2011 Southern Economic Association meetings (Washington DC), and the 2012 NBER Universities Research Conference 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 and storm surge that destroyed hundreds of buildings along the Mississippi gulf coast. In this paper, we study the effect of direct storm-inflicted damage on establishments' ability to recover, focusing on the Mississippi coast. We use data from the Census Bureau's Longitudinal Business Database (LBD) on approximately 10,000 business establishments in Mississippi, including nearly 2,300 businesses in four counties with significant storm damage, combined with precise information on the location and extent of storm damage from the Federal Emergency Management Administration (FEMA). These data allow us to pinpoint which establishments were hit directly (e.g., damaged or destroyed by wind or storm surge) 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 2.5 percentage points, or about 10%.

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 weak 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 size.

Finally, we observe that most short-run predictors of survival are significantly weakened in the longer run. By 2008 the differential impact of damage by firm size fell to 50% of its initial level and we no longer find any attenuation in the effect of distance from the nearest bank for larger chains. In future work we plan to extend the time period of this study to 2010 to test whether this convergence in the storm's impact continued or reversed as recovery continued.

In work currently underway we are refining our sample to include only sole proprietorships, for which we can link in the owners' demographic information. We plan to use this smaller sample 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.

Our paper is related to a small but growing literature on the effects of natural disasters on businesses and labor markets and to a much larger literature on credit constraints. Most of the disaster literature has used county-level data and emphasized employment and growth outcomes. Along these lines, Strobl (2011) uses county-level data to estimate the effects of hurricanes on net growth, Belasen and Polachek (2009) estimate county-level effects of hurricanes on employment and earnings, and Ewing and Kruse (2005) estimate the short- and long-term effects of hurricanes on unemployment and economic activity. In contrast, our paper uses establishment-level data to isolate the direct effect of physical storm-related damage on the establishment's survival. Closer to the spirit of our paper, Leiter, Oberhofer, and Raschky (2009) use establishment-level data on European firms to test for "creative destruction" in the aftermath of flooding. Key differences between our paper and theirs are, first, that they do not have establishment-level damage data, and use information at a more aggregate level (roughly equivalent to a county) to distinguish between affected and unaffected establishments; and second, that their focus is on the intensive margin — within-establishment changes in employment, assets, and productivity — whereas we focus on the extensive margin via establishment exit. (We do not consider entry because there is very little post-storm entry into the damaged areas by the end of our study period. This may change as we extend our study period to 2010.)

Our paper is also related to a much larger literature on the impacts of credit and resource constraints on firm growth and survival. Because the literature on credit constraints tends to use firm- or establishment-level data, it is often constrained by available data to focus on a particular type of firm. For example, studies using CompuStat data (such as Sharpe, 1994) necessarily focus on large, publicly traded companies, whereas studies using the Survey of Small Business Finance (such as Rice and Strahan, 2010) or the Kauffman firm survey use data only on small firms. In contrast to these studies, we are able to use data on the full distribution of firms thanks to the use of Census records. In addition, while studies developing countries have often exploited either field experiments (e.g., de Mel, McKenzie, and Woodruff, 2008) or natural experiments (e.g., Khwaja and Mian, 2008), this approach has been relatively rare in studies of the U.S. and other developed countries. Hurricane Katrina's devastating damage of the Mississippi coast provides a natural-experiment setting in which we can observe the responses of small and large enterprises to a cost shock and relate these differences to differential access to credit. Our paper is most closely related to Fort, Haltiwanger, Jarmin, and Miranda (2012), which uses similar data to ours and exploits geographic and time variation in business-cycle and housing-price shocks to identify the relative response of small and young firms. Our paper uses a much narrow geographic area and a shorter time span to examine a similar question using finer geographic detail and a natural-experiment setting.

One recent paper that, like ours, straddles the literatures on disasters and financing is Hosono, Miyakawa, Uchino, Hazama, Ono, Uchida, and Uesugi (2012), which uses detailed firm-level data to estimate the impact of the Kobe earthquake on the supply of loans. That paper finds that firms whose headquarters were located outside the damaged area but which had borrowing relationships with banks located inside the damaged area fared worse than undamaged firms borrowing from undamaged banks. Our paper complements these findings by focusing on damaged businesses and on factors, including access to credit markets, correlated with their ability to withstand the damage.

The rest of the paper is organized as follows. Section 2 provides some background on hurricane Katrina. 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 conclude with Section 8.

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 hurricane Katrina, the most damaging storm of that season.

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). In Louisiana, 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 and storm surge).

Katrina's damage in Louisiana was widespread and caused large-scale population relocations and destruction of infrastructure. The population in many of the parishes has yet to recover. The population relocation created significant demand shocks; in the hospitality industry, which is a major focus of our paper, infrastructure damage also reduced tourism, exacerbating the extent of the demand shock. Because it is difficult if not impossible to compare the consumption patterns of the displaced and remaining populations, we cannot separately identify demand and cost shocks in Louisiana.

In contrast, infrastructure damage in Mississippi was for the most part limited, localized, and short-lived, and population loss was much more limited and short-lived. It is for this reason that the present study focuses on Mississippi. As one example, three weeks after Katrina, a bridge on Interstate 10 in Mississippi that was battered by a barge during the storm was open to traffic (Northway, 2005). A second bridge, Biloxi Bay Bridge, on U.S. 90 in Harrison and Jackson counties, took longer to reconstruct reopened in 2007 (Kunzelman, 2007). Because of the localization and short life of most infrastructure damage, we are able to identify the effects of damage to specific business establishments separately from widespread demand and cost shocks in Mississippi.

Figure 1 shows a map of Mississippi, highlighting the four counties that were most affected by hurricane Katrina. Table 1 lists the 2000 and 2010 population in the affected counties and the rest of the state. Population changes between 2000 and 2010 were generally modest in Mississippi. The exception is Stone County, which saw a population gain of nearly 27%. Stone County is very small, however, and accounts for less than 0.5% of our observations.

Given our concern with the impact demand shocks have on the relative activity of large and small firms it is important to gauge the extent of such shocks in Mississippi. One indicator of economic recovery is the local unemployment rate, which rose in Hancock, Harrison, and Jackson counties in 2005 and 2006, but by 2007 had returned to its pre-storm levels (Sayre and Butler, 2011). Another indicator of economic activity, especially relevant for the hospitality sectors including restaurants and hotels, is passenger air traffic. Figure 2 shows the dramatic decline and the recovery of the number of air passengers traveling to and from New Orleans and Biloxi over the period 2005–2008. The figure was calculated using monthly data from the Bureau of Transportation Statistics.[1] Passenger air travel to and from New Orleans declined by almost three log points between August and September 2005, and had only recovered to within approximately 20% of its original level by 2008. The initial shock was smaller at the Gulfport-Biloxi airport, and the recovery was complete within a few months.[2]

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). Our analysis of SBA data indicates that 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 million 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. Of the total amount, less than one

[1] The data are available at `http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=258`. Accessed May 31, 2011.

[2] Two additional proxies for economic activity are population counts and tax receipts. Plyer, Bonaguro, and Hodges (2010) show that Orleans Parish, which experienced massive flooding and infrastructure damage, lost between half and three quarters of its population between July 2005 and July 2006, while other parishes lost little population or experienced an influx of evacuees. Census data show that St. Bernard, Cameron, and Orleans parishes each lost more than a a third of its population between 2000 and 2010. Other parishes experienced large population gains due to the relocation of evacuees. Evidence on Louisiana's slow recovery can also be seen in sales tax receipts. (We thank Allison Plyer for providing us with monthly sales tax receipts for six Louisiana parishes.) Sales tax receipts in Jefferson, St. Charles, St. John, and St. Tammany parishes in Louisiana were sharply down relative to the same month in 2004 for only a month or two, after which they 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.

third was disbursed to Mississippi businesses.

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. In some cases this was 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

The primary building block in our analysis is 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 Mississippi, the state most affected by Katrina's category-three winds. 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 geo-spatial damage maps from FEMA to determine which establishments were directly hit by Katrina's winds or storm surge.

