Do managers overreact to salient risks?

Evidence from hurricane strikes[*]

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Abstract

Consistent with salience theories of choice, we find that managers overreact to salient risks. We study how managers respond to the occurrence of a hurricane event when their firms are located in the neighborhood of the disaster area. We find that the sudden shock to the perceived liquidity risk leads managers to increase the amount of corporate cash holdings, even though the real liquidity risk remains unchanged. Such an increase in cash holdings is only temporary. Over time, the perceived risk decreases, and the bias disappears. This bias is costly for shareholders because it leads to higher retained earnings and negatively impacts firm value by reducing the value of cash. We examine alternative explanations for our findings. In particular, we find only weak evidence that the possibility of risk learning or regional spillover effects may influence our results.

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"It is a common experience that the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road."

A. Tversky and D. Kahneman (1974)

1. **Introduction**

In this paper, we provide empirical evidence that managers exhibit biases when assessing risk. Specifically, we show that managers systematically respond to near-miss liquidity shocks by *temporarily* increasing the amount of corporate cash holdings. Such a reaction cannot be explained by the standard Bayesian theory of judgment under uncertainty because the liquidity shock stems from a hurricane landfall whose distribution is stationary (Elsner and Bossak, 2001; Pielke et al., 2008). Instead, this reaction is consistent with salience theories of choice (Tversky and Kahneman, 1973, 1974; Bordalo, Gennaioli and Shleifer, 2012a, 2012b, 2013) that predict that the *temporary* salience of a disaster leads managers to reevaluate their representation of risk and put excessive weight on its probability.

Most corporate policy decisions are made under uncertainty and require managers to estimate risk. Standard corporate finance models assume that managers do so by estimating probabilities through a pure statistical approach. Under this assumption, beliefs about risky outcomes are based on all available information and are formed regardless of context-specific factors. In practice, however, assessing risk is complicated and time-consuming. Because individuals have limited cognitive resources, psychologists argue that they may rely on heuristics, i.e., mental shortcuts that simplify the task of assessing probabilities (Tversky and Kahneman, 1973 and 1974) by focusing on "what first comes to mind" (Gennaioli and Shleifer, 2010). Under this alternative manner of assessing risk, all information is not given equal importance, which may lead people to make mistakes in their estimation that can have important consequences. In this paper, we ask whether managers also use such heuristic rules and investigate whether this practice affects corporate policies.

We focus on the "availability heuristic" rule. Tversky and Kahneman (1973 and 1974) show that people have a tendency to infer the frequency of an event from its availability, namely the ease with which concrete examples of a situation in which this event occurred come to mind. As the quote above suggests, the drawback of such a heuristic rule is that availability may also be affected by the salience of the event. For many reasons (e.g., a dramatic outcome or high levels of media coverage), certain events have unusual characteristics that stand in stark contrast with the rest of the environment. Because such events are more salient, they come to mind more easily. People using the availability heuristic will then overestimate the probability that these events will occur again. As shown by Bordalo, Gennaioli and Shleifer (2012b), such people behave as "local thinkers" who use only partial (i.e., salient) information to estimate probabilities. They overweight possible outcomes whose features draw their attention while neglecting others and thereby make incorrect inferences about the true probability of an event.

If corporate managers also use the availability heuristic, salient risk situations should lead them to overreact and make inappropriate decisions in terms of risk management. Specifically, we hypothesize that managers then overestimate the probability that the risk will materialize again and take excessive precautionary measures against it.

Testing this hypothesis empirically gives rise to two major difficulties. First, the risk perceived by the manager cannot be directly observed. To address this problem, we focus on how managers estimate the risk of liquidity shock at the firm level and use the variations in corporate cash holdings to measure how their perception of this risk changes. Given the overwhelming evidence that corporate cash holdings are primarily used as a buffer against the risk of liquidity shortage, variations in cash holdings should provide a good indication of the changes in liquidity risk that are perceived by firm decision makers.[1]

[1] Froot et al. (1993) and Holstrom and Tirole (1998, 2000) provide a theoretical basis for predicting that cash will be used in imperfect financial markets as an insurance mechanism against the risk of liquidity shock. Empirically, several papers

Second, testing this hypothesis also requires the identification of a salient event whose occurrence does not convey any new information about the real distribution of its probability. For instance, the bankruptcy of Lehman Brothers in 2008 was a salient event that might have led bankers to reevaluate their *subjective* estimation of their risk exposure. However, this event is also likely to have affected the *objective* distribution of their risks.[2] It is therefore impossible to disentangle the part of their reactions caused by the increase in *subjective* risks from that caused by the increase in *objective* risks.

We address this problem here by using hurricanes as the source of liquidity shocks. Hurricanes are risks that are well suited for our purpose for three reasons. First, hurricane frequency is stationary (Elsner and Bossak, 2001; Pielke et al., 2008); thus, the occurrence of hurricane does not convey any information about the probability of a similar event occurring again in the future. Second, their occurrence is a salient event that is exogenous to firm or manager characteristics and represents a credible source of liquidity shock. Finally, hurricane events permit a difference-in-differences identification strategy because their salience is likely to decline as the distance from the disaster zone increases. This feature allows us to estimate the *causal* effect of risk saliency on the perceived risk by comparing how a treatment group of firms located in the neighborhood of the disaster zone and a control group of distant firms adjust their cash holdings after a disaster.

We find that managers respond to the sudden salience of liquidity risk caused by the proximity of a hurricane by increasing the amount of their firm cash holdings, although there is nothing to indicate that this risk is now bigger than it was. On average, during the 12-month period following the hurricane, firms located in the neighborhood area increase their cash holdings by 0.84 percentage points of total assets relative to firms farther away. We also find

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document a positive correlation among various possible sources of cash shortfall in the future and the current amount of cash holdings; these studies thus confirm that precautionary motives are central to accumulating cash reserves (e.g., Kim et al., 1998; Harford, 1999; Opler et al., 1999; Almeida et al., 2004; Bates et al., 2009, Acharya et al., 2012).

[2] See Shleifer and Vishny (2011) for an analysis of how Lehman Brothers bankruptcy affected banks' balance sheets and increased the risk of fires sales.

that this cash increase is temporary. The amount of cash increases sharply during the first three quarters following the disaster and then progressively returns to pre-hurricane levels over the next four quarters. Thus, as time passes, salience decreases, people forget the event, and the bias vanishes. This bias increases when managers are likely to be less sophisticated (i.e., managers of firms without previous experience of hurricane strikes in their neighborhood area, managers of small firms, and managers of young firms) and decreases when they have good reasons to care less about liquidity risks because their firms are not financially constrained.

We also find that this bias is costly for shareholders. First, we find that managers institute higher earnings retention to increase cash holdings. Second, using the methodology of Faulkender and Wang (2006), we find that the market value of cash decreases when firms are subject to this bias. The additional cash accrued in the balance sheet does not lead to a positive change in market capitalization, which suggests that it would most likely have been better employed otherwise.

We then discuss alternative non-behavioral explanations to our findings, such as the possibility of changes in risk, risk learning, and regional spillover. First, cash holdings could increase if the real probability of being hit by a hurricane increases or if managers ignore the risk and learn of its existence only when the hurricane occurs. However, both of these explanations would imply a permanent increase in cash holdings, which we do not find. Second, cash might increase temporarily because of regional externalities. For instance, the hurricane may temporarily create new business opportunities for firms in the neighborhood area. These firms would then make more profits and hold more cash. However, this type of spillover effect would imply a positive change in operating performance (sales, income), which we do not find. The hurricane might also locally increase business uncertainty for firms in the neighborhood area. These firms may then postpone investment and accumulate cash.

However, this additional uncertainty should generate greater variance in revenues or increased volatility in stock returns, which we also do not find. To further alleviate the concern that these effects (or any other form of regional spillover effect) are driving our results, we perform two additional tests. First, we focus on all vulnerable firms (and not necessarily firms in the neighborhood of the affected region). Those firms may be far away from the disaster zone (e.g. firms located in the East coast when a hurricane hits Louisiana). Second, we focus on US firms exposed to earthquake risk and examine how they react to violent earthquakes that occur *outside* the US. In both situations, the distance to the disaster zone makes the possibility of regional spillover irrelevant. Nevertheless, our primary finding still holds. In both cases, cash holdings increase after the disaster.

Finally, we verify that holding more cash protects firm revenues better in the case of a hurricane. Indeed, if managers respond to the salience of hurricane risk by increasing cash holdings, then we would expect that holding cash helps to reduce firm losses when this risk materializes. We test this prediction and examine how firms located in disaster areas perform in terms of revenue after the disaster depending on the level of their cash holdings before the hurricane. We find that firms that hold more cash perform better and recover much faster than other firms. This finding explains why managers are willing to increase cash holdings when they perceive that the risk of a hurricane strike is higher.

Our paper shows that managers are prone to use the availability heuristic to assess risk, which affects firm value by reducing the value of cash. As such, this study contributes first to the literature on behavioral corporate finance. Baker and Wurgler (2012) organize this literature around two sets of contributions: "irrational investors" and "irrational managers." Our paper is related to the "irrational managers" strand of the literature, which primarily focuses on how overconfidence and optimism can affect both investment and financing decisions (Malmendier and Tate, 2005; Hirshleifer, Low and Teoh, 2012; Landier and

Thesmar, 2009). More recently, this literature has begun to study the effects of bounded rationality (Brav et al., 2005), such as reference point thinking (Baker, Pan and Wurgler, 2012; Baker and Xuan, 2011; Loughram and Ritter, 2002; Ljungqvist and Wilhelm, 2005; Dougal et al., 2011).

Next, our results are related to the growing literature that focuses on the effects of individual traits and past experiences on investors' decisions (Malmendier and Nagel, 2011; Malmendier and Nagel, 2013; Kaustia and Knüpfer, 2008; Choi et al., 2009; Greenwood and Nagel, 2009). Because saliency is experienced-based, our paper complements this literature and shows that irrelevant contextual factors also influence firm decision makers.[3]

Finally and more generally, our paper contributes to the vast literature on the effects of behavioral biases "in the field."[4] *A priori*, managers may act rationally because they are neither unsophisticated agents nor students in a lab with no real economic environment. Therefore, as noted by Levitt and List (2007), we should expect managers not to be affected by behavioral biases. Whether they rely on the availability heuristic to make financial decisions is thus an open question and to the best of our knowledge, this paper is the first to empirically show that managers use the availability heuristic to assess risk and the first to study its effects.

The rest of the paper is organized as follows. Section 2 briefly summarizes what is known about hurricane risk. Section 3 proposes hypotheses based on the availability heuristic phenomenon and reviews the related scientific and anecdotal evidence. Section 4 presents our empirical design. Section 5 provides evidence about whether managers overreact to salient risks. Section 6 investigates whether this reaction is costly. Section 7 discusses the possibility

[3] Another strand of research examines how salience affects individuals' attention. This literature shows that investors pay more attention to salient news (Barber and Odean 2008), which affects stock prices (Ho and Michaely, 1988; Klibanoff, Lamont, and Wizman, 1998; Huberman and Regev, 2001).
[4] DellaVigna (2009) provides a detailed survey of the real effects of behavioral economics.

of alternative non-behavioral explanations. Section 8 examines the effects of cash holdings on post-hurricane performance. Section 9 concludes.

2. **Hurricane activity on the US mainland**

Hurricanes are tropical cyclones that form in the waters of the Atlantic and eastern Pacific oceans with winds that exceed 32 m per second (approximately 72 miles per hour). In this section, we briefly summarize what is known about the risk of hurricanes in the US and why it is justified to use such a risk for our experiment. We highlight that hurricane risk can randomly affect an extensive number of firms throughout the US territory, is impossible to predict accurately, has not changed over time and should remain unchanged in the coming decades in terms of both volume (frequency) and value (normalized economic cost).

2.1. Event location

Hurricanes can randomly affect a large fraction of the US territory. Coastal regions from Texas to Maine are the main areas at risk. An extensive inland area can also be affected, either by floods resulting from the heavy rainfalls accompanying hurricanes or by the high winds produced by the hurricane as it moves across land. In the SHELDUS database (the main database for natural disasters in the US), 1,341 distinct counties (approximately 44% of the total counties in the US) are reported to have been affected at least once by a major hurricane. Figures 1 through 4 show on a map examples of disaster areas for hurricanes Fran, Floyd, Allison, and Katrina.

[INSERT FIGURES 1 TO 4 AROUND HERE]

2.2. Event frequency

Hurricanes are regular events in the US. Since 1850, an average of 2 hurricanes strike the US mainland every year.