We limit our analysis to retail and restaurant businesses and hotels and other accommodation facilities (including casinos) for several reasons.[3] 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.

[3]These business establishments correspond to NAICS 44-45 and 721-722, with a few exceptions noted below.

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.[4]

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.[5]

The LBD is constructed from several sources, of which the most important for our purposes are administrative business filings from the Internal Revenue Service (IRS).[6] These filings are processed by the Census Bureau on a flow basis as they are received. Establishments in the LBD are defined to be "active" if they have positive payroll 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

[4]For this reason, we omit from the data non-store retailers such as catalog companies and vending-machine operators, NAICS 454, as well as caterers and mobile food-service providers, NAICS 72232 and 72233.

[5]Firm age is computed using the same methodology as in Haltiwanger, 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.

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

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, particularly for smaller firms. 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 define an establishment exit between year t and year $t' > t$ if the establishment had positive payroll in year t but not in year t'. In future work, we plan to augment the data using the 2007 Census, which includes information on establishment-level revenue as well as payroll. This will allow us to redefine exit using establishment revenues and check the robustness of our payroll-based estimates.

We geocode establishments using Geographic Information System (GIS) tools to assign latitude and longitude based on the business's address. 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. Beginning in 2007, the Census Bureau's Geography Division has provided geocoding for all business establishments. For establishments still in operation in 2007 we use the Geography Division's geocodes. For establishments that exited prior to 2007 we use ArcGIS's "address locator" geocoding tool to attach latitude and longitude information to business addresses.

ArcGIS provides a normalized "score," out of 100, to indicate the quality of the geocoding; we keep only geocodes scored 60 or above. In 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.

Not all addresses are of the necessary quality to be able to geocode down to the latitude and longitude successfully, either by the Geography Division or us. 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, in each of the four Mississippi counties that experienced direct damage from Katrina, we were able to geocode more than 85% of establishments. Table 2 lists the number of geo-coded establishments in each of the four affected counties in comparison with the rest of the state.[7]

Table 3 compares summary statistics of establishment and firm characteristics for geocoded and non-geocoded establishments in both 2002 and 2004. Non-geocoded establishments belong to larger firms than geocoded establishments, but only one size measure (number of states with operations by the firm) shows a statistically significant difference across the two groups.

In addition to establishments in the retail, restaurant, and hotel sectors, we also geocoded all banks (NAICS 5221) and dentists (NAICS 6212) in 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 was 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.

[7]Geography Division is able to geocode a similar number in 2007.

Damage information comes from FEMA and is described in detail in Jarmin and Miranda (2009). Using remote-sensing technology, FEMA classified damaged areas over the period August 30 to September 10 using a four-tier damage scale: limited, moderate, extensive, and catastrophic. We reduce this to a two-tier system, combining "extensive" and "catastrophic" into one category, and combining the "limited" and "moderate" into a second category. In practice, there was very little extensive damage, with almost all of the extensive/catastrophic damage being catastrophic. Critically, damage designations are not based on insurance claims. However, because FEMA's remote-sensing maps focus primarily on developed areas, we may under-estimate the damage in less-developed areas.

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 gray dot on the map represents a single business establishment.[8] Establishments in red (diagonally cross-hatched) areas were extensively or catastrophically damaged, while those in green (horizontal and vertical cross-hatched) areas were limitedly or moderately damaged by winds. Establishments in the white areas were physically undamaged. In addition, a handful of business establishments were located in areas in Mississippi that still had standing water as of September 6, 2005 (one week after the storm). These areas are indicated in the figure in blue (diagonally lined) and are excluded from our analysis; none of our results are sensitive to this exclusion.

Table 2 provides summary statistics for establishments in the four affected counties, compared with the rest of the state, in 2004. Approximately 380 establishments were in areas later designated by FEMA as having endured extensive or catastrophic wind damage, and 350 more were in areas later designated as having suffered limited or moderate damage.

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

(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 left blank, but they are included in the total.

Productivity measures are derived from the 2002 Economic Census, specifically the Census of Retail Trade (CRT) and the 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.[9] Because the weight of non-labor inputs varies by sector, we normalize productivity to have mean zero and standard deviation of one separately by sector (retail, restaurants, and hotels).

Table 4 shows pre-storm summary statistics for the 2002 and 2004 cross-sections of establishments in our data. We restrict the 2002 sample to establishments that are at least two years old to maintain a consistent age distribution across samples. (The 2004 sample includes only establishments that are at least two years old because productivity is measured in 2002.) 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 states in which the firm operates, the only variables whose mean differs statistically between the damaged and undamaged sample are the distance variables: undamaged establishments more than twice the distance than damaged establishments to both the nearest bank and the nearest dentist.

To check that we have a reasonably complete census of Mississippi establishments, note that County Business Patterns (CBP) lists 12,498 retail establishments in Mississippi in 2004

[9]Revenue information is not available in annual data sets, but only in the quinquennial Economic Censuses. Our ratio measure is also used in Basker (2012). 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 (2012), and Betancourt (2005) for further discussion.

and an additional 4,591 establishments in accommodation and food services, a category that includes both restaurants and hotels. Of these 17,089, 403 were non-store retailers, 49 were caterers, and 11 were mobile food-service providers, leaving 16,626 establishments in the NAICS codes we include in our analysis.[10] The Business Dynamics Statistics (BDS) establishment-age by state table indicates that 17.5% of Mississippi establishments in 2004 were less than two years old, and are therefore excluded from our sample. Nationwide, 18.3% of retail establishments and 19.4% of service establishments were less than two years old in 2004.[11] Given this variation in establishment age, we expect somewhere between 13,400 and 13,750 establishments in our analysis, depending on the exact age distribution among the relevant establishments in Mississippi. Table 3 shows about 13,350 establishments match our basic criteria in 2004, very close to this full census. We lose some observations when we geocode these observations, as noted above.

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 are currently in the process of matching the owner's race and gender from the 2000 Population Census 100% ("short-form") file. We are also in the process of matching the residential address information of the owners of sole proprietorships using both the 2000 decennial Census and the Census Bureau's 2004 Master Address File Address Reference File (MAF-ARF), which provides the residential address of U.S. residents. After combining the MAF-ARF/Decennial Census residential-address file with the Master Address File (MAF), which contains the latitude and longitude of all known residential addresses in the United States, we will repeat the GIS procedure described above to determine which housing units were damaged by Katrina and to what extent. This allows us to determine, for the sole proprietors in our sample, not only whether their business was

[10]All CBP data since 1998 are available at `http://www.census.gov/econ/cbp/index.html`.

[11]BDS data are not broken are available by both state and age. Details at `http://www.census.gov/ces/dataproducts/bds/data_estab.html`.

damaged by wind but also whether their residential address was damaged.

Table 5 provides summary statistics for the sole-proprietor sample in 2002 and 2004. As in the earlier tables, the first panel shows 2002 data for undamaged and damaged establishments and the second panel shows 2004 data. We omit firm-size measures because the 99th percentile sole proprietorship in our sample operated just one establishment. Compared to the full sample of establishments, which had 17 employees on average, sole proprietorships in our sample have only approximately 4 employees. They are also further from the nearest bank and dentist than the full sample. Perhaps surprisingly, they are only slightly younger on average than the full sample. As was the case with the full sample, sole proprietorships located in areas that were later damaged by storms are closer to banks and dentists than those in undamaged areas, but the difference is only statistically significant for dentists. No other establishment-level characteristics differ statistically by damage classification.

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 area" refers to establishments in areas that were extensively or catastrophically damaged by Katrina in the fall of 2005 as identified through FEMA's geo-spatial maps. "Undamaged area in damaged county" refers to establishments located in areas that were either undamaged or damaged to a limited or moderate extent, in Hancock, Harrison, Jackson, and Stone counties (the counties in which FEMA designated damaged areas). Finally, "rest of state" refers to 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 relative to 2002. The immediate effect of Katrina was an approximately 35% reduction in the number of payroll active establishments in the damaged areas of Mississippi. These areas remained depressed in 2008, while the number of establishments in undamaged areas continued the positive trend growth through 2008 with a small dip for establishments located in undamaged areas of damaged counties.

The finding that recovery of the hardest-hit areas was slow is consistent with other evidence. Burton, Mitchell, and Cutter (2011) use repeated photographic evidence to construct a recovery index for post-Katrina Mississippi. They find that three years after the storm, i.e., by late 2008, approximately 65% of the Mississippi Gulf Coast was fully recovered in the sense that damaged buildings had been either repaired or razed and reconstructed. They also note some variation in this recovery, with some towns, such as Moss Point, MS, which did not experience much catastrophic damage, achieving over 90% recovery. However, they also note that the communities of Diamondhead, Pass Christian and Waveland, which had experienced the most catastrophic damage, each "achieved a recovery rate of [less than] 50 per cent or more by the end of year three post-storm" (p. 504). Using Florida county-level sales data for the period 1992–2006, Belasen and Dai (2011) also find long-lasting declines in economic activity in counties that were struck by hurricanes.

Figure 5 repeats the above analysis using 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 75%. This is partly because single-establishment firms were hit harder than chains (as we will show later) and partly because the quarterly data are finer and pick up on very short-term fluctuations in activity.

The other difference we observe in the quarterly data is a short-lived decline in the establishment activity count in areas of the county that were not severely damaged by the storms.[12] This slump is due to a combination of three factors: demand and supply disruptions, temporary closures of businesses with less-than-extensive damage, 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 three sorts. The first is inaccurate geocoding of business establishments. As detailed in Section 3, we have done our best to drop observations whose addresses do not represent the true business location (for example those that use an accountant office's address, or a residential address) but our best efforts may not have removed all such instances. The second is measurement of the damage areas by FEMA. In particular, damage may be understated in less-dense areas. We have no way to verify these designations and have to take them as given. The third type of measurement error 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.

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 by about 10% per year because they do not include new entrants that replenish the stock of establishments. The break in the establishment count in the damaged areas, and to a lesser extent in the undamaged sections of damaged counties, 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.

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

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. We are motivated by a well-established literature that relates firm size and access to credit. In a series of influential papers, Gertler and Gilchrest (1994) and Sharpe (1994) find that small firms are more responsive to sensitive to monetary shocks, consistent with these firms facing tighter credit constraints.

To this end we estimate a cross-sectional liner probability model of exit for business establishment i located in county $j(i)$ and in six-digit NAICS $n(i)$, as follows:

$$\begin{aligned}\text{Exit}_i = \alpha_{j(i)} + \gamma_{n(i)} + \sigma \ln(\text{FirmSize})_i + \delta \text{Damage}_i + \beta \ln(\text{FirmSize})_i \cdot \text{Damage}_i \\ + \pi \cdot \text{Prod}_i + \phi \cdot \text{Prod}_i \cdot \text{Damage}_i + \text{controls}_i + \varepsilon_i, \quad (1)\end{aligned}$$

where **Exit** is a binary variable defined either over a two-year ("short-run") horizon or over 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 or had a different owner at $t+2$; in the long run, **Exit** equals 1 if the establishment had no payroll or had a different owner in $t+4$. We treat ownership changes as exits since they constitute the exit of the original owner through divestiture or the sale of the entire firm.[13] We capture the effect of Katrina 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 Mississippi.

[13]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. Not all ownership changes are of small businesses. The Las Vegas Review-Journal reported in March 2006 that the casino-and-hotel chain Harrah's sold one of its destroyed properties in Gulfport while reopening the other (Stutz, 2006).

On the right-hand side, $\boldsymbol{\alpha}$ is a county fixed effect intended to capture different area-wide exit probabilities due to overall demand and infrastructure shocks. The six-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, may have fared better than others in the immediate aftermath of the storm (Pearson, Hickman, and Lawrence, 2011). All establishment- and firm-level control variables are evaluated in 2004. **FirmSize** is measured by the number of establishments operated by the firm that owns establishment i.[14] **Damage** is a vector of two damage indicators: limited or moderate damage and extensive or catastrophic damage, as described in Section 3.

The variable **Prod** is the ratio of revenue to payroll in 2002, normalized by sector (retail, restaurants, hotels). To allow for the possibility that more productive establishments may be able to better withstand shocks, as well as have better reasons to return to operation after a negative shock, we also include the interaction between **Prod** and **Damage**. Productivity differentials may be correlated with constraints of many types including credit constraints; our estimates of differential exit rates are conditional on such differences.

The interaction between **FirmSize** and **Damage** captures the differential exit rates for establishments in damaged areas by chain size. Establishment-level controls are log age (all establishments in the sample are at least two years old), 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 (Haltiwanger, Jarmin, and Miranda, forthcoming). The error term $\boldsymbol{\varepsilon}$ is clustered at the county level. Among other things, this clustering accounts for the fact that business survival is interdependent across the county.

Our data permit more than one transition between the two states (in operation and

[14] Results are qualitatively similar when we use two alternative measures of firm size: the number of states in which the firm operates, following Foster, Haltiwanger, and Krizan (2007), and total firm-level employment, following Jarmin, Klimek, and Miranda (2004).

not in operation). In the aftermath of Katrina, 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 rather than a hazard model that imposes a single transition. We define an "exit" between 2004 and 2006 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 for computational convenience, partly due to the large number of fixed effects: there are 110 six-digit NAICS codes ($\{\gamma_{n(i)} : n = 1, \ldots, 110\}$) alone. 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 4%, depending on the regression.[15]

We include all establishments in Mississippi in the retail, restaurant, and hotel sectors as controls. However, because we have county fixed effects in all regressions, the coefficients on the two damage variables are identified within county: they represent the differential exit rates of damaged establishments relative to the average exit rate of undamaged establishments within the county. Establishments in other counties are used to identify control variables, including the 110 NAICS fixed effects and firm and establishment characteristics. The coefficients on the interaction terms of firm size and damage are identified within county, but their magnitude is also affected by the main firm-size effects, which depend in part on the control group. We have also estimated all the regressions using alternative control groups, including only the four counties with direct damage (Hancock, Harrison, Stone, and Jackson), an eight-county region that includes those four counties and four adjacent counties (Pearl River, Forrest, Perry, and George), as well as the state excluding adjacent counties. For the most part, the results of interest are not sensitive to the control group; where they

[15] Note that even though the CEF is not linear in this case it is still true that the linear probability model is the best linear predictor of this function (Angrist and Pischke, 2009).

are, we discuss the differences in the text.

The identifying assumption in our analysis is that, within the counties affected by Katrina, 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).[16] 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 county and detailed-industry fixed effects fully capture demand shocks following the storms due to temporary and permanent out-migration and a drastic reduction in tourism. 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 exit over this period and location in a future storm-damage zone 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.

[16] 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).

Estimates from this regression are presented in Table 6. 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 only report the coefficients related to damage and firm size. However, the coefficients on establishment-level productivity, employment, and age are consistently negative and significant, suggesting that more productive, older, and larger establishments were less likely to exit even after controlling for firm characteristics (this finding is consistent with other research, including Haltiwanger, Jarmin, and Miranda, forthcoming).

Looking at column (1), we see that establishments belonging to larger firms have slightly lower exit rates. This continues to hold if we replace the firm-size variable with other measures (employment or number of states in which the firm operates, not shown) and is consistent with previous findings (see, for example Foster, Haltiwanger, and Krizan, 2006). We find no statistically significant or economically large relationship between future damage, or the interaction of future damage and firm size, on exit rates.

Turning to columns (2) and (3), the probability of exit is 23 and 24 percentage points higher, respectively, following the storm in areas that experienced extensive or catastrophic damage relative to areas that did not experience any storm damage. The probability of exit in areas with limited or moderate damage is much smaller, three and four percentage points respectively in the short and long runs, and statistically significant in the short run.

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*, reduced the impact of extensive or catastrophic damage on the probability of exit by 2.3 percentage points in the short run. This coefficient is significant at the 1% level. There is also a smaller effect, about 1.1 percentage points, associated with a doubling in chain size in an area of limited or moderate damage.

In the longer run the interaction effects shrink by about half and their standard errors double. The interaction of extensive or catastrophic damage with firm size, however, remains statistically significant.