[INSERT FIGURE 5 AROUND HERE]

Figure 5 suggests no particular increasing or decreasing trend in this frequency. This absence of a trend is supported by the climatology literature (e.g. Elsner and Bossak, 2001; Landsea, 2005; Emanuel, 2005; Landsea, 2007, Pielke et al, 2008; Blake et al., 2011). In the US, Elsner and Bossak (2001) find that the distribution of hurricane strikes have been stationary since early industrial times for all hurricanes and major hurricanes as well as for regional activity.[5] Regarding possible future changes in storm frequencies, Pielke et al. (2008) conclude in their survey that given "*the state of current understanding (...) we should expect hurricane frequencies (...) to have a great deal of year-to-year and decade-to-decade variation as has been observed over the past decades and longer*."[6]

2.3. Event cost

The total cost of hurricane strikes in terms of economic damages is now much larger than it was at the beginning of the past century (Blake, Landsea and Gibney, 2011). However, after normalizing hurricane-related damage for inflation, coastal population and wealth, no trend of increasing damage appears in the data. For instance, Pielke et al. (2008) find that had the great 1926 Miami hurricane occurred in 2005, it would have been almost twice as costly as Hurricane Katrina; thus, they stress that "*Hurricane Katrina is not outside the range of normalized estimates for past storms.*" Overall, their results indicate that the normalized

[5] "the distributions of hurricanes during each [time] subinterval are indistinguishable, indicating a stationary record of hurricanes since early industrial times. Stationarity is found for all hurricanes and major hurricanes as well as for regional activity" (p. 4349)

[6] In section 7, we discuss how possible change in the frequency of hurricane strikes in the US could affect the interpretation of our results. Further analyses on the likelihood of hurricane disaster at the county level are also documented in section 7. In particular, we show that the proximity of a hurricane disaster reveals no information about future hurricane likelihood in a given county.

economic cost of hurricane events has not changed over time, consistent with the absence of trends in hurricane frequency and intensity observed over the last century.

2.4. Event anticipation

Global tropical storm activity partly depends on climatic conditions that are predictable on seasonal time scales. However, the exact time, location and intensity of future hurricane strikes are "*largely determined by weather patterns in place as the hurricane approaches, which are only predictable when the storm is within several days of making landfall*".[7] Therefore, hurricane disasters in the US mainland are uncertain events that are very difficult to anticipate. Such events "*can occur whether the season is active or relatively quiet*", and in many instances come as a surprise to the local population.[8]

3. The psychological mechanisms for probability evaluation and risk assessment

3.1. The availability heuristic

Because assessing the likelihood of uncertain events is a complex and time-consuming task, people naturally tend to use their own experiences for developing simple mental rules to rapidly adjust their beliefs and adapt to their environment. Tversky and Kahneman (1973, 1974) describe such heuristic rules and show that, although useful in general, they sometimes lead people to make mistakes. One such rule is the "availability heuristic," which derives from the common experience that "frequent events are much easier to recall or imagine than infrequent ones." Therefore, when judging the probability of an event, most people assess how easy it is to imagine an example of a situation in which this event actually occurred. For example, people may assess the probability of a traffic accident by recalling examples of such occurrences among their acquaintances.

[7] See National Oceanic and Atmospheric Administration (NOAA) website.
[8] See NOAA website.

Tversky and Kahneman (1973, 1974) show that the use of this rule is problematic because availability may also be affected by factors that are not related to actual frequency. In particular, they argue that factors such as familiarity with the event, the salience of the event, the time proximity of the event and/or the preoccupation for the event's outcome can affect its availability and generate a discrepancy between subjective probability and actual likelihood. The availability of a car accident, for instance, will be higher when the person involved in the accident is famous (familiarity), if the accident was observed in real time (salience), if the accident occurred recently (time proximity), or if the physical pain caused by the injuries resulting from traffic accidents has been recently "vividly portrayed" (preoccupation with the outcome). In all these cases described above, the subjective probability of a car accident will then be temporarily higher than its actual likelihood.

3.2. Scientific and anecdotal evidence

The availability heuristic theory is consistent with anecdotal and scientific evidence. In a series of studies by Lichtenstein et al. (1978), people were asked to estimate the frequency of several dozen causes of death in the United States. The results from this study show that salient causes that killed many people during a single occurrence were overestimated, whereas less salient causes were systematically underestimated. In a survey conducted to understand how people insure themselves against natural hazards, Kunreuther et al. (1978) observe a strong increase in the number of people willing to buy insurance at a premium immediately after an earthquake. Conversely, people were found to be reluctant to buy such insurance even at a subsidized rate in the absence of a recent major earthquake. Johnson et al. (1993) also find that people are willing to pay more than two times the amount for the same insurance

product in situations in which the risk is salient compared to situations in which it is not, confirming that saliency increases perceived risk.[9]

To account for such empirical findings, Bordalo, Gennaioli, and Shleifer (2012b, 2013b) develop a theoretical framework of choice under risk in which salient attributes grab individuals' attention. In their model, individuals do not equally consider the full set of possible states of the world when it comes to assessing risk. They neglect non-salient states, and over-emphasize the salient ones. Because the salience of a state depends on contextual factors, individuals then make context-dependent risk estimations. When a good state is salient, they over-estimate the likelihood of a positive outcome and take too much risk. When a bad state is salient, they over-estimate the probability of a negative outcome and are excessively risk averse. In both cases, individuals overreact to salient risks.[10]

3.3. Implications and hypothesis development

In this paper, we focus on decision makers in firms. We ask whether they rely on the availability heuristic to assess risk and examine whether they overreact to salient risks (hereinafter, the *availability heuristic* hypothesis). Firm decision makers are neither uninformed, unsophisticated agents (such as home owners or property insurance retail buyers), nor are they undergraduate students in an experiment conducted outside of a real economic environment.[11] Whether managers will make incorrect financial decisions in the real world because of the availability heuristic therefore largely remains an open question.

[9] Other similar results can be found in the housing literature, in which changes in housing prices can be used to infer changes in perceived risk. This literature shows that the occurrence of a salient event (e.g., floods, earthquakes, nuclear accidents, etc.) systematically results in a decrease in property prices that is larger than the value of the insurance premium (see, for instance, MacDonald et al., 1990; Bin et al., 2004, 2008; Kousky, 2010)

[10] Other models based on the mechanism of salience include Bordalo, Gennaioli and Shleifer (2012a, 2013a), Gabaix (2011), Gennaioli and Shleifer (2010), Köszegi and Szeidl (2013), and Schwartzstein (2009). These models share the common assumption that individuals do not consider the whole set of available information before making a decision and neglect part of it. Significant judgment errors then occur when the neglected data are relevant for decision making.

[11] Levitt and List (2007) discuss the limitations of lab experiments and explain why economic agents may evolve toward more rational behaviors when placed in a familiar environment.

One challenge is that we cannot directly observe the risk perceived by firm managers. To address this difficulty, we assume that changes in risk perception can be inferred from variations in corporate cash holdings. There is indeed strong theoretical and empirical evidence in the corporate finance literature that the main driver of policies regarding cash holdings is risk management. Froot et al. (1993) and Holstrom and Tirole (1998, 2000) provide a theoretical basis for predicting that cash will be used as an insurance mechanism against the risk of a liquidity shock in imperfect financial markets because firms have limited access to external financing. In this context, cash holdings offer a buffer against any risk of cash shortage that would prevent firms from financing positive Net Present Value (NPV) projects. Consistent with this argument, several empirical papers document a positive correlation among various possible sources of cash shortfalls for future and current levels of cash holdings (Kim et al., 1998; Harford, 1999; Opler et al., 1999; Almeida et al., 2004; Bates et al., 2009; Ramirez and Altay, 2011; Acharya et al., 2012). Surveys of CFOs also confirm this link. For instance, Lins et al. (2010) find that a sizeable majority of CFOs indicate that they use cash holdings for general insurance purposes.

If managers rely on the availability heuristic to assess the risk of an event that would trigger a cash shortage, cash holdings should then vary in response to the salience of this event. Under the *availability heuristic* hypothesis, we thus argue that corporate cash holdings will increase in those situations in which the risk of cash shortage becomes more salient.

Because firms are not identical to one another, the effect of event saliency on corporate cash holdings may vary in the cross section of the population. A primary source of heterogeneity is the level of managerial sophistication; sophisticated agents are expected to be less affected by behavioral biases. Therefore, changes in cash holdings for firms with sophisticated managers should be less sensitive to event saliency. Another source of heterogeneity is the level of financial constraints. Managers of less financially constrained

firms should be less concerned about potential liquidity shocks. Therefore, changes in cash holdings for unconstrained firms should be less sensitive to event saliency. Another source of heterogeneity consists of firms' vulnerability to hurricane disasters. Indeed, not all industries are similarly affected by hurricane events. Certain industries may suffer higher losses, perhaps because they are more difficult to insure or because they are more dependent on the local economy. Changes in cash holdings should be more sensitive to event saliency for firms that operate in such vulnerable industries.

4. Empirical design

4.1. Identification strategy

In this paper, we use both the occurrence of hurricanes and the proximity of the firm to the disaster area to identify situations in which the risk of liquidity shocks becomes salient. Our motivation for the use of hurricanes relies on the following arguments. First, hurricanes can trigger liquidity shocks because of the heavy damage they can inflict.[12] Although firms might buy insurance to cover this risk, direct insurance is unlikely to cover all type of indirect losses. In addition, Froot (2001) shows that hurricane insurance is overpriced.[13] Thus, firms should prefer to self-insure by accumulating cash reserves instead of directly insuring this liquidity risk. Second, the occurrence of hurricanes is a salient event because hurricanes draw people's attention and leave their marks on observers' minds. Third, this saliency effect is likely to vary with the proximity of the landfall. Indeed, we expect the event to be salient for managers whose family members and friends are directly affected by the disaster, which is likely to occur for firms located in the disaster area and the environs nearby (referred to herein

[12] Cash shortages can come in many ways, including reinvestment needs caused by the partial destruction of operating assets (headquarters, plants, equipment, etc.), a drop in earnings because of a drop in local demand, or new investment financing needs caused by unexpected growth opportunities (reconstruction opportunities, acquisition of a local competitor, etc.).

[13] Froot (2001) shows that hurricane insurance is in short supply because of the market power enjoyed by the small number of catastrophe reinsurers. As a result, insurance premiums are much higher than the value of expected losses. Garmaise and Moskowitz (2009) provide evidence that such inefficiencies in the hurricane insurance market lead to partial coverage of this risk at the firm level, which hurts bank financing and firm investment.

as the neighborhood) but not for more distant firms. The hurricane event should also receive more attention in situations in which firms are at risk, which again is more likely to occur when firms are located in the neighborhood of the disaster area. Fourth, the occurrence of a hurricane makes hurricane risk salient but does not imply a change in the risk itself. The distribution of hurricanes is stationary; therefore, there is no reason to believe that the real risk of hurricane landfall changes after its occurrence. Finally, hurricanes are exogenous events that can randomly affect a large number of firms. A firm's distance from hurricane landfalls thus offers an ideal natural experiment framework to test for the presence of a causal link between event saliency and managers' risk perception through changes in corporate cash holdings.

4.2. Data

We obtain the names, dates and locations of the main hurricane landfalls in the US from the SHELDUS (Spatial Hazard and Loss Database for the United States) database at the University of South Carolina. This database provides the location for each disaster at the county level for all major hurricanes since the early 1960s. In SHELDUS, a county is reported as an affected county whenever the hurricane event and the subsequent rainfalls cause monetary or human losses. To ensure that the event is sufficiently salient, we focus on hurricanes with total direct damages (adjusted for CPI) above five billion dollars. We also restrict the list to hurricanes that occurred after 1985 because there are no financial data available from Compustat Quarterly before that date. This selection procedure leaves us with 15 hurricanes between 1989 and 2008.[14] We obtain detailed information about their characteristics (start date, end date, date of landfall, direct number of deaths, total damage, and category) from the tropical storm reports available in the archive section of the National

[14] We obtain the same results when using all hurricanes from the SHELDUS database. Our results also remain unchanged when we remove the largest hurricanes (e.g. Katrina).

Hurricane Center website and from the 2011 National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum. Table 1 presents summary statistics for these 15 hurricanes.

[INSERT TABLE 1 AROUND HERE]

We obtain financial data and information about firm headquarters location from Compustat's North America Fundamentals Quarterly database.[15] We use headquarters rather than plants or clients' location to identify the location of the firm because our objective is to study managers' risk perception, which requires knowing where the decision makers are. Quarterly data rather than annual data are used to identify changes in cash holdings in firms near hurricane landfalls with the highest possible precision.[16] We restrict our sample to non-financial and non-utility firms whose headquarters are located in the US over the 1987-2011 period. If the county location of a firm's headquarters is missing or if the fiscal year-end month is not a calendar quarter-end month (i.e., March, June, September or December), the firm is removed from the sample. This selection procedure leaves us with a firm-quarter panel dataset of 11,948 firms and 411,490 observations. In Panel A of Table 2, we present summary statistics for the main firm-level variables we use. All variables are winsorized at the first and 99th percentile and are defined in Appendix 1.

[INSERT TABLE 2 AROUND HERE]

4.3. Assignment to treatment and control groups

We measure the degree of salience of each hurricane event according to the distance between the firm's headquarters and the landfall area. For this purpose, we define three different geographic perimeters that correspond to various distances from the landfall area: the *disaster zone*, the *neighborhood* area, and the *rest of the US mainland*. The *disaster zone*

[15] One possible concern with location data is that Compustat only reports the current county of firms' headquarters. However, Pirinsky and Wang (2006) show that in the period 1992-1997, less than 3% of firms in Compustat changed their headquarter locations.

[16] We obtain the same results with annual financial data (See Internet appendix).

includes all counties affected by the hurricane according to the SHELDUS database. The *neighborhood* area is obtained through a matching procedure between affected counties and non-affected counties according to geographical distance. Under this procedure, we first assign a latitude and longitude to each county using the average latitude and average longitude of all the cities located in the county. For each affected county, we next compute the distance in miles to every non-affected county using the Haversine formula.[17] We then match with replacement each affected county with its five nearest neighbors among the non-affected counties.[18] This procedure leaves us with a set of matched counties that constitute our neighborhood area and a set of non-matched counties that form the *rest of the US mainland* area. Figures 1 to 4 present the results of this identification procedure on a map for hurricanes Fran, Floyd, Allison and Katrina.