We have checked the robustness of these results in several unreported regressions. Changing the sample to omit counties immediately adjacent to the damaged counties or even to omit all undamaged counties does not change the results in any meaningful way, although standard errors on some coefficients increase.

We plan to add two more specifications in the near future with slightly different time horizons. Both will use 2004 as the base year. The first will use the 2007 Economic Census rather than the LBD to determine business activity, allowing us to define activity using revenue rather than payroll. The second will use the recently released 2010 LBD to provide a longer horizon on exits. If reentry has been slow, as it appears to have been anecdotally, we may see even more of a convergence in entry rates by 2010.

One concern about these results is that the observed differences may be due to systematic measurement error (bias) in our outcome variable because our measure of economic activity is payroll- rather than revenue-based. This may happen if large businesses maintain some payroll although they no longer received revenues in 2006. It may also happen if small businesses continue to receive revenue although they no longer show up as active in payroll measures. We discuss these possible measurement problems in more detail next.

5.2 Robustness Checks: Labor Hoarding and Labor Depletion

5.2.1 Labor Hoarding

Using payroll data to measure 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 could be multiple reasons for this; for instance, the business may retain good employees in expectation that the business will resume operations; 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; keep the business operating at a skeletal level in order to gain an advantage when business returns; or hold on to a few employees 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.

There is some anecdotal evidence to support the notion of labor hoarding, at least in the very short run. For example, MGM Mirage, owner of the Beau Rivage casino in Biloxi, agreed to continue paying employees and provide health benefits for 90 days following the storm (Kast, 2005). While we are not aware of any systematic labor hoarding persisting into 2006, if the practice did occur it could bias our estimates.

As a first step, we test for this possibility by redefining the **Exit** variable to include any case in which the establishment's payroll fell by 90% or more, and re-estimate Equation (1) 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.

A second robustness test we plan to implement will use the 2007 Economic Census to redefine exits using 2007 revenues. While this correction is not available on an annual basis, it will allow us to determine how common the practice of "hoarding" is using data on both payroll and revenues, and to see to what extent hoarding drives our results.

5.2.2 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 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

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 consider whether establishments' ability to weather the storm's damage was correlated with pre-storm location characteristics, specifically, their distance to a bank.

We are motivated by a debate in the finance literature about the importance of distance to a small business's ability to borrow from a commercial bank. Berger and Udell (1995), for example, find that relationship lending matters for small businesses. More recently, Brevoort and Hannan (2004) have shown a negative relationship between distance from a bank and the probability that a business receives a small commercial-business loan, a finding disputed by Petersen and Rajan (2002); DeYoung, Frame, Glennon, and Nigro (2011) but reaffirmed by Brevoort, Holmes, and Wolken (2010).[17]

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; that is, not interacted with damage. The probability model is extended as follows:

$$
\begin{aligned}
\text{Exit}_i &= \alpha_{j(i)} + \gamma_{n(i)} + \sigma \ln(\text{FirmSize})_i + \tau \ln(\text{Distance})_i + \delta \text{Damage}_i \\
&+ \beta \ln(\text{FirmSize})_i \cdot \text{Damage}_i + \eta \ln(\text{Distance})_i \cdot \text{Damage}_i + \mu \ln(\text{FirmSize})_i \cdot \ln(\text{Distance})_i \\
&+ \psi \ln(\text{FirmSize})_i \cdot \ln(\text{Distance})_i \cdot \text{Damage}_i + \pi_{s(i)} \cdot \text{Prod}_i + \phi_{s(i)} \cdot \text{Prod}_i \cdot \text{Damage}_i \\
&+ \text{Establishment controls}_i + \varepsilon_i \qquad (2)
\end{aligned}
$$

where **Distance** is the distance between establishment i and the nearest bank lending institution included in the 2002 LBD. This regression includes, in addition to all the variables from Equation (1), 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 7. To conserve space, we omit the limited and moderate damage variable and its interactions and focus on establishments in the areas characterized by extensive and catastrophic damage.[18]

The first column shows the effect of these variables on exits between 2002 and 2004. Several coefficients are statistically significant. The probability of exit between 2002 and 2004 is approximately three points lower in areas that were later damaged by the storm.

[17] In a very different context, Mian (2006) finds that the distance between a bank branch and the bank's headquarters also matters for lending; specifically Mian (2006) finds that distant branches of foreign banks are less inclined to risk lending to sound firms that require loans.

[18] The limited/moderate damage indicator and its interactions generally have the same sign as the extensive/catastrophic indicator and its interactions, but coefficients on the whole have smaller magnitudes and/or larger standard errors.

The probability of exit declines with firm size and increases with distance from the nearest bank in the pre-storm period. The negative coefficient on the interaction of distance and firm size implies that the increase in exit rates correlated with distance from a bank diminishes for larger firms. Finally, the baseline estimates show a positive and statistically significant coefficient on the three-way interaction term: The mitigating effect of firm size on the relationship between distance and exit does not hold in the pre-storm period in the area later damaged by the storm.

The negative relationship between firm size and exit was already noted in Section 5.1. The new effect, the relationship between distance to the nearest bank and exit, is likely a combination of a causal effect noted in the finance literature whereby physical distance is a proxy for the existence or strength of a lending relationship; correlation with unobserved neighborhood-specific factors, such as neighborhood safety and customer traffic that tend to be higher in areas with banks and contribute to business success; and correlation with unobserved business-specific factors that also contribute to the business's success. We should note that we do not know whether a firm actually borrows from the nearest bank. Therefore, to the extent that this coefficient represents a causal relationship, it is necessarily attenuated. Omitted-variable bias, at the same time, exaggerates the size of the coefficient. Because these two effects operate in opposite directions, we cannot say whether the coefficient is biased towards or away from zero. That firm size mitigates the effect of distance to the nearest bank may mean that the relationship between distance and exit is causal, but that large firms have other borrowing options and are not as tied to the local bank.

The second column shows the effect of these variables on exits between 2004 and 2006. Establishments in the extensive-and-catastrophic-damage area were 31 percentage points more likely to exit than other establishments over this time period. The direct effect of firm size is slightly smaller than in the baseline regression, while the direct effect of distance disappears. As in Table 6, the coefficient on the interaction of firm size and extensive or catastrophic damage is negative and significant; in fact, it is larger both in absolute terms and especially relative to the baseline period. *Ceteris paribus*, establishments that experienced severe structural damage from Katrina were less likely to exit between 2004 and 2006 if they belonged to larger firms. 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 16 percentage points; for the second, the increase would have been 27 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 eleven percentage points in the aftermath of extensive or catastrophic damage.

Compare the above two establishments with two establishments that are otherwise identical but part of a 100-establishment chains. For the first of these, experiencing extensive or catastrophic damage would have increased its exit probability between 2004 and 2006 by 9 percentage points; for the second, the increase would have been 16 percentage points.For these establishments, the differential increased exit probabilities due to extensive or catastrophic damage is about seven 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 three points *more* than it increases the exit probability of an establishment in a 100-establishment chain.

The following thought experiment provides a way of understanding the relative magnitudes of the coefficients. Consider a single-unit establishment, located 0.55 miles from the nearest bank, in a location about to be catastrophically damaged by Katrina's winds and storm surge. Suppose we have two policy interventions available to us just before the storm hits. The first intervention moves the nearest bank 0.45 miles closer to the establishment, so the establishment is now 0.1 miles from its nearest bank, with all the benefits this entails. The second intervention keeps the bank in its current location but incorporates the establishment into an existing firm with $(x-1)$ additional establishments (and all the benefits this entails, including access to credit). Each of these interventions would have a direct effect on the establishment's probability of exit, which we ignore for the current experiment. Instead, we calculate the value of x that reduces the *increase* in the establishment's exit probability due to the catastrophic damage to the same extent as a move from the 75th to the 25th percentile of distance from a bank: $x = \exp\left(\frac{(\ln(0.1)-\ln(0.55))\cdot\eta}{\ln(0.55)\cdot\psi+\beta}\right)$, where β, η, and ψ are the coefficients, respectively, on the interaction of log firm size and extensive/catastrophic damage; log distance and extensive/catastrophic damage; and log distance, log firm size, and extensive/catastrophic damage; from Equation (2). Given the coefficients in Column (2) of Table 7, the reduction in excess probability of exit due to the storm from this 0.45-mile bank relocation is equivalent to an increase in firm size from one establishment to 42.

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. The coefficient on the triple interaction term is positive in the long-run regression, which represents a return to its pre-storm level. This, too, is consistent with the results in Table 6, suggesting that any differential impact of the storm on exits dissipated in the longer run.

As with the results in Section 5, a concern is that this result could be driven by omitted-variable bias. In particular, 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).

While we cannot entirely rule out these concerns, we attempt to address them by repeating the above 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, the proximity of a dental office should not have any causal effect on the exit probability of a store, restaurant, or hotel.

Are dentists a good control group for banks? We attempt to answer this question with two empirical exercises. First, Figure 7 shows the distribution of distance to the nearest dentist and the nearest bank for establishments in single-unit firms, firms with 2-100 establishments, and firms with more than 100 establishments. The distributions are largely similar and overlapping, but, as Table 4 also showed, distance to the nearest bank is shorter than distance to the nearest dentist. This is particularly true for establishments in large multi-unit firms. Next, Figure 8 shows scatter plots of the distance to the nearest bank and the nearest dentist, again by the establishment's firm size. The mass is on and just above the 45-degree line, consistent with most establishments being further away from dentists than from banks. The correlation coefficients range from 0.39 for the establishments in the largest chains to 0.56 for single-unit firms. The figure also shows more clearly the much wider distribution of distances to both the nearest bank and the nearest dentist for single-unit firms.

A third check, in progress, is to map dentists and banks in Mississippi and check for different patterns of spatial agglomeration.

Because of this correlation we still expect to find some relationship between distance to a dentist and survival. Moreover, because distance to a dentist is more correlated with distance to a bank for establishments in small firms, we may even find a differential effect by firm size. However, we should expect this effect to be smaller than the effect of distance to a bank.

The last three columns of Table 7 show these results. None of the coefficients on distance to the nearest dental office or its interaction with size or damage are statistically significant with the exception of the interaction of distance and damage in the long-run regression (significant at the 5% level).

Broadly, these results support the findings of Brevoort and Hannan (2004) and Brevoort, Holmes, and Wolken (2010) who find that distance matters.

7 Sole Proprietorships

In this section, still under construction, we zoom in on the subset of establishments in our data that are organized as 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. The importance of liquidity for small businesses is well established; Holtz-Eakin, Joulfaian, and Rosen (1994), for example, show that individuals receiving an inheritance are much more likely to become entrepreneurs, and that this effect increases with the size of the inheritance received, a finding confirmed by many subsequent studies.

7.1 The Role of Establishment Location

First, we repeat the location analysis of Section 6 to test whether distance to a bank and/or dentist matters for sole proprietorships. These results are shown in Table 8. The on difference from our earlier regressions is that we no longer control for firm size since there is essentially no variation in this variable.

The coefficient on the interaction of distance to the nearest bank and extensive/catastrophic damage is large and very significant. Returning to our calculations in Section 6, it implies that, *ceteris paribus*, the difference between the 2004–06 exit rate of a sole proprietorship 0.55 miles from a bank and a sole proprietorship 0.1 miles from the nearest bank, if both were catastrophically damaged, is 30 percentage points. That difference shirks to 17 percentage points by 2008, but it remains statistically significant at the 1% level. We also find an effect of the interaction between distance to the nearest bank and limited or moderate damage in the long run, which increases in the long run.

Point estimates are much smaller (and standard errors much larger) in the regressions that substitute distance to the nearest dentist for distance to the nearest bank. Pre-storm estimates using dentists are very similar to those that used banks. In the short run, none of the effects are statistically significant, including the direct effect of damage. In the long run, the direct effect of damage returns, and there is also a statistically significant effect of the interaction of distance to the dentist and limited/moderate damage (significant at the 10% level), but not the interaction of distance to dentist and extensive/catastrophic damage.

These results are consistent with the notion that small businesses are most credit constrained and also most reliant on local banks for financing.

7.2 The Role of Owner Demographics

As a next step, we plan to test for an interaction between storm damage and owner demographics; specifically, whether female-owned sole proprietorships were more likely to exit following significant storm damage than sole proprietorships owned by 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).

7.3 The Role of Home Damage

Another variable we hope to soon link in is the home address of sole proprietorships. Homes were destroyed in many Mississippi communities, including Biloxi and Gulfport.

We expect to find that sole proprietors whose homes were damaged were less likely to return to operation. This could be for any of a number of reasons. First, sole proprietorships often use their homes as the main collateral when obtaining business loans. In this context, Hurst and Lusardi (2004) find that individuals whose homes appreciated in value were more likely to become entrepreneurs; we are testing for the reverse effect. Second, residents whose homes were damaged may have been constrained not only with respect to their financial and physical resources but also with respect to their emotional and mental resources to deal with one crisis at a time. Third, some of these residents may have decided to move away having experienced a loss of both home and business.

8 Concluding Remarks

The pattern we document in this paper indicate that businesses in areas damaged by Katrina, especially those with extensive and catastrophic damage, exited at higher rates than businesses in other areas, controlling for establishment and firm size, establishment age and productivity, county, and six-digit NAICS. Second, we find that these excess exits were concentrated among smaller firms and establishments located further from banks, particularly in the short run.

These results are consistent with the presence of credit constraints, but they may also be driven by unobserved business and location quality as well as data issues. We plan to extend the current analysis using additional specifications, particularly for sole proprietorships, as well as additional data sets and time periods.

Since there has not been much entry into Katrina-damaged counties in the post-storm years, we can only speculate on the interaction of our exit observations with entry in other settings. If single-establishments firms, small chains, and other types of constrained businesses exit disproportionately in the aftermath of a shock and these types of businesses are also over-represented among entrants, the overall distribution of firm sizes may not change dramatically. However, if small operators exit in higher rates but do not enter in higher rates, the distribution of firm sizes may shift towards larger firms. This shift could contribute to existing concentration trends in the retail, restaurant, and hotel sectors.

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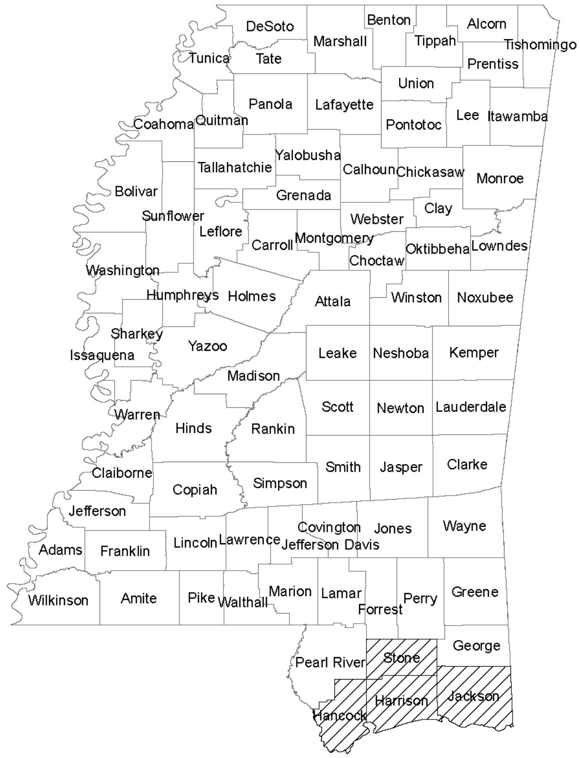

Figure 1. Mississippi (Shaded Counties Most Affected by Katrina)