[INSERT FIGURES 1 TO 4 AROUND HERE]

Firms located in the *neighborhood* area (represented by the light blue zone on the map) are assigned to the treatment group because the hurricane landfall should be a salient event for the managers of such firms. Given their proximity to the disaster zone, the hurricane is indeed a near-miss event, meaning that they could have been affected by the hurricane but were not by chance. For that reason, we expect the event to raise firm managers' attention. Firms located in the *rest of the US mainland* (the blank zone on the map) are assigned to the control group. Given their distance from the landfall area, the hurricane should not be a salient event for the managers of these firms. Some of these managers may even completely ignore the event if they are located in an area in which the risk of a hurricane strike is not of concern. Firms located in the *disaster zone* (the dark blue zone on the map) are separated in our analysis because of the direct effects of the hurricane on their cash levels. Given their location, these firms are affected by the disaster. The event is not only obviously salient for

[17] The Harversine formula gives the distance between two points on a sphere from their longitudes and latitudes.
[18] We find that on average, a county has approximately five adjacent counties. Our results remain the same when we use three or four rather than five nearest non-affected counties.

their managers but is also a potential source of direct cash outflow (e.g., replacement costs of destroyed operating assets) or cash inflow (e.g., receipt of the proceeds of insurance claims). The variation of cash holdings surrounding the hurricane event is thus more likely to reflect the direct effects of the disaster rather than the change in managerial perceived risk. In practice, we do not remove these firms from our sample.[19] Instead, we control to ensure that the variation of cash holdings that we observe when these firms are affected by the hurricane does not influence our results. Panel B of Table 2 presents summary statistics for each group of firms.

[INSERT TABLE 2 AROUND HERE]

The statistics are mean values computed one quarter before a hurricane's occurrence. The last column shows the t-statistic from a two-sample test for equality of means across treated and control firms. Treatment firms and control firms appear to be similar along various dimensions, including the amount of cash holdings.

4.4. Methodology

We examine the effect of the hurricane saliency on managers' risk perception through changes in the levels of corporate cash holdings using a difference-in-differences estimation. The basic regression we estimate is

$$Cash_{itc} = \alpha_i + \delta_t + \gamma X_{itc} + \beta Neighbor_{tc} + \varepsilon_{itc}$$

where *i* indexes firm, *t* indexes time, *c* indexes county location, $Cash_{itc}$ is the amount of cash as a percentage of total assets at the end of the quarter, α_i are firm fixed effects, δ_t are time fixed effects, X_{itc} are control variables, $Neighbor_{tc}$ is a dummy variable that equals one if the county location of the firm is in the neighborhood of an area hit by a hurricane over the last 12

[19] In fact, we cannot exclude these firms because these firms can also be in the neighborhood of another hurricane at another point in time. Because we are considering various hurricane strikes over time, it is possible that the same firm may be in each of the three groups defined in our experiment (*disaster zone*, *neighborhood*, and *the rest of the US mainland*).

months and zero if not, and ε_{itc} is the error term that we cluster at the county level to account for potential serial correlations (Bertrand, Duflo and Mullainathan, 2004).[20]

Firm fixed effects control for time invariant differences among firms (which include fixed differences between treatment and control firms). Time (year-quarter) fixed effects control for differences between time periods, such as aggregate shocks and common trends. The other variables, X_{itc}, systematically include a dummy variable $Disaster\_zone_{tc}$ to capture the effect of the hurricane strike when the firm is located in the disaster zone. This $Disaster\_zone_{tc}$ variable enables the comparison of firms in the neighborhood area with firms farther away (the rest of the US mainland) by isolating the changes in cash holdings observed when firms are located in the disaster zone from the rest of our estimation.[21] Our estimate of the effect of hurricane landfall proximity is β, which is our main coefficient of interest. It measures the change in the level of cash holdings after a hurricane event for firms in the neighborhood of the disaster area relative to a control group of more distant firms.

5. **Do managers overreact to salient risks?**

5.1. Main results

We examine the effect of the event availability on the risk perceived by firm managers through differences in corporate cash holdings after a hurricane landfall. Tables 3 and 4 present our main results.

[INSERT TABLE 3 AROUND HERE]

Table 3 reports the effects of being in the neighborhood of a disaster area in the 12 months after a hurricane. Column 1 shows that, on average, firms located in the neighborhood of a disaster zone increase their cash holdings (as % of total assets) by 0.84 percentage points

[20] Allowing for correlated error terms at the state level or firm level leads to similar inferences in the statistical significance of regression coefficients.
[21] When firms are located in the disaster area, changes in cash holdings are likely to be caused by the direct effects of the hurricane.

during the four quarters following the hurricane event. This effect represents an average increase in cash holdings of 16 million dollars in absolute terms and accounts for 8% of the within-firm standard deviation of cash holdings.

We investigate the robustness of this effect in the rest of Table 3. First, our results may capture within-year seasonality. Because hurricane activity is seasonal, firms in the neighborhood area might anticipate the possibility of hurricane strikes and hold more cash at the end of the third quarter of the year. We control for this possibility by using firm-calendar quarter fixed effects (i.e. four quarter fixed effects for each firm) rather than firm fixed effects. Second, our result might be driven by industry-specific shocks. Thus, we use year-quarter-SIC3 fixed effects rather than year-quarter fixed effects to remove any time varying unobserved heterogeneity across industries (Gormley and Matsa, 2013). Column 3 shows that the inclusion of these two high-dimension fixed effects does not alter our estimation.[22] In fact, the magnitude of the effect of hurricane proximity on cash holdings remains exactly the same. In column 3, we show that this effect is robust to the inclusion of firm-specific controls: age, size and market-to-book. Because such controls might be endogenous to the proximity of a hurricane disaster, we do not include them in our basic specification.[23] Similar to Bertrand and Mullanaithan (2003), we prefer to verify that our findings are not modified by their inclusion.[24] Overall, the effect is extremely robust to the different specifications, and the magnitude of the coefficient is always the same. Consistent with the *availability heuristic* hypothesis, managers respond to the sudden salience of danger by increasing their firm cash holdings, although there is no indication that the danger is bigger now than it was.

[INSERT TABLE 4 AROUND HERE]

[22] See Guimarães and Portugal (2010) for a simple procedure to estimate models with two high-dimension fixed-effects

[23] See Roberts and Whited (2012) for a discussion about the effect of including covariates as controls when they are potentially affected by the treatment.

[24] Similarly, this result does not change when other control variables frequently associated in the literature with the level of cash holdings are added, such as capital structure, working capital requirements, capital expenditures, or R&D expenses.

In Table 4, we examine how the effect of hurricane proximity on cash holdings changes over time. Specifically, we study the difference in the level of cash holdings between treated and control firms at different points in time before and after hurricane landfall. To do so, we replace the *Neighbor* variable with a set of dummy variables, *Neighbor_q(i)*, that captures the effect of the saliency of the event at the end of every quarter surrounding the hurricane. For each quarter *i* (-*i*) after (before) the hurricane, we create a variable, *Neighbor_q+i*, that is equal to one if the county location of the firm headquarters at the end of the quarter was in the neighborhood of an area hit by a hurricane during quarter *q0* and zero otherwise. The regression coefficient estimated for this dummy variable then measures the difference-in-differences in the level of cash holdings i (-i) quarters after (before) the disaster. We undertake the same procedure for the *Disaster_zone* variable. This approach allows us to identify when the effect starts and how long it lasts. Column 1 of Table 4 shows that no statistically significant change in cash holdings appears before the hurricane event for firms located in the neighborhood area. However, consistent with a causal interpretation of our result, we do find that the amount of cash begins to increase following the occurrence of the hurricane.[25] This effect increases during the subsequent three quarters, and the increases in cash holdings reach their maximum during *q+2* and *q+3*, which is when the following annual hurricane season begins and becomes active. On average, hurricanes from our sample occur by mid-September. The next annual hurricane season starts around mid-June (i.e. after q+2 and before q+3). The coefficient for the *Neighbor_q+2* and *Neighbor_q+3* variables show that, on average, firms located in the neighborhood area respond to the saliency of the disaster by increasing their cash levels by 1.15 and 1.13 percentage points of their total assets (approximately 20 million dollars and approximately 11% of the within-firm standard deviation of *cash*) at the end of the second and third quarters after the hurricane, respectively.

[25] The positive and statistically significant effect for *Neighbor_q0* does not contradict our interpretation. Indeed, *q0* is the first balance sheet published *after* the event and therefore shows the change in cash that occurs *in reaction to* the hurricane.

The level of cash holdings then begins to decrease, and the effect progressively vanishes over the next three quarters. The coefficient for the *Neighbor_q+8* variable shows that the average difference in cash holdings between firms in the neighborhood area and control firms is not statistically different from zero two years after the hurricane landfall.

This drop in the amount of cash holdings is consistent with our behavioral interpretation. As time goes by, memories fade, the salience of the event decreases, and the subjective probability of risk retreats to its initial value. Managers then reduce the level of corporate cash holdings.

[INSERT FIGURE 6 AROUND HERE]

We plot the result of this analysis in a graph in which we also display the evolution of the difference in corporate cash holdings between firms located in the *disaster zone* and control firms. This graph is presented in Figure 6. While firms in the neighborhood area experience a temporary increase in cash holdings, firms hit by the hurricane display a symmetric decrease. This "reversed mirror" trend is notable for two reasons. First, it confirms that the occurrence of a hurricane can trigger a liquidity shock, as firms hit by a hurricane experience a significant drop of 0.6 percentage points in their cash holdings. Second, it offers an indication of the magnitude of the increase in cash observed when firms are located in the neighborhood area. Indeed, the graph demonstrates that the additional amount of cash accrued in the balance sheet (+1.1 percentage points of total assets), presumably for insurance purposes against the risk of cash shortages after a hurricane strike, exceeds the actual loss of cash (-0.6 percentage points) that firms experience when this risk materializes. Thus, even if the increase in cash holdings observed for firms in the neighborhood area was justified, the magnitude of this increase would be excessive compared to the real loss of cash at risk. However, we do recognize that the loss of cash (-0.6%) we observe here may not correspond to the real economic cost of the hurricane. We address this issue in Section 7 when we

examine market reaction at the time of landfall. We find that the present value of losses caused by the disaster represents 1.03% of the total assets of the firm, on average, which remains lower than the increase in cash observed in firms located in the neighborhood area (+1.1%). This last result is useful to determine whether managers overreact to the salience of hurricane risk, or if alternatively they properly take hurricane risk into account only when a disaster occurs and neglect this risk in normal times. Here, we cannot (and do not) rule out the possibility of risk neglect in normal times. However, we can rule out the possibility that managers correctly adjust cash holdings when a disaster occurs. Indeed, the magnitude of the increase in cash compared to the value of losses suggests that managers overshoot and increase cash holdings too much, which is more consistent with an overreaction-based explanation.

5.2. Cross sectional variation in managers' responses

Because firms have different characteristics, they may not respond in the same way to the salience of hurricane risk. We first investigate whether this response changes with the degree of sophistication of firm decision makers. Our primary proxy for sophistication is the experience of a firm's managers in terms of hurricane proximity. Indeed, we expect managers to learn from past experiences and to be less sensitive to danger saliency if they have previously been "fooled." In practice, we count the number of instances in which a firm has been located in the neighborhood area during previous hurricane events. We then split our sample into three categories of sophistication (low, medium, and high). Firms are assigned to the low (medium or high) sophistication category if their headquarters were never (once or more than once, respectively) located in the neighborhood area during a prior hurricane event.

To complement this analysis, we also use two more indirect proxies for sophistication: firm size and age. We use firm's size because we expect large firms to be run by sophisticated

CEOs and CFOs (e.g. Krueger Landier and Thesmar, 2011). We use the age of the firm because various studies in the behavioral literature show that young age is more associated with behavioral biases (Greenwood and Nagel, 2009; or Malmendier and Nagel, 2011). Each period, we split our sample into terciles of firm size and terciles of firm age, and we assign firms to the high, medium, or low sophistication category if they belong to the high, medium, or low tercile of the distribution, respectively.

For each criterion (experience, size, and age), we define three dummy variables corresponding to each sophistication category (e.g., *Low Sophistication*, *Medium Sophistication*, *High Sophistication*). We then interact each dummy variable with the *Neighbor* variable to investigate how the response to the salience of hurricane risk varies with the degree of managerial sophistication.

[INSERT TABLE 5 AROUND HERE]

Columns 1 to 3 of Table 5 indicate that a low degree of sophistication systematically leads to a strong increase in the amount of cash holdings. Conversely, we find no statistically significant change in cash holdings for firms whose managers are likely to be more sophisticated. In all three cases, an F-test indicates that the difference between the two coefficients (high vs. low) is statistically significant at the 1% or 5% level. Overall, the results of table 5 are mostly consistent with our availability heuristic hypothesis, which predicts that sophisticated managers should react less to salient risks. The effect of managers' experience on how neighboring firms react to the event (column 1) is also notable because it mitigates the concern that our main finding is driven by possible regional spillover effects between the disaster area and the neighborhood area. As further discussed in section 7, corporate cash holdings may increase temporarily in the neighborhood area because of possible connections between the neighboring firms and the local economy shocked by the natural disaster. However, this explanation implies that a temporary increase in cash should *consistently* be

observed after each hurricane event, which is not what column 1 suggests. Indeed, column 1 indicates that as managers accumulate experience because the same event repeats, this temporary increase in cash holdings tends to be weaker.