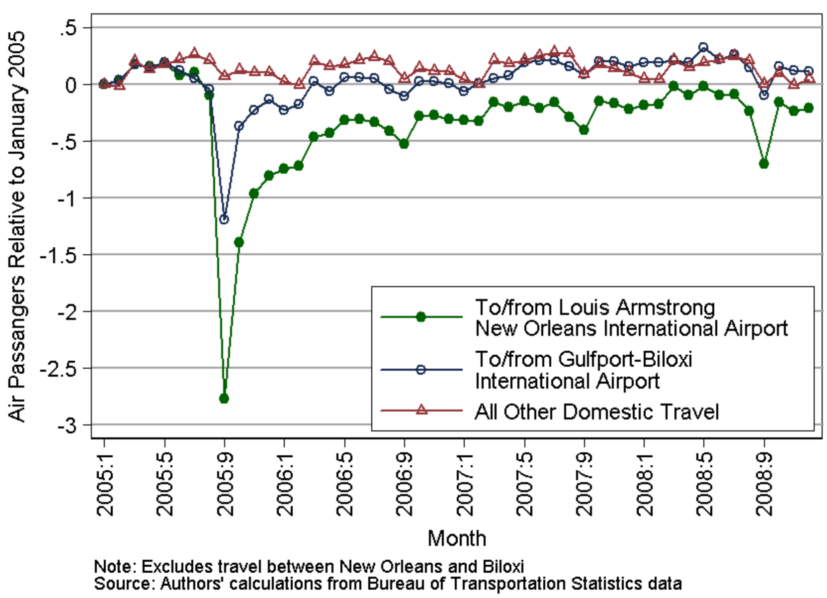

Figure 2. Air Passenger Travel to and from New Orleans and Biloxi, 2005–2008

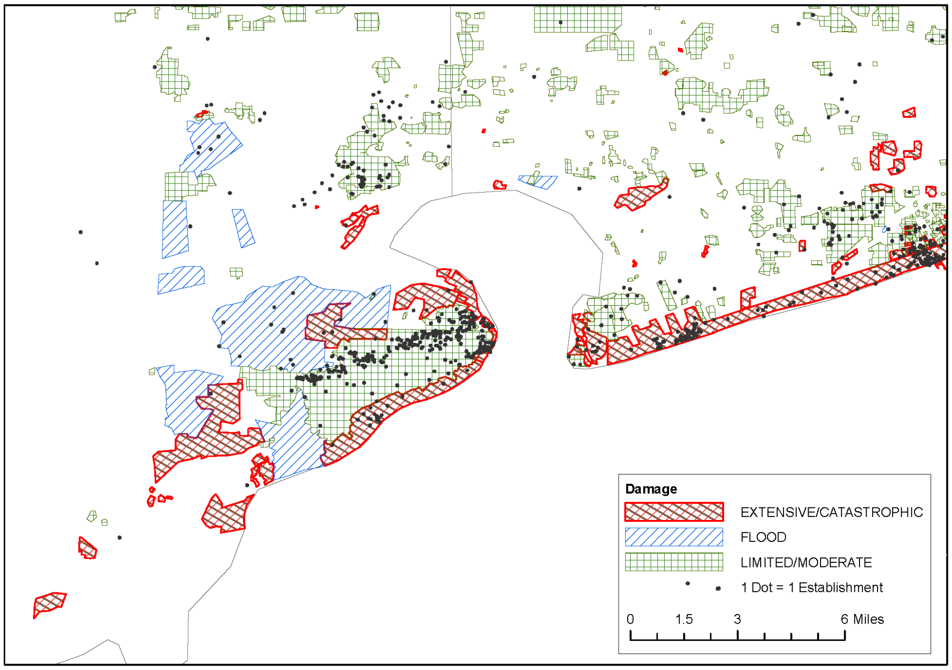

Figure 3. Damage Area Closeup: Harrison and Hancock Counties, MS

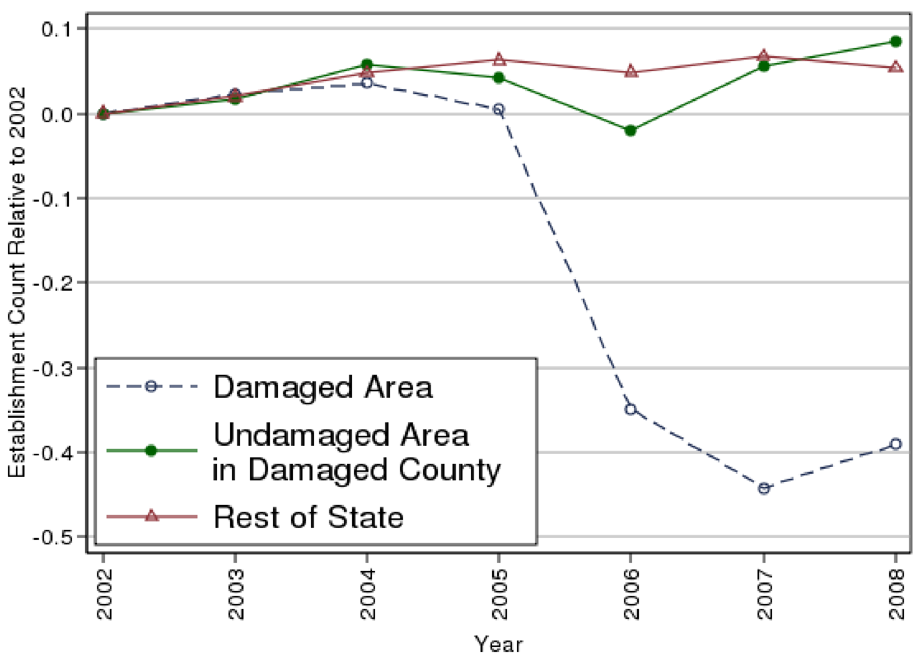

Figure 4. Log Change, since 2002, in Stores, Restaurants and Hotels

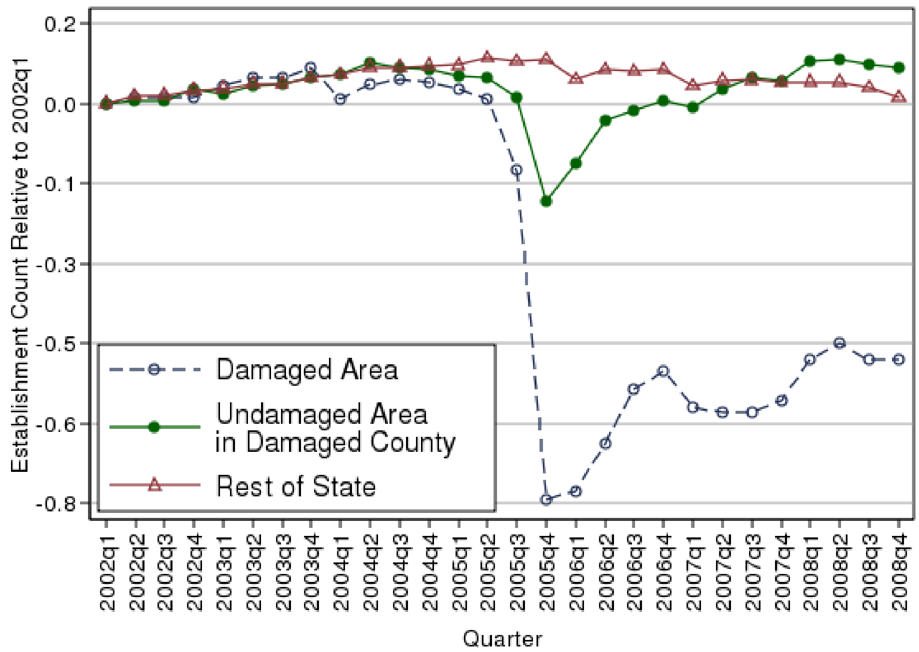

Figure 5. Log Change, since 2002q1, in Single-Unit Stores, Restaurants and Hotels

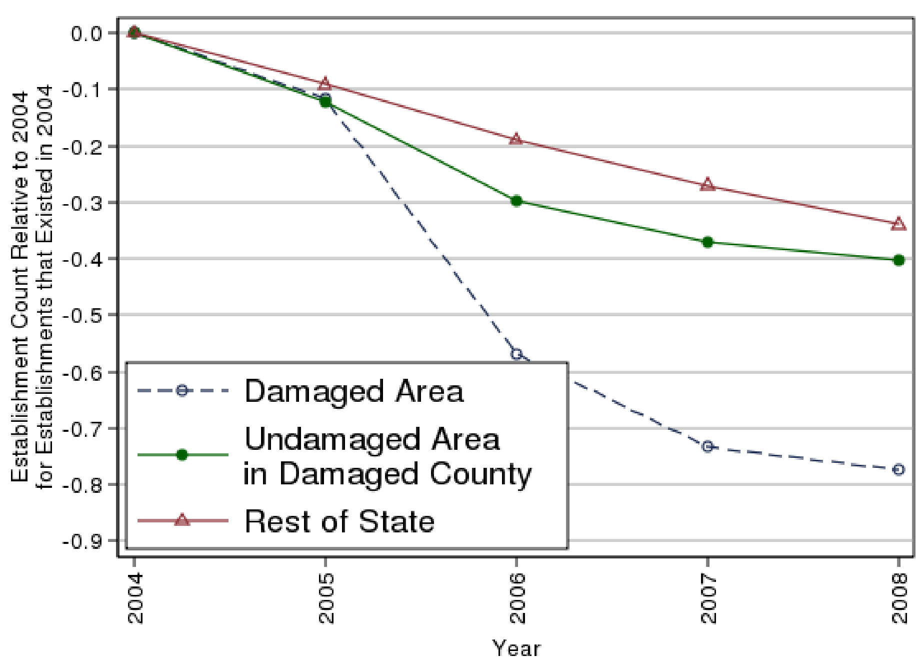

Figure 6. Log Change, since 2004, in Stores, Restaurants and Hotels that Existed in 2004

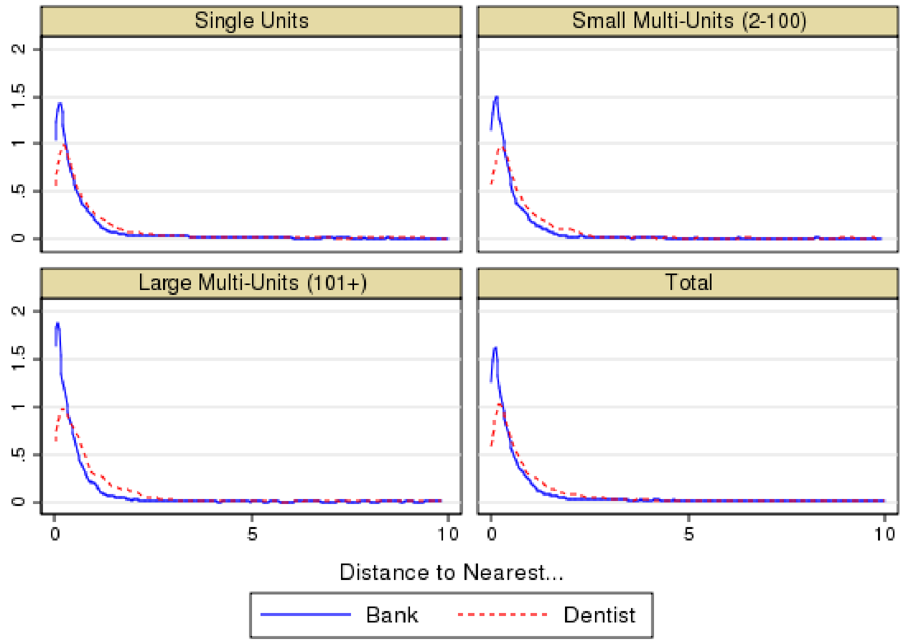

Figure 7. Distribution of Distance to Nearest Bank and Nearest Dentist, by Firm Size

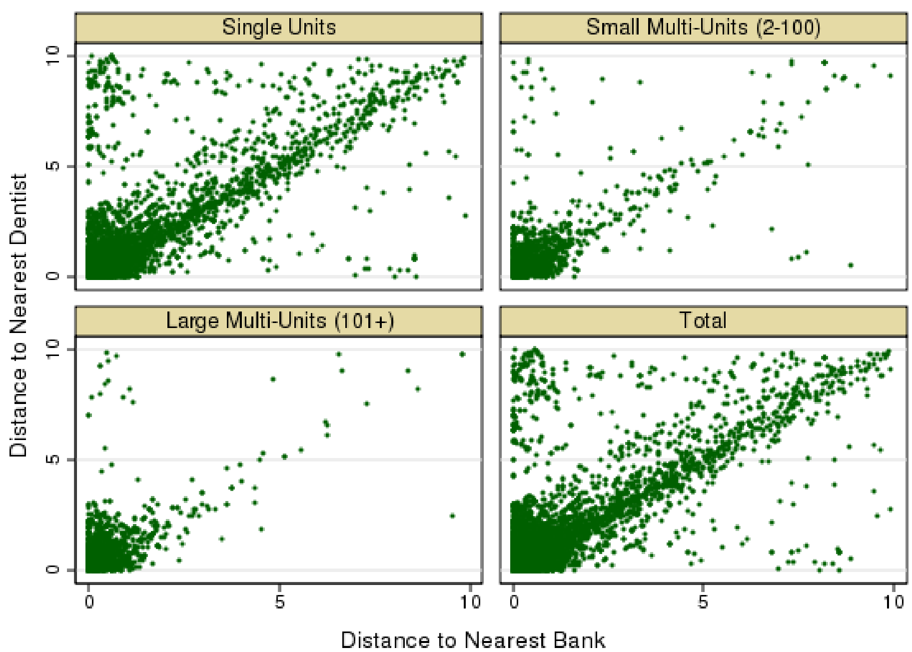

Figure 8. Correlation between Distance to Nearest Bank and Nearest Dentist, by Firm Size

Table 1. Population of Selected Mississippi Counties 2000–2010

County	2000 Population	2010 Population	Log Change
Hancock	42,967	43,929	+ 2.2%
Harrison	189,601	187,105	− 1.3%
Jackson	131,420	139,668	+ 6.1%
Stone	13,622	17,786	+26.7%
Rest of State	2,467,048	2,578,809	+ 4.4%

Source: Authors' Calculations from Population Census, 2000 and 2010

Table 2. County Summary Statistics, 2004

County	Estabs[a]	Geo-Coded[a]	Extensive or Catastrophic	Limited or Moderate
Hancock	180	170	11.4%	63.9%
Harrison	1,050	920	35.6%	17.6%
Jackson	540	470	6.6%	17.3%
Stone	60	50		
Rest of State	11,620	9,260		
Total[b]	13,460	10,870	3.5%	3.2%

[a] Counts rounded to nearest 10 observations.
[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	13,200	404.2	426.2	397.9	0.24
States with operations by firm	13,200	7.7	8.8	7.4	0.00
Firm employment	13,200	10,836.4	9,265.0	11,292.3	0.16
Establishment employment	13,200	16.1	14.2	16.7	0.89
Establishment age	13,200	11.8	11.5	11.9	0.13
Productivity[c]	13,110	0.0	0.1	0.0	0.65

		2004 Mean for:			
Variable	Obs[a]	All	Non-Geocoded	Geocoded	T-test[b]
Establishments in firm	13,350	447.8	461.5	444.5	0.56
States with operations by firm	13,350	8.0	8.7	7.8	0.60
Firm employment	13,350	11,669.1	10,443.0	11,964.0	0.39
Establishment employment	13,350	16.7	15.4	17.0	0.27
Establishment age	13,350	12.1	11.9	12.2	0.10
Productivity[c]	13,290	0.0	0.1	0.0	0.37

[a] Counts rounded to nearest 10 observations

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

[c] Normalized ratio of revenue to payroll in 2002

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

Variable	Obs[a]	2002 Mean for: All	Undamaged	Damaged	T-test[b]
Single-unit firms	10,190	0.6	0.6	0.6	0.758
Establishments in firm	10,190	399.0	392.7	486.0	0.430
States with operations by firm	10,190	7.4	7.3	9.3	0.000
Firm employment	10,190	11,334.9	11,347.4	11,159.7	0.948
Establishment employment	10,190	16.8	16.7	18.1	0.608
Establishment age	10,190	11.9	11.9	11.9	0.954
Distance to nearest bank (miles)[c]	9,740	0.9	1.0	0.4	0.000
Distance to nearest dentist (miles)[c]	9,740	1.7	1.8	0.8	0.000
Productivity[d]	10,190	0.0	0.0	0.0	0.489