In the Internet Appendix, we further investigate how this response varies in the cross section of firm population. First we find that managers of firms located in the neighborhood area have a stronger response to the salience of liquidity risk when their firms are more financially constrained. Second, we show that firms in the neighborhood area also respond more strongly when their firm is more vulnerable to a hurricane disaster. Specifically, the amount of corporate cash holdings increases more when a firm operates in an industry that suffers higher losses in the case of hurricane disaster, when firms operations mainly rely on intangible assets that are more difficult to insure, and when firms are less diversified geographically.

The last set of results indicates that our effect is concentrated on neighboring firms for which hurricane risk is very relevant. By contrast, firms that are less vulnerable to this specific liquidity risk react less even though their managers are exposed to the same traumatic event. This finding casts doubt on the possibility of a fear-based reaction, in which the hurricane disaster modifies managers' preferences and temporarily increases their risk aversion (Guiso, Sapienza and Zingales, 2013). In this fear-based story, all managers exposed to the same traumatic situation would react in the similar way, which is not what we find.

5.3. Robustness and validity check

Our main source of concern is the slight heterogeneity between treated firms and control firms. Although these firms are fairly comparable along various dimensions, Table 2 indicates that some differences exist in terms of age and dividends. To ensure that our results are not driven by this heterogeneity, we combine our difference-in-differences approach with

a matching approach. We match on SIC3 industry, size, age, market-to-book, financial leverage, working capital requirements, capital expenditures, and dividends. The results of this analysis as well as a detailed description of our matching procedure are presented in the Internet Appendix. Overall, this analysis leads to the same conclusion as the one obtained with the simple difference-in-differences approach: firms located in the neighborhood area temporarily increase their level of cash holdings after the hurricane.

To ensure that this result is both valid and robust, we also conduct a series of additional tests that are described and reported in the Internet Appendix. In particular, we run a placebo test in which we randomly change the dates of hurricanes to ensure that our results are driven by hurricane landfalls. We also re-run our main regression in many different ways to verify that our effect is robust to alternative specifications. Finally, we verify that our effect is not driven by the manner in which we scale corporate cash holdings. Thus, we re-run the main regression using firm size (total assets) as the dependent variable and find nothing.

6. Is managers' reaction costly?

Because the liquidity risk remains unchanged, managers' decisions to temporarily increase cash holdings after a hurricane event are likely to be suboptimal in terms of resource allocation. In this section, we examine whether this temporary increase in cash is costly for shareholders. We begin by analyzing the counterparts to this cash increase. Next, we study whether this response to risk saliency negatively impacts firm value by reducing the value of cash.

6.1. Source of cash

The cash increase observed after the hurricane landfall may come from a variety of sources: an increase in revenues (*Sales Growth* variable) and operating profits (*EBIT Margin*

variable), a drop in net working capital requirements (*NWC* variable), a drop in investments (*Net_investment* variable), a decrease in repurchases (*Repurchases* variable), a reduction of dividends (*Dividend* variable), or an increase in new financing (debt or equity) (*New_financing* variable). Because total assets include the amount of cash holdings, we do not normalize these items by total assets and instead use the amount of sales (unless the literature suggests another more relevant normalization method). Next, we replicate our difference-in-differences analysis and apply our basic specification to each item separately.[26] The results of this analysis are reported in Table 6.

[INSERT TABLE 6 AROUND HERE]

We begin by examining whether hurricanes affect operating activity. Column 1 shows that, on average, the occurrence of a hurricane has no significant effect on revenues for firms located in the neighborhood area of the disaster zone. While sales growth decreases by 2.4 percentage points relative to the control group for firms hit by the hurricane, we find no evidence that the relative sales growth for neighborhood firms is affected by the proximity of the disaster. Column 2 confirms that neighborhood firms are truly unaffected in terms of operating activity. Unlike firms in the disaster zone, firms located in the neighborhood area suffer no significant decrease in operating margin (the coefficient on the *Neighbor* variable is not statistically different from zero).

In the rest of Table 6, we examine other possible channels through which the change in cash holdings may occur. We find no evidence that the proximity of the hurricane modifies either the investment activity (columns 3 and 4) or the financing activity (column 7). All coefficients have the expected sign and go in the direction of an increase in cash, but none is statistically significant. We also find no evidence that neighborhood firms reduce the amount of repurchases after the hurricane (column 5). The sign of the coefficient is negative, but

[26] We include firm-quarter fixed effects rather than firm fixed effects in the specification to adjust for within-year seasonality. Using firm fixed effects leads to the same results.

again, it is not statistically significant. However, we find that the proximity of the disaster changes payout policies. Indeed, column 6 indicates that firms in the neighborhood area tend to pay lower dividends and retain more earnings after the hurricane (the coefficient on the Neighbor variable is negative and statistically significant at the 5% level). The economic magnitude of the coefficient is low compared to the increase in cash. One possible interpretation is that managers also marginally adjust all sources of cash inflow. This would explain why all other coefficients have the right sign but turn out insignificant

In columns 8, 9 and 10, we further investigate whether hurricanes affect the payout policy or the financing policy. We use a linear probability model to assess whether hurricane landfalls affect the likelihood of stock repurchases, dividend payment, and new financing issues. In column 8, we find that the likelihood of a stock repurchase is lower in the case of hurricane proximity. Similarly, column 9 indicates a decrease in the probability of dividend payment. However, we find no change in the probability of new security issues in column 10.

Overall, these results suggest that, when located in the neighborhood area of a disaster zone, firm managers increase earnings retention and probably, also marginally adjust all other sources of cash inflow.

6.2. Value of cash

We next investigate whether this change in cash holdings is an efficient decision or a source of value destruction for shareholders. If it is an efficient decision, the increase in cash holdings should translate into a similar increase in value for firm shareholders. If by contrast, cash would have been better employed otherwise, the additional cash accrued in the balance sheet should be discounted and will not result in a similar increase in terms of market capitalization.

In our tests, we follow the literature on the value of cash (Faulkender and Wang, 2006; Dittmar and Mahrt-Smith, 2007; Denis and Sibilkov, 2010). We examine how a change in cash holdings leads to a change in market valuation for firms in the neighborhood relative to control firms over different time periods surrounding the hurricane event. We estimate the additional market value that results from a change in a firm's cash position by regressing the abnormal stock return of the firm on its change in cash holdings and various control variables. The coefficient for the change in cash holdings is then interpreted as a measure of the value of a marginal dollar of cash. Next, we interact this coefficient with a dummy variable, *Neighbor_q0*, that is equal to 1 if the firm is in the neighborhood area at time *q0*. This allows us to assess whether being in the neighborhood area of a hurricane marginally deteriorates or improves the value of a marginal dollar of cash. The abnormal return we use is the stock return in excess of the Fama and French (1993) size and book-to-market portfolio return. All control variables are those used in the cash value literature. We exclude from our analysis those observations that correspond to firms located in the disaster zone and to stocks that are not sufficiently liquid.[27] Finally, we perform this analysis for different time windows around the date of the hurricane strike to examine how the effect varies over time. The results of this analysis are reported in Table 7.

[INSERT TABLE 7 AROUND HERE]

In columns 1 and 2 of Table 7, we estimate the value of cash during two time periods that end before the occurrence of the hurricane. We find that being located in the neighborhood area at time *q0* does not change the value of cash before the occurrence of the hurricane. This result is reassuring as cash variations for these firms (Neighborhood area) are not yet statistically different from those of other firms in the rest of the US mainland. However, when the time window begins to capture the hurricane event, the same analysis

[27] Stocks not sufficiently liquid are defined as stocks with more than 50% of zero daily returns during the time window considered in the analysis (see Lesmond et al. (1999) for a discussion about the relationship between illiquidity and zero returns).

shows that the value of cash decreases for firms that are in the neighborhood area. In column 3, for instance, the interaction term between *Neighbor_q0* and *Change in cash* is negative and statistically significant. This result indicates that over a 6-month period surrounding the hurricane landfall, the value of a marginal dollar of cash decreases on average by 22 cents when the firm is located in the neighborhood area compared to an average value of 88 cents otherwise. In columns 4 and 5, we use larger time windows around the event, and we obtain similar results. Unsurprisingly, the effect disappears when the time window becomes too large (column 6) because firms located in the neighborhood area increase their level of cash holdings only temporarily.

Overall, these results suggest that the managerial decision to increase the amount of corporate cash holdings temporarily after hurricanes negatively impacts firm value by reducing the value of cash.

7. Are there any other alternative explanations?

In this section, we discuss alternative explanations to our results, namely, the possibility of "regional spillover," "change in risk," and/or "risk learning." We first examine and test the implications of each alternative interpretation. Next, we propose and perform another experiment based on earthquake risk whose design alleviates the concern that such alternative explanations are driving our findings.

7.1. The possibility of "regional spillover"

First, cash might increase temporarily because of geographical externalities. Indeed, firms located in the neighborhood area could be indirectly affected by the hurricane. Such indirect effects may then explain why the amount of cash holdings temporarily increases. We

review the main possible regional spillover effects and test whether they are likely to drive our results.

7.1.1. Higher business and / or investment opportunities

A first spillover effect might arise if the hurricane creates new business or investment opportunities for firms in the neighborhood area. In this case, neighborhood firms may temporarily hold more cash because they make more profits or because they plan to invest in the disaster zone.[28] Under this possible interpretation of our results, firms located in the neighborhood area should thus perform better and invest more after the disaster. However, none of our findings in Table 6 are consistent with such predictions. Indeed, we find no evidence that the proximity of the hurricane positively impacts either growth in terms of revenue or operating income. In addition, we do not find that neighborhood firms invest more after the hurricane. In the Internet Appendix, we further investigate how the hurricane affects the growth of sales for neighborhood firms relative to the control group at every quarter surrounding the disaster. The graph in Figure 7 illustrates the main outcome of this analysis.

[INSERT FIGURE 7 AROUND HERE]

This graph shows that growth in revenues for neighborhood firms does not increase significantly relative to the control group after the hurricane. Therefore, and unlike firms located in the disaster zone, firms located in the neighborhood area are on average truly unaffected. This conclusion is also supported by the analysis of the market reaction at the time of the hurricane landfall.

[INSERT TABLE 8 AROUND HERE]

In Table 8, we report the results of a simple event study analysis. For each group of firms (disaster area, neighborhood area, and the rest of the US mainland), we estimate the

[28] For instance, a firm operating in the building materials industry and located in the neighborhood area may face a significant increase in demand caused by new housing and reconstruction needs in the disaster zone. This firm may then temporarily have more revenues and hold more cash. Alternatively, this firm might take advantage of the difficulties faced by local competitors to invest in the disaster zone. In this case, such a firm could accumulate cash temporarily to seize new investment opportunities and would ultimately generate higher revenues.

average Cumulated Abnormal Return (CAR) of the stock price over the hurricane event period. The methodology used to perform this event study is described in the Internet Appendix. Unsurprisingly, we find a negative abnormal return for firms located in the disaster zone. However, we find no significant reaction for firms located in the neighborhood area, which suggests that investors perceive that there are no benefits (new business and/or investment opportunities) from the proximity of the natural disaster.[29]

7.1.2. Higher business uncertainty

A second form of spillover effect might arise if the hurricane creates locally higher business uncertainty. In this case, managers may decide to stop and/or postpone their investment projects. Neighborhood firms would then temporarily hold more cash. However, this explanation would imply a negative reaction at the announcement of the hurricane, which we do not find. We also do not find that firms in the neighborhood area reduce their investments in Table 6 (Column 4). We also explicitly test whether the proximity of the hurricane creates higher uncertainty.

We begin by examining whether the proximity of the hurricane affects the volatility of firm revenues.

[INSERT TABLE 9 AROUND HERE]

We use two different approaches to conduct this examination. In Panel A of Table 9, we estimate revenue volatility at the firm level using the standard deviation of sales growth in a time series. We estimate the standard deviation of the growth in revenues before and after the hurricane for each firm over a four-quarter period.[30] We then test whether this standard deviation is higher for firms in the neighborhood are after the hurricane. In panel B of Table 9, we estimate revenue volatility at the county level using the standard deviation of sales

[29] We also note that at the time of the event study, the change in cash holdings is not yet observable by market participants. Thus, finding no market reaction here is not inconsistent with the decrease in the value of cash observed afterwards in Table 10

[30] Estimating the standard deviation over a longer time window leads to the same results.

growth in cross section. We estimate the standard deviation of the growth in revenues across all firms from the same county at every quarter surrounding the hurricane event. We then test whether this standard deviation at the county level is affected by the hurricane. Under both approaches, we find that the proximity of the hurricane strike does not significantly affect the variance in revenues.

[INSERT TABLE 10 AROUND HERE]

Our analysis of stock return volatility in Table 10 also provides evidence that the hurricane does not create higher uncertainty for firms in the neighborhood area. In Panel A, we follow a methodology proposed by Kalay and Loewenstein (1985) and use an F-test to assess whether a hurricane event affects stock return variances. We find that an F-test cannot reject at the 5% level the null hypothesis that the pre-hurricane and post-hurricane stock return variances are equal for the majority of firms in the neighborhood area (64.8%). We next compute stock return volatility at each quarter and test in Panel B whether this volatility changes for firms in the neighborhood area using our baseline specification; we again find that the proximity of the hurricane does not affect stock return volatility. Overall, these results suggest that investors do not perceive higher uncertainty after the hurricane.

7.1.3. Higher financing constraints

Other regional spillover effects include the possibility that the hurricane hurts the lending capacity of banks. If bank customers withdraw their deposits after the hurricane, banks located in the disaster zone and/or the neighborhood area may no longer be able to effectively finance the local economy. Firms in the neighborhood might anticipate that banks will be constrained after the shock and may decide to hold more cash as a precaution. Under this explanation, the amount of new credits at the bank level should decrease after the hurricane. We test this prediction in the Internet Appendix and find the opposite result. In fact, the amount of new commercial and industrial loans increases after the hurricane event

for banks located in the disaster zone and for banks located in the neighborhood area relative to other banks. This result casts doubts on the possibility that the hurricane damages the entire local bank lending capacity. It is also consistent with our findings in Table 6 that the proximity of the hurricane does not negatively affect the probability of issuing new financing (Column 10).

A similar alternative story could be that the hurricane hurts local insurance companies and generates insurance rationing (Froot and O'Connell (1999), Froot (2001)). Neighboring companies may react to increased insurance costs by reducing their level of insurance and by increasing their level of cash instead. After some time, insurance premia return to normal levels. Firms then insure again and decrease their cash holdings accordingly. However, at least two of our findings are difficult to reconcile with this explanation. First, cash holdings increases over a one-year period whereas Froot and O'Connell (1999) show that prices for insurance tend to rise over a 3-year period. Second, under the insurance-based explanation, the increase in cash holdings should be concentrated on firms that depend on insurance companies to insure their business. By contrast, firms that are more likely to self-insure should react less. Our result from the internet appendix does not support this prediction. In fact, firms with a lot of intangible assets that cannot be directly insured react more.

7.1.4. Other forms of regional spillover effects

Because a variety of other forms of regional spillover effects might affect our results, we conduct another series of tests in which we focus on firms operating outside of the disaster zone and outside of the neighborhood area. To the extent that these firms are less dependent on the local economy, any increase in corporate cash holdings should be less likely to be driven by a regional spillover effect. The results of these tests are reported in Table 11.

[INSERT TABLE 11 AROUND HERE]

In the first column, we re-run our main test and focus on firms that do not have significant business connections with other firms potentially affected by the hurricane event. Using the Compustat Customer Segment database, we identify 287 neighborhood firms from our sample that have their main customer and/or provider in the disaster area. Column 1 indicates that excluding those firms from our sample does not change our main result: neighborhood firms increase the amount of their corporate cash holdings after a disaster.

In the second column, we examine the effect of the disaster on "the neighbors of neighbors". We define two groups of neighbors according to geographical distance. Specifically, we create a fourth category of firms that correspond to firms located in the neighborhood of the disaster zone but not in its close neighborhood (hereafter, a "Remote Neighbor"). To identify these firms, we match with replacement each affected county with its ten nearest neighbors among the non-affected counties. Firms are then assigned to the Remote Neighbor group if their headquarters are located in the ten nearest non-affected counties but not in the five closest. For each firm identified as a "Remote Neighbor", we calculate the distance between its headquarters and the headquarters of the closest affected firm. On average, we find that firms from our Remote Neighbor group are 80 miles away from the disaster zone. Despite the distance, the regression in Column 2 indicates that these firms also respond to the occurrence of the hurricane by increasing the amount of cash holdings.

In the third column, we focus on all vulnerable firms (excluding firms in the neighborhood of the affected region). Those firms may be far away from the disaster zone (e.g. firms located in the East coast when a hurricane hits Louisiana). We define a firm as sensitive to the risk of hurricane strike if it has been strongly affected once by a hurricane during the sample period.[31] We create a dummy variable *Vulnerable* that is equal to one if (i)

[31] To detect these firms, we look for significant drop in revenues after a hurricane landfall. Our methodology is the following. We first compare the growth in revenues observed in the data after each disaster with the prediction from the regression specified in Table D and reported in the Internet Appendix. Next, we exclude firms whose actual sales growth is higher than predicted. A firm is then defined as vulnerable if the difference between its actual and predicted sales growth is lower than the median of the distribution.

the firm is identified as sensitive to the risk of hurricane disaster, (ii) the firm is neither in the disaster area nor in the neighborhood area, and (iii) the hurricane made landfall over the past twelve months. We obtain a group of 614 "vulnerable firms", whose average distance from the disaster zone is 444 miles. Despite such a distance, the regression in Column 3 indicates that the managers of these firms increase cash holdings after the hurricane.

Overall, these results suggest that while some regional spillover effects may possibly affect firms in the neighborhood area, these effects cannot be the key explanation of our primary finding.

7.2. The possibility of a "change in risk"

Cash holdings might also increase if the real probability of being struck by a hurricane increases. However, this explanation would imply a permanent increase in cash, which we do not find in our results. To be consistent with a "change in risk" interpretation, the increase in risk must be temporary.

Such a temporary increase in risk might occur if hurricane strikes cluster in certain geographic areas during a one-year or two-year period. In this case, being a neighbor could indicate that the probability of being hit by a hurricane in the coming year is now higher than it used to be. We are not aware of any evidence of such a clustering phenomenon in the climate literature (see section 2). Nevertheless, we assess this possibility by testing whether the probability of being hit by a hurricane depends on the geographical location of past hurricane strikes. We use a linear probability model to test whether being in the neighborhood of an area hit by a hurricane affects the probability of being hit by a hurricane in the future. The dependent variable is a dummy equal to 1 if the county is hit by a hurricane. The main explanatory variable is a dummy equal to 1 if a hurricane event occurred over the past 12

months and if the county was in the neighborhood of the disaster zone. The results of this test are reported in table 12.

[INSERT TABLE 12 AROUND HERE]

In Column 1, the regression coefficient for the variable *Neighbor* is not statistically different from zero, which indicates that when a hurricane makes landfall in a given county, the event reveals no information about future disaster likelihood in the neighboring counties.[32]

7.3. The possibility of "risk learning"

Finally, cash holdings might increase if managers ignore or underestimate the risk before the occurrence of the hurricane and learn the true probability of a disaster after the hurricane's landfall. However, this explanation would again imply a permanent increase in cash, which we do not find.

It is also difficult to reconcile such a risk-learning hypothesis with our results regarding the value of cash. If managers learn the true probability of suffering a liquidity shock and increase their cash holdings accordingly, investors should value this decision positively and should not discount the additional cash in the balance sheet.

7.4. Reaction to extreme earthquakes outside the US

To further alleviate the concern that our results are driven by a non-behavioral explanation, we perform one final experiment based on earthquake risk rather than hurricane risk. We test the validity of the *availability heuristic* hypothesis by looking at US firms whose headquarters are located in urban communities in which earthquakes are frequently felt. We then focus on the announcement of extremely violent (and therefore salient) earthquakes outside the US and examine whether these firms respond to such announcements by changing

[32] Column 2 shows the same result when taking into account all hurricanes from the SHELDUS database (and not only the 15 biggest).

the amount of their cash holdings. Finding an increase in cash holdings would then be consistent with the *availability heuristic* hypothesis while allowing us to rule out other possible explanations. Indeed, it would neither be consistent with the *change in risk* hypothesis nor with the *risk-learning* hypothesis because the occurrence of an earthquake outside the US (for instance, in Pakistan) provides no information about the likelihood of experiencing an earthquake in US territory.[33] It would also not be consistent with the *geographical spillover* hypothesis because of the distance to the disaster area. We obtain information about the level of intensity felt by zip code address for each earthquake from the "*Did you feel it?*" surveys performed under the Earthquake Hazard Program by the USGS. For each zip code, we compute the average earthquake intensity felt over the past 20 years. We assign the average earthquake intensity felt to each firm in Compustat using the zip code from the headquarters' address. We then focus on firms within the top 10% of the average intensity felt distribution and assign them to a seismic zone group (treatment group). All other firms are assigned to a non-seismic zone group (control group). Next, we focus on the strongest earthquakes that have occurred outside the US in the past 30 years according to descriptions of magnitude, total deaths, and total damage. We obtain all this information from the Significant Earthquake Database.[34] These selection criteria lead to the list of major non-US earthquakes described in the Internet Appendix. We then estimate the average change in cash holdings for the seismic zone group around the announcement of the earthquake outside the US using exactly the same matching methodology as the one previously used and described above for hurricanes. The results of this analysis are depicted in the graph of Figure 8.[35]

[INSERT FIGURE 8 AROUND HERE]

[33] In addition, this test focuses on US firms whose managers frequently feel earthquakes. Thus, they cannot ignore this risk. This also casts doubts on the possibility of a learning reaction.

[34] National Geophysical Data Center/World Data Center (NGDC/WDC) Significant Earthquake Database, Boulder, CO, USA. (Available at http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=1&d=1)

[35] More details about our methodology and the detailed results are provided in the Internet Appendix.

Figure 8 shows qualitatively the same pattern as that previously observed. Firm managers located in seismic areas respond to the sudden salience of earthquake risk by temporarily increasing the level of cash holdings compared to firms located outside a seismic zone. This analysis confirms that firm managers are subject to the availability bias while rejecting other non-behavioral explanations.

8. The effects of cash holdings on post-hurricane performance

If managers respond to the salience of hurricane risk by increasing corporate cash holdings, and if this reaction is motivated by seeking insurance against such risk, then we should expect cash holdings to protect firm revenues and reduce losses when this risk materializes. We run this falsification test in this section. We focus on firms affected by a hurricane event and examine how the level of cash holdings before the disaster affects firm performance in terms of sales growth after the disaster.

To perform this test, we again use a difference-in-differences methodology. We use an approach identical to that used to estimate the effect of a hurricane on cash holdings except that (i) firms in the treatment group are firms whose headquarters are located in the disaster area, (ii) firms assigned to the control group are all other firms, and (iii) the outcome variable we are interested in is growth in revenues. We estimate how firms that are directly affected by the hurricane perform in terms of sales growth relative to the control group after the disaster conditional on their level of cash holdings (low, medium or high) before the hurricane. The graph depicted in Figure 9 illustrates the main outcome of this analysis.[36]

[INSERT FIGURE 9 AROUND HERE]

This graph compares three categories of firms defined according to the level of their cash holdings before the hurricane (high, medium, or low) and shows how each category performs in terms of sales growth relative to the control group over time. All categories of

[36] More details about our methodology and the detailed results are provided in the Internet Appendix.

firms appear to be negatively affected by the hurricane during the first two quarters following the hurricane event. On average, sales growth is approximately 9% lower for treated firms than for control firms during the second quarter following the disaster, and the economic magnitude of this revenue loss is similar across the three categories of firms. However, performance in terms of sales growth in subsequent quarters is different. Firms in the high cash tercile before the disaster rapidly catch up with firms in the control group in terms of sales growth. These high cash firms even temporarily outperform control firms and recover their loss of revenues within the year following the shock. By contrast, it takes approximately two years for firms in the low cash tercile to catch up with firms in the control group in terms of sales growth, and these low cash firms never recover their losses.

Overall, these results confirm that holding cash contributes to insuring against the effects of hurricane risk. They are consistent with our primary finding and help to explain why managers may be willing to increase the amount of corporate cash holdings when they perceive that the risk of a hurricane strike is higher.

9. Conclusions

In their seminal paper, Tversky and Kahneman (1973, 1974) observe that people have a tendency to develop heuristic rules to reduce the complex task of estimating probabilities. They show that, although useful in general, relying on these rules can also produce mistakes. This paper provides direct evidence that firm managers rely on one such rule to assess risk: the availability heuristic. Using cash holdings as a proxy for risk management, we find that managers located in the neighborhood area of a hurricane landfall temporarily perceive more risk after the event even though the real risk remains unchanged. We show that this mistake, which is caused by the temporary salience of the danger, is costly and inefficient. It leads to reduce shareholders compensation and destroys firm value by reducing the value of cash.

Over our sample period and across all firms, the total amount of cash temporarily immobilized because of this assessment bias is almost 65 billion dollars. Given the large and increasing diversity of risks that must be assessed every day by firm managers, our results suggest that the total real economic cost of this bias is likely to be considerable.

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Figure 1 – Identification of Neighbors: Illustration for Hurricane Fran (1996)

This map presents the result of the matching procedure performed to identify the degree of proximity of each county to the area affected by hurricane Fran in 1996. Each county inside the disaster area is matched with replacement with the five nearest counties outside the disaster area according to geographical distance. The geographical distance is computed using the average latitude and longitude of all the urban communities of the county. Firms located in the Neighborhood (dark blue counties on the map) are assigned to treatment group. Firms located in the rest of the US mainland (White counties on the map) are assigned to control group. Firms located in the disaster zone (light blue counties on the map) are not considered in the analysis.

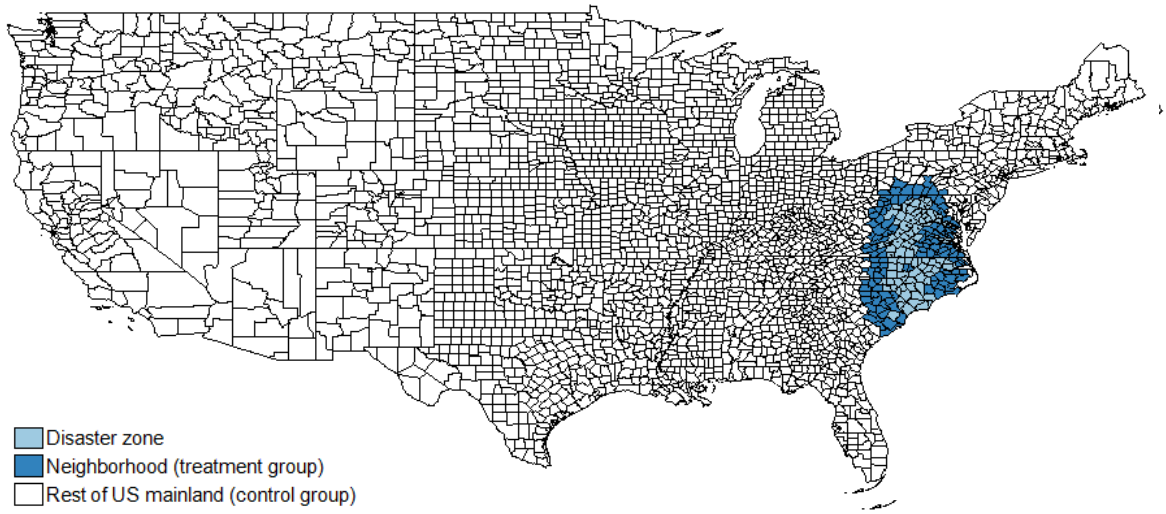

Figure 2 – Identification of Neighbors: Illustration for Hurricane Floyd (1999)

This map presents the result of the matching procedure performed to identify the degree of proximity of each county to the area affected by hurricane Floyd in 1999. Each county inside the disaster area is matched with replacement with the five nearest counties outside the disaster area according to geographical distance. The geographical distance is computed using the average latitude and longitude of all the urban communities of the county. Firms located in the Neighborhood (dark blue counties on the map) are assigned to treatment group. Firms located in the rest of the US mainland (White counties on the map) are assigned to control group. Firms located in the disaster zone (light blue counties on the map) are not considered in the analysis.

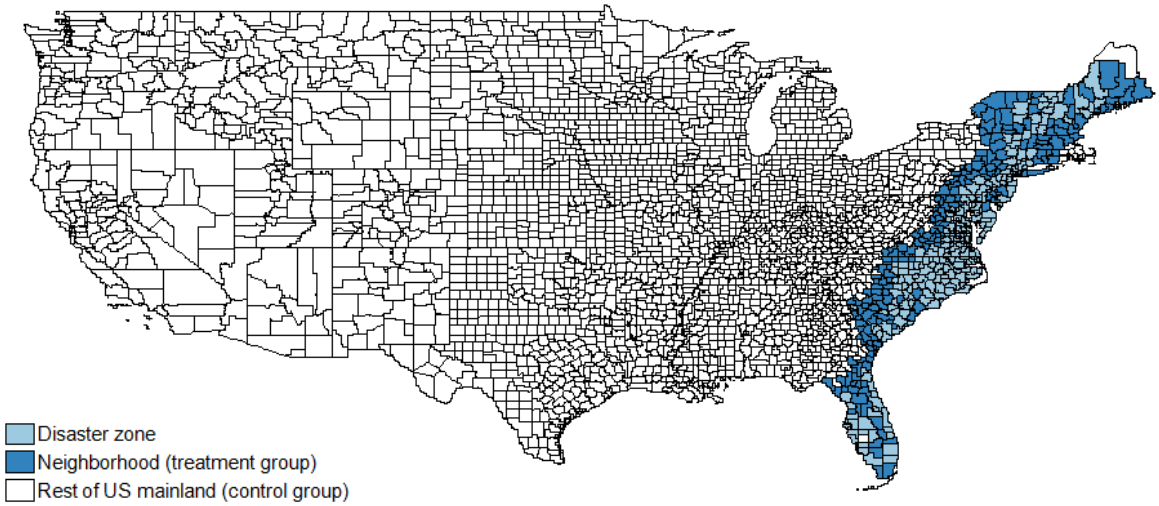

Figure 3 – Identification of Neighbors: Illustration for Hurricane Allison (2001)

This map presents the result of the matching procedure performed to identify the degree of proximity of each county to the area affected by hurricane Allison in 2001. Each county inside the disaster area is matched with replacement with the five nearest counties outside the disaster area according to geographical distance. The geographical distance is computed using the average latitude and longitude of all the urban communities of the county. Firms located in the Neighborhood (dark blue counties on the map) are assigned to treatment group. Firms located in the rest of the US mainland (White counties on the map) are assigned to control group. Firms located in the disaster zone (light blue counties on the map) are not considered in the analysis.

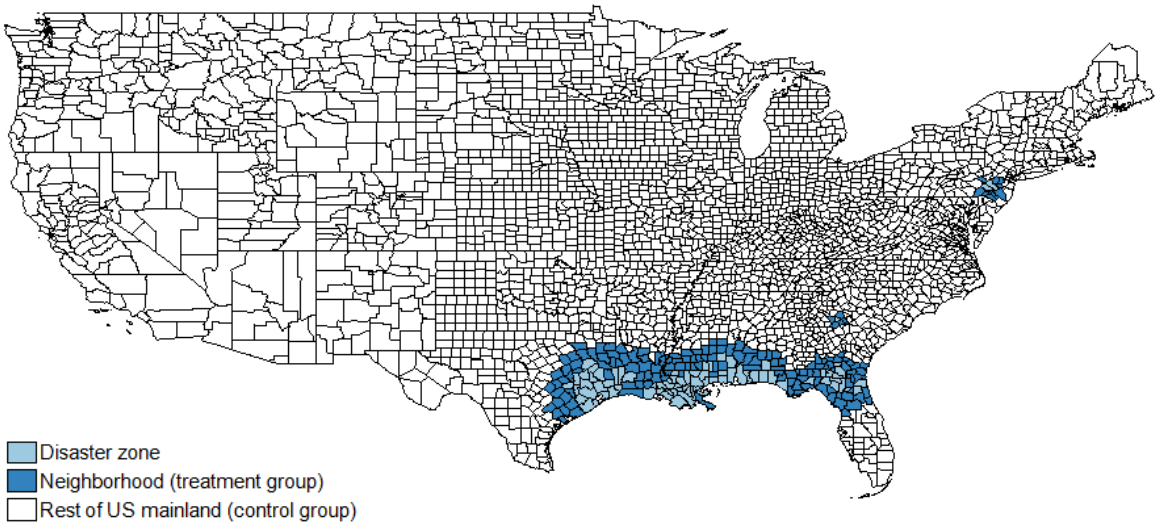

Figure 4 – Identification of Neighbors: Illustration for Hurricane Katrina (2005)

This map presents the result of the matching procedure performed to identify the degree of proximity of each county to the area affected by hurricane Katrina in 2005. Each county inside the disaster area is matched with replacement with the five nearest counties outside the disaster area according to geographical distance. The geographical distance is computed using the average latitude and longitude of all the urban communities of the county. Firms located in the Neighborhood (dark blue counties on the map) are assigned to treatment group. Firms located in the rest of the US mainland (White counties on the map) are assigned to control group. Firms located in the disaster zone (light blue counties on the map) are not considered in the analysis.

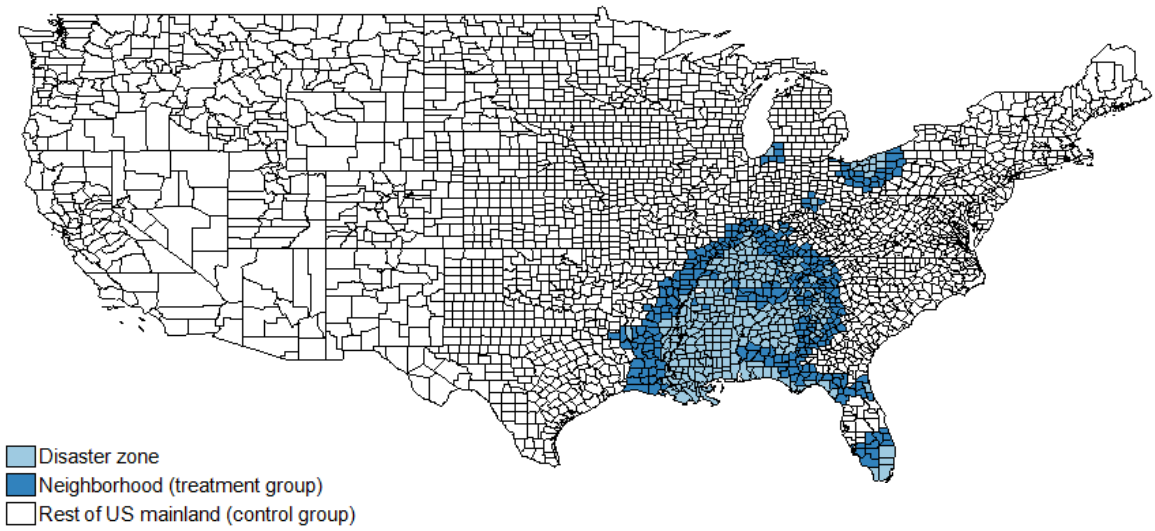

Figure 5 – Annual Number of Hurricanes since 1850

This graph presents the total annual number of hurricanes with landfall in the US mainland since 1850. The source of the information is the NOAA Technical Memorandum (2011)

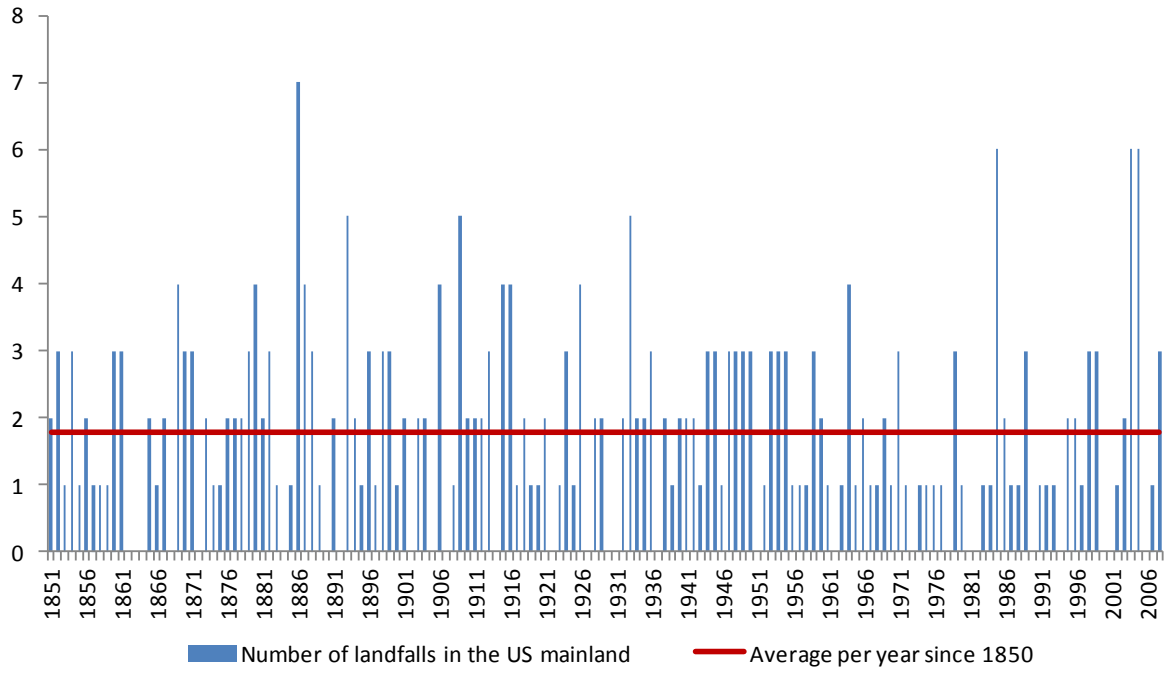

Figure 6 – Effects of Hurricane Proximity on Corporate Cash holdings

This graph presents difference-in-differences in the level of corporate cash holdings at different quarters surrounding the hurricane event (quarter *q0).* The blue line plots the difference-in-differences in the level of corporate cash holdings for firms located in the neighborhood area. The red line plots the difference-in-differences in the level of corporate cash holdings for firms located in the disaster zone. All difference-in-differences estimates use firms in the *Rest of the US Mainland* zone as the control group. These estimates are obtained using the specification of Table 4. ***, **, and * denote significance at the 1%, 5% and 10% levels.

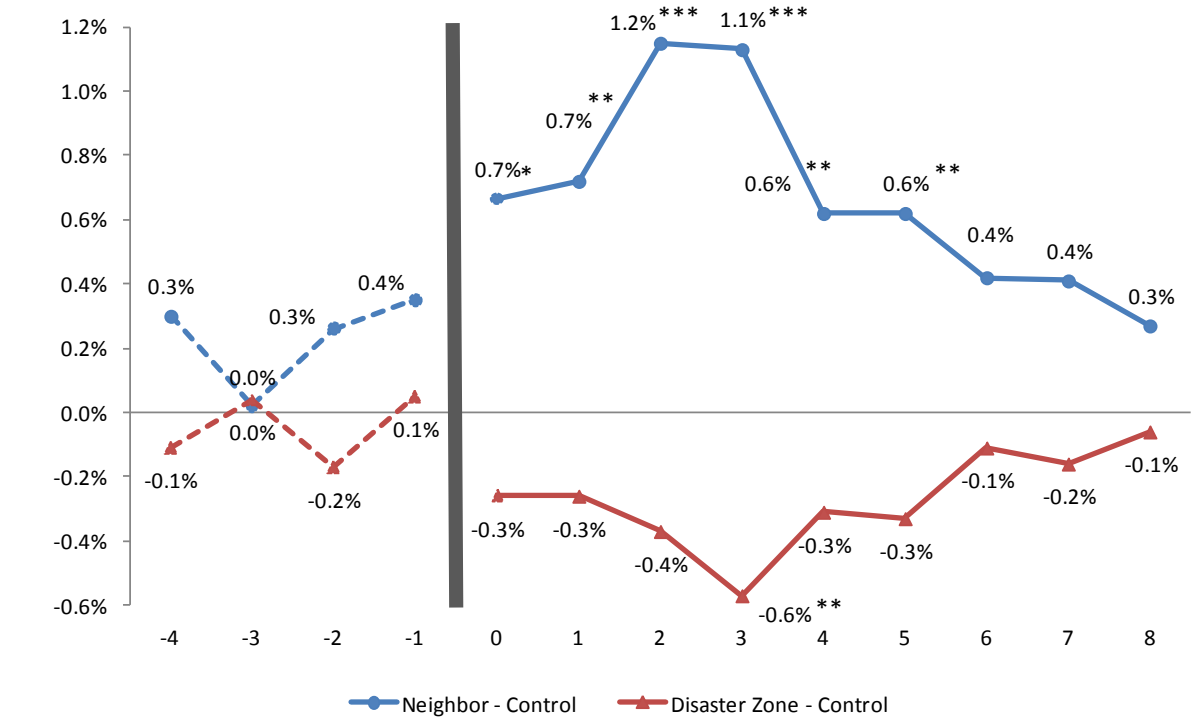

Figure 7 – Effects of Hurricane Proximity on Sales Growth

This graph presents difference-in-differences in sales growth at different quarters surrounding the hurricane event (quarter *q0).* The growth in sales is the growth in total revenues relative to the same quarter of the previous year. The blue line plots the difference-in-differences in sales growth for firms located in the neighborhood area. The red line plots the difference-in-differences in sales growth for firms located in the disaster zone. All difference-in-differences estimates use firms in the *Rest of the US Mainland* zone as the control group. These estimates are obtained using the specification of Table D reported in Internet Appendix. ***, **, and * denote significance at the 1%, 5% and 10% levels.

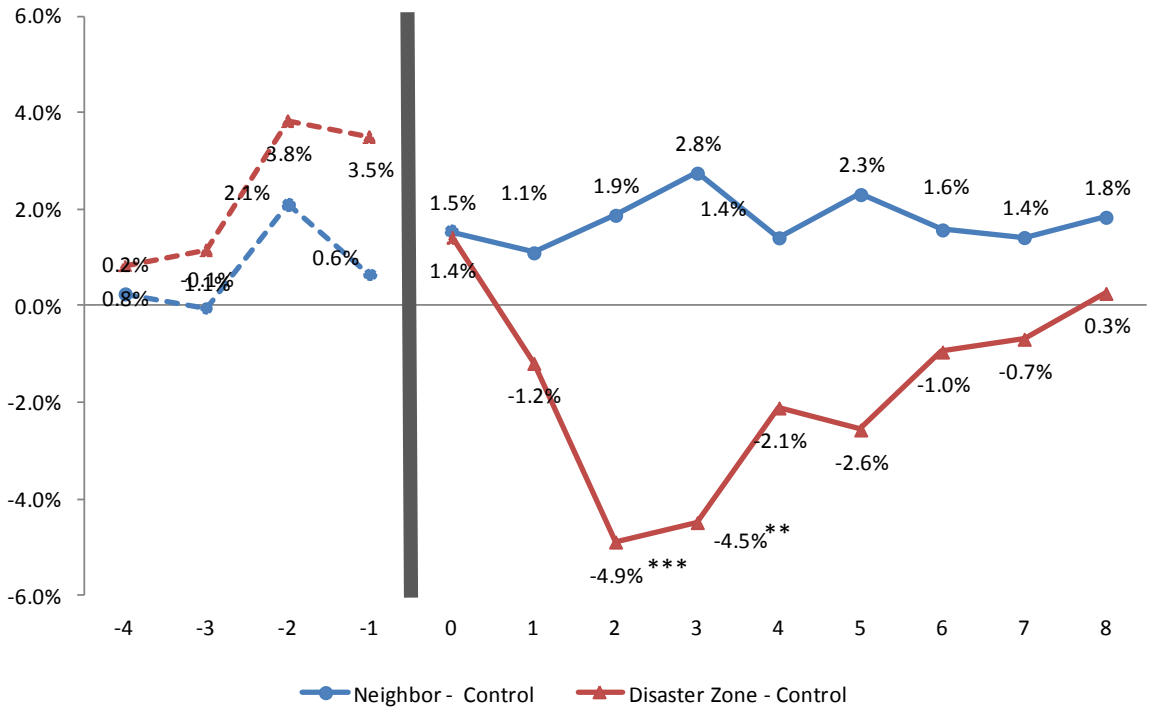

Figure 8 – Effects of Earthquakes outside the US on Corporate Cash holdings of US Firms

This graph presents difference-in-differences in the level of corporate cash holdings at different quarters surrounding the announcement of a violent earthquake outside the US (quarter *q0)* for a sample of US firms located in a seismic area. This sample comprises 1,191 treated firms whose headquarters are located in a urban community where an earthquake is frequently felt according to the U.S. Geological surveys ("Seismic zone firms"). For each treated firm, the counterfactual outcome is the weighted average of the change in the level of cash holdings relative to q-2 over all control firms with the same SIC 3 code ("Matched firm"). The weighting is achieved through a kernel function so that the closer control firms in terms of Mahalanobis distance to the treated firm receive greater weight. The Mahalanobis distance is computed at quarter *q-2* (ie. three months before the earthquake occurrence) along four dimensions: size, age, market-to-book, and financial leverage. ***, **, and * denote significance at the 1%, 5% and 10% levels.

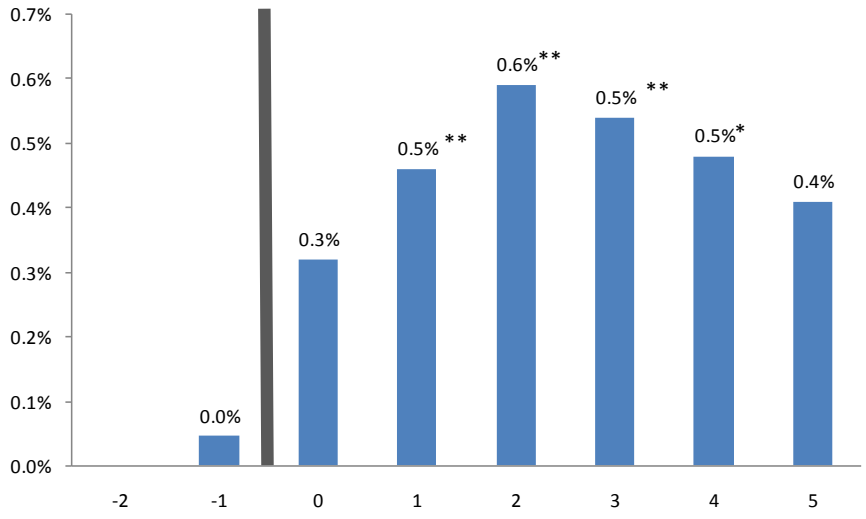

Figure 9 – Effects of Cash Holdings on Revenues of Firms Located in the Disaster Area

This graph presents difference-in-differences in sales growth between firms located inside and outside the disaster area at different quarters surrounding the hurricane event (quarter *q0)* conditional on the level of corporate cash holdings before the occurrence of the disaster. The growth in sales is the growth in total revenues of the firm relative to the same quarter of the previous year. The blue (respectively, red, green) line plots the difference-in-differences in sales growth for the sub-sample of firms with a level of cash holdings in the top (respectively, middle, bottom) tercile of the distribution at the end of the quarter before the occurrence of the hurricane. All difference-in-differences estimates use firms in the *Rest of the US Mainland* zone as the control group. These estimates are obtained using the specification of Table I reported in Internet Appendix. ***, **, and * denote significance at the 1%, 5% and 10% levels.

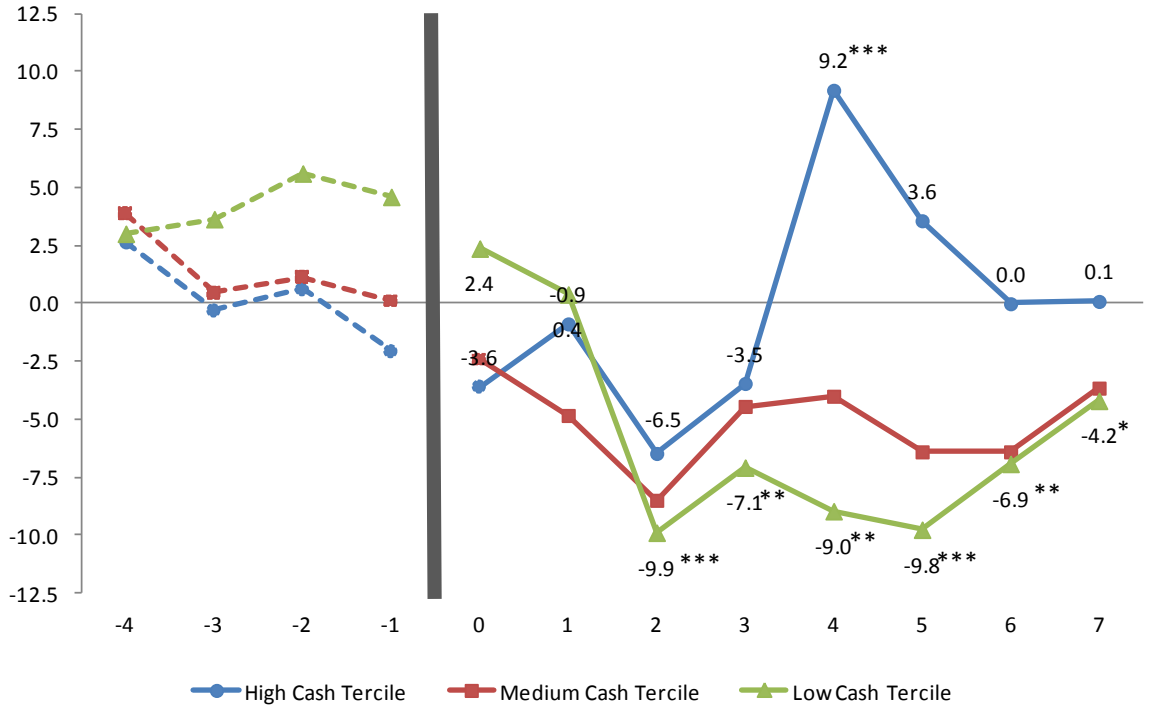

Table 1 – Major Hurricanes Landfall in the US Mainland over the 1987-2011 Period

This table describes the 15 major hurricanes according to total damages (adjusted for inflation) that occurred in the US mainland over the 1987-2011 period. *Fatalities* is the estimated total number of direct deaths in the US mainland due to the hurricane. *Damages* is the estimated value of total direct damages due to tropical storms in the US mainland expressed in billion dollars. *Damages (CPI adjusted)* is the estimated value of total damages expressed in billion dollars adjusted for the Consumption Price Index as of 2010. *Category* measures the wind intensity according to the Saffir and Simpson Hurricane Wind Scale which ranges from 1 (lowest intensity) to 5 (highest intensity). Primary source of information is the SHELDUS database. Information about *Start date*, *End date*, *Landfall date*, *Damages* and *Fatalities* comes from the tropical storm reports available in the archive section of the National Hurricane Center website. Information about Category comes from the NOAA Technical Memorandum (2011).

Name	Year	Start date	End date	Landfall date	Fatalities	Damages	Damages (CPI adjusted)	Category
Hugo	1989	9/10/1989	9/22/1989	9/22/1989	21	7.0	12.3	4
Andrew	1992	8/16/1992	8/28/1992	8/24/1992	26	26.5	41.2	5
Opal	1995	9/27/1995	10/5/1995	10/4/1995	9	5.1	7.4	3
Fran	1996	8/23/1996	9/8/1996	9/6/1996	26	4.2	5.8	3
Floyd	1999	9/7/1999	9/17/1999	9/14/1999	56	6.9	9.0	2
Alison	2001	6/5/2001	6/17/2001	6/5/2001	41	9.0	11.1	TS*
Isabel	2003	9/6/2003	9/19/2003	9/18/2003	16	5.4	6.4	2
Charley	2004	8/9/2004	8/14/2004	8/13/2004	10	15.1	17.4	4
Frances	2004	8/25/2004	9/8/2004	9/5/2004	7	9.5	11.0	2
Ivan	2004	9/2/2004	9/24/2004	9/16/2004	25	18.8	21.7	3
Jeanne	2004	9/13/2004	9/28/2004	9/26/2004	4	7.7	8.8	3
Katrina	2005	8/23/2005	8/30/2005	8/25/2005	1,500	108.0	120.6	3
Rita	2005	9/18/2005	9/26/2005	9/24/2005	7	12.0	13.4	3
Wilma	2005	10/15/2005	10/25/2005	10/24/2005	5	21.0	23.5	3
Ike	2008	9/1/2008	9/14/2008	9/13/2008	20	29.5	29.9	2

(*) "TS" : Tropical Storm

Table 2 – Descriptive Statistics

This table reports firm-level summary statistics. Panel A reports statistics of the main firm-level variables over the 1987-2011 period. Panel B presents average values of the variables for treated and control firms one quarter before the hurricane strike. Treated and control firms are defined according to their headquarter locations. The last column shows the t-statistic from a two-sample test for equality of mean across treated and control firms. All variables are from Compustat Quarterly, excluding financial, utilities and non US firms. All variables are winsorized at the 1st and 99th percentiles. The variables are defined in Appendix 1.

Panel A: Firm Level Statistics

	N	Mean	SD	P25	Median	P75
Age	411,490	10.0	7.8	3.8	8.0	14.5
Assets	411,490	1,156	3,716	19	95	510
Cash	411,490	18.0%	22.4%	2.0%	7.8%	26.0%
Debt	409,801	29.8%	34.8%	3.8%	21.8%	41.9%
Dividend	210,680	11.0%	20.7%	0.0%	0.0%	14.4%
EBIT Margin	397,098	-54.8%	246.6%	-9.1%	4.5%	11.5%
Market-to-Book	359,449	2.8	6.7	1.0	1.9	3.5
Net Investments	382,576	41.9%	120.5%	2.9%	8.1%	28.9%
Net Working Capital	408,392	13.8%	47.6%	5.8%	16.0%	27.1%
Repurchases	209,049	25.7%	88.8%	0.0%	0.0%	0.4%
Sales Growth	371,703	23.8%	73.6%	-6.2%	8.2%	28.2%

Panel B: Descriptive Statistics for Treated and Control Firms

Firm Headquarter Location Group Assignement	Disaster Zone Excluded	Neighborhood Treatment	Rest of US Control	*t* -statistic
Age	10.9	11.2	10.2	2.14**
Assets	1,316	1,308	1,135	1.15
Cash	14.5%	18.1%	18.7%	-0.41
Debt	33.0%	30.0%	29.0%	0.96
Dividend	8.4%	8.9%	10.4%	-1.95*
EBIT Margin	-62.2%	-59.4%	-55.3%	-0.55
Market-to-Book	2.90	3.08	2.85	1.34
Net Working Capital	10.2%	12.2%	13.5%	-1.02
Net Investments	38.3%	44.5%	44.7%	-0.05
Repurchases	28.7%	23.8%	23.6%	0.09
Sales Growth	28.8%	23.7%	24.5%	-0.45
N	2,941	3,102	40,087	
N distinct firms	1,959	2,201	9,801	

Table 3 – Impact of Hurricane Proximity on Corporate Cash Holdings

This table presents difference-in-differences estimates of the effect of the proximity of a hurricane strike on the level of corporate cash holdings. *Cash* is the total amount of cash and cash equivalents scaled by the total assets of the firm at the end of the quarter. *Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the neighborhood of an area hit by a hurricane over the past 12 months. *Disaster_zone* is a dummy variable equal to 1 if the county of the firm headquarters is in an area hit by a hurricane over the past 12 months. All other variables are defined in Appendix 1. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent Variable: Cash / Assets (in percentage points)			
	[1]	[2]	[3]
Neighbor	0.84***	0.83***	0.81***
	(0.23)	(0.24)	(0.28)
Disaster zone	-0.30	-0.22	-0.28
	(0.22)	(0.22)	(0.26)
Size			-1.06***
			(0.18)
Age			-1.01
			(12.41)
Market-to-Book			0.12***
			(0.01)
Firm Fixed Effects	Yes	-	-
Year-Quarter Fixed Effects	Yes	-	-
Firm-Quarter Fixed Effects	-	Yes	Yes
Year-Quarter-SIC3 Fixed Effects	-	Yes	Yes
N	411,490	411,490	359,449

Table 4 – Impact of Hurricane Proximity on Corporate Cash Holdings over Time

This table presents difference-in-differences estimates of the effect of the proximity of a hurricane strike on the level of corporate cash holdings at different quarters surrounding the hurricane event. *Cash* is the total amount of cash and cash equivalents scaled by the total assets of the firm at the end of the quarter. *Neighbor_q+i* is a dummy equal to 1 if the county of the firm headquarters at quarter *q+i* is in the neighborhood of an area hit by a hurricane during quarter *q0*. *Disaster_zone_q+i* is a dummy variable equal to 1 if the county of the firm headquarters at quarter *q+i* is in the area hit by a hurricane during quarter *q0*. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent variable: Cash / Assets (in percentage points)		
	Coefficient	Standard Error
Neighbor_q-4	0.30	(0.26)
Neighbor_q-3	0.02	(0.29)
Neighbor_q-2	0.26	(0.28)
Neighbor_q-1	0.41	(0.34)
Neighbor_q0	0.65*	(0.33)
Neighbor_q+1	0.73**	(0.31)
Neighbor_q+2	1.15***	(0.28)
Neighbor_q+3	1.13***	(0.27)
Neighbor_q+4	0.61**	(0.31)
Neighbor_q+5	0.63**	(0.29)
Neighbor_q+6	0.42*	(0.25)
Neighbor_q+7	0.41	(0.28)
Neighbor_q+8	0.27	(0.28)
Disaster zone_q-4	-0.12	(0.24)
Disaster zone_q-3	0.05	(0.25)
Disaster zone_q-2	-0.17	(0.26)
Disaster zone_q-1	0.04	(0.28)
Disaster zone_q0	-0.26	(0.29)
Disaster zone_q+1	-0.25	(0.26)
Disaster zone_q+2	-0.37	(0.28)
Disaster zone_q+3	-0.57**	(0.24)
Disaster zone_q+4	-0.31	(0.25)
Disaster zone_q+5	-0.32	(0.27)
Disaster zone_q+6	-0.11	(0.30)
Disaster zone_q+7	-0.17	(0.32)
Disaster zone_q+8	-0.07	(0.28)
Firm Fixed Effects	Yes	
Year-Quarter Fixed Effects	Yes	
N	411,490	

Table 5 – Cross Sectional Effects According to Managerial Sophistication

This table presents difference-in-differences estimates of the effect of the proximity of a hurricane strike on the level of corporate cash holdings conditional on various measures for the level of managerial sophistication. *Cash* is the total amount of cash and cash equivalents scaled by the total assets of the firm at the end of the quarter. The sophistication of managers is measured according to three criteria: Experience (number of cases in which the firm is located in the neighborhood area), the size of the firm (total assets), and the age of the firm (number of years in Compustat). For each measure of sophistication, *High (respectively, Medium, Low) sophistication* is a dummy variable equal to 1 if the degree of sophistication of managers of the company is identified as high (respectively, medium, low). *Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the neighborhood of an area hit by a hurricane over the past 12 months. *Disaster_zone* is a dummy variable equal to 1 if the county of the firm headquarters is in the area hit by a hurricane over the past 12 months. All other variables are defined in Appendix 1. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent variable: Cash / Assets (in percentage points)			
	[1]	[2]	[3]
Sophistication criteria	Experience	Size	Age
Neighbor x High Sophistication	-0.89	0.31	0.26
	(0.66)	(0.27)	(0.36)
Neighbor x Medium Sophistication	0.64	0.63*	0.62
	(0.52)	(0.37)	(0.39)
Neighbor x Low Sophistication	1.18***	1.68***	1.91***
	(0.34)	(0.52)	(0.54)
High Sophistication	0.38	-3.12***	1.54***
	(0.47)	(0.37)	(0.37)
Low Sophistication	-0.11	0.42	4.73***
	(0.37)	(0.49)	(0.30)
Disaster zone	-0.26	-0.28	-0.26
	(0.22)	(0.23)	(0.25)
Firm Fixed Effects	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes
N	411,490	411,490	411,490
High - Low sophistication	2.07***	1.37**	1.65***
F -test	(7.95)	(4.53)	(6.63)

Table 6 – Source of Change in Cash due to Hurricane Landfall Proximity

This table presents difference-in-differences estimates of the effect of the proximity of a hurricane strike on various outcome variables that affect the level of corporate cash holdings. *Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the neighborhood of an area hit by a hurricane over the past 12 months. *Disaster_zone* is a dummy variable equal to 1 if the county of the firm headquarters is in the area hit by a hurricane over the past 12 months. All other variables are defined in Appendix 1. All dependent variables in columns 1 to 7 are expressed in percentage points. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent variable	Sales growth (%)	EBIT Margin (%)	NWC (% Assets)	Net investment (% PPE)	Repurchase (% Earnings)	Dividend (% Earnings)	New financing (% MV)	Repurchase dummy	Dividend dummy	New financing dummy
				OLS				Linear Probability Model		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Neighbor	1.42	-2.9	-0.42	-1.02	-0.24	-0.54**	0.29	-0.01**	-0.01*	0.01
	(1.42)	(2.32)	(0.42)	(1.65)	(1.53)	(0.27)	(0.24)	(0.01)	(0.00)	(0.00)
Disaster zone	-2.35**	-6.30**	-0.64	-3.80**	0.1	-0.61**	-0.71**	0	0	0
	(1.20)	(3.16)	(0.70)	(1.85)	(1.64)	(0.27)	(0.30)	(0.01)	(0.01)	(0.00)
Firm-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	371,703	397,098	408,392	382,576	209,049	210,680	352,257	357,831	386,532	389,921

Table 7 – Change in the Value of Cash after the Hurricane Landfall

This table presents changes in the value of corporate cash holdings over different time windows surrounding the hurricane event. The dependent variable is the excess return of the firm relative to the Fama and French (1993) 25 size and book-to-market portfolios over the specified time window. Hurricane landfall occurs at quarter *q0*. *Neighbor_q0* is a dummy variable equal to 1 if the county of the firm headquarters was in the neighborhood of the area hit by the hurricane at quarter *q0*. *Change in X* indicates a change in *X* from quarter *q-2* to quarter *q+i*. Variables *X* are defined in Appendix 1. All independent continuous variables are scaled by the market value of equity of the firm at the beginning of the time window (q-2). Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent variable: Excess Stock Return Relative to the Fama & French (1993) 25 Portfolios						
Time Window	[q-2 ; q-1]	[q-2 ; q0]	[q-2 ; q+1]	[q-2 ; q+2]	[q-2 ; q+3]	[q-2 ; q+4]
	[1]	[2]	[3]	[4]	[5]	[6]
Change in Cash * Neighbor_q0	-0.23	-0.15	-0.22**	-0.27**	-0.24*	-0.12
	(0.14)	(0.13)	(0.11)	(0.13)	(0.15)	(0.14)
Change in Cash	0.32***	0.59***	0.88***	1.08***	1.27***	1.29***
	(0.06)	(0.08)	(0.08)	(0.10)	(0.08)	(0.10)
Change in Earnings	0.04	0.17***	0.22***	0.33***	0.60***	0.89***
	(0.03)	(0.03)	(0.04)	(0.09)	(0.07)	(0.10)
Change in Dividends	-0.26	1.56	2.73**	6.15***	1.31	4.24**
	(0.95)	(1.32)	(1.08)	(1.79)	(1.61)	(1.69)
Change in Interest Expenses	0.46	-0.65	-2.67***	-3.86***	-4.08***	-0.23
	(0.45)	(0.54)	(0.54)	(0.85)	(0.80)	(0.32)
Change in Non Cash Assets	0.06***	0.08***	0.13***	0.14***	0.15***	0.12***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Change in R&D	-0.5	-0.43	0.80***	0.51	-0.67	-0.51
	(0.32)	(0.36)	(0.29)	(0.67)	(0.56)	(0.54)
Lagged Cash	0.05***	0.12***	0.21***	0.34***	0.37***	0.33***
	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Change in Cash x Lagged Cash	-0.03	-0.24**	-0.22**	-0.25**	-0.41***	-0.36***
	(0.08)	(0.11)	(0.11)	(0.12)	(0.08)	(0.09)
Leverage	-0.13	-0.13***	-0.20***	-0.25***	-0.30***	-0.32***
	(0.12)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Change in Cash x Leverage	-0.07***	-0.36***	-0.63***	-0.74***	-0.94***	-1.31***
	(0.01)	(0.12)	(0.13)	(0.16)	(0.16)	(0.18)
Net Financing	0.00	-0.04*	-0.08***	-0.05**	-0.02	-0.06***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Neighbor_q0	0.01**	0.01	0.00	0.00	-0.01	-0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Constant	-0.01	-0.02***	-0.04***	-0.04***	-0.07***	-0.08***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	12,196	11,808	11,466	10,894	10,359	10,136

Table 8 – Market Reaction at Hurricane Landfall

This table presents the Average Cumulative Abnormal stock Return (ACAR) over the hurricane landfall period (hereafter the "event window") depending on the proximity of the firm headquarters to the disaster area. For each hurricane, firms are assigned to the *Disaster zone* group, the *Neighbor* group, or the *Control* group depending on the location of their headquarters. The event windows start one day before the beginning of the hurricane strike and end one day after the end of the hurricane strike. For each group of firms, ACAR and *z* statistics are estimated