Variable	Obs[a]	2004 Mean for: All	Undamaged	Damaged	T-test[b]
Single-unit firms	10,740	0.6	0.6	0.6	0.908
Establishments in firm	10,740	444.3	439.7	508.9	0.173
States with operations by firm	10,740	7.8	7.7	9.6	0.000
Firm employment	10,740	11,973.8	12,098.9	10,229.8	0.559
Establishment employment	10,740	17.5	17.5	18.0	0.824
Establishment age	10,740	12.3	12.3	12.3	0.919
Distance to nearest bank (miles)[c]	10,350	0.9	1.0	0.4	0.000
Distance to nearest dentist (miles)[c]	10,350	1.7	1.7	0.8	0.000
Productivity[d]	10,740	0.0	0.0	0.0	0.920

[a] Counts rounded to nearest 10 observations; sample omits estabs aged < 2
[b] p-value from t-test for equality of the means
[c] Distance computed using banks and dentists in operation in 2002
[d] Normalized ratio of revenue to payroll in 2002

Table 5. Establishment Summary Statistics: Sole Proprietorships, 2002 and 2004

Variable	Obs[a]	2002 Mean for: All	Undamaged	Damaged	T-test[b]
Establishment employment	1,840	4.3	4.3	4.1	0.755
Establishment age	1,840	11.2	11.2	11.0	0.821
Distance to nearest bank (miles)[c]	1,750	1.6	1.6	0.6	0.000
Distance to nearest dentist (miles)[c]	1,750	2.4	2.5	0.8	0.000
Productivity[d]	1,840	0.0	0.0	0.0	0.310

Variable	Obs[a]	2004 Mean for: All	Undamaged	Damaged	T-test[b]
Establishment employment	1,730	4.4	4.4	4.6	0.727
Establishment age	1,730	11.6	11.6	11.8	0.781
Distance to nearest bank (miles)[c]	1,650	1.5	1.6	0.6	0.100
Distance to nearest dentist (miles)[c]	1,650	2.4	2.5	0.8	0.000
Productivity[d]	1,730	0.0	0.0	0.0	0.284

[a] Counts rounded to nearest 10 observations

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

[c] Distance computed using banks and dentists in operation in 2002

[d] Ratio of revenue to payroll in 2002

Table 6. Difference-in-Difference Exit Regressions: Firm Size and Damage

	2002–04	2004–06	2004–08
Extensive/Catastrophic Damage	-0.0191	0.2275***	0.2378***
	(0.0129)	(0.0272)	(0.0370)
Limited/Moderate Damage	0.0054	0.0320***	0.0418
	(0.0134)	(0.0063)	(0.0361)
ln(Establishments)	-0.0049**	-0.0054***	-0.0079***
	(0.0021)	(0.0013)	(0.0023)
Extensive/Catastrophic × ln(Estabs)	-0.0008	-0.0234***	-0.0129***
	(0.0028)	(0.0022)	(0.0049)
Limited/Moderate × ln(Estabs)	-0.0016	-0.0108**	-0.0048
	(0.0023)	(0.0054)	(0.0101)
Productivity×Sector	✓	✓	✓
Productivity×Sector×Damage	✓	✓	✓
County FE	✓	✓	✓
NAICS FE (6 digit)	✓	✓	✓
Establishment controls[a]	✓	✓	✓
Observations	10,186	10,744	10,744
Percent predicted outside [0, 1]	2%	4%	1%

Robust standard errors in parentheses, clustered by county.

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

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

Table 7. 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 Damage[a]	-0.0315*	0.3098***	0.3398***	-0.0241*	0.2524***	0.2776***
	(0.0170)	(0.0220)	(0.0422)	(0.0143)	(0.0109)	(0.0182)
ln(Establishments)	-0.0087***	-0.0053***	-0.0066***	-0.0057***	-0.0060***	-0.0084***
	(0.0023)	(0.0017)	(0.0022)	(0.0020)	(0.0015)	(0.0022)
ln(Distance)[b]	0.0095***	-0.0007	0.0027	0.0061	-0.0040	0.0013
	(0.0029)	(0.0040)	(0.0045)	(0.0039)	(0.0042)	(0.0047)
Extensive/Catastrophic × ln(Establishments)	0.0055*	-0.0261***	0.0036	0.0012	-0.0240***	-0.0075*
	(0.0031)	(0.0053)	(0.0058)	(0.0022)	(0.0037)	(0.0043)
Extensive/Catastrophic × ln(Distance)	-0.0087	0.0632***	0.0744***	-0.0077	0.0330	0.0415**
	(0.0065)	(0.0091)	(0.0117)	(0.0112)	(0.0245)	(0.0167)
ln(Establishments) × ln(Distance)	-0.0024***	0.0004	0.0009	-0.0010	-0.0001	-0.0003
	(0.0007)	(0.0008)	(0.0009)	(0.0006)	(0.0008)	(0.0010)
Extensive/Catastrophic × ln(Estabs) × ln(Distance)	0.0034***	-0.0046**	0.0034*	0.0018	-0.0021	0.0020
	(0.0011)	(0.0021)	(0.0020)	(0.0017)	(0.0020)	(0.0026)
County FE	✓	✓	✓	✓	✓	✓
NAICS FE (6 digit)	✓	✓	✓	✓	✓	✓
Establishment controls[c]	✓	✓	✓	✓	✓	✓
Productivity×Sector	✓	✓	✓	✓	✓	✓
Productivity×Sector×Damage	✓	✓	✓	✓	✓	✓
Observations	9,741	10,345	10,345	9,741	10,346	10,345
Percent predicted outside [0, 1]	2%	4%	1%	2%	4%	1%

Robust standard errors in parentheses, clustered by county

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

[a] The limited/moderate damage indicator 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, log establishment employment, and zero employment indicator

Table 8. Difference-in-Difference Exit Regressions: Establishment Location for Sole Proprietorships

	Distance to Nearest Bank			Distance to Nearest Dentist		
	2002–04	2004–06	2004–08	2002–04	2004–06	2004–08
Extensive/Catastrophic	-0.0066	0.3345***	0.3131***	0.0174	0.0575	0.1935**
Damage	(0.0728)	(0.0992)	(0.0602)	(0.0649)	(0.1031)	(0.0747)
Limited/Moderate	-0.0006	0.0905**	0.1379***	0.0596	0.0039	0.0747**
Damage	(0.0604)	(0.0380)	(0.0494)	(0.0659)	(0.0269)	(0.0303)
ln(Distance)[a]	0.0162**	-0.0081	-0.0007	0.0145**	-0.0028	-0.0083
	(0.0078)	(0.0063)	(0.0075)	(0.0069)	(0.0081)	(0.0091)
Extensive/Catastrophic	-0.0200	0.1787***	0.0973***	-0.0060	-0.0366	0.0081
× ln(Distance)	(0.0478)	(0.0339)	(0.0150)	(0.0589)	(0.0825)	(0.0529)
Limited/Moderate	-0.0383	0.0674**	0.0931***	0.0193	0.0089	0.0746*
× ln(Distance)	(0.0409)	(0.0270)	(0.0185)	(0.0552)	(0.0428)	(0.0418)
County FE	✓	✓	✓	✓	✓	✓
NAICS FE (6 digit)	✓	✓	✓	✓	✓	✓
Establishment controls[b]	✓	✓	✓	✓	✓	✓
Productivity×Sector	✓	✓	✓	✓	✓	✓
Productivity×Sector×Damage	✓	✓	✓	✓	✓	✓
Observations	1,749	1,653	1,653	1,749	1,653	1,653
Percent predicted outside [0, 1]	1%	2%	1%	1%	2%	1%

Robust standard errors in parentheses, clustered by county

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

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

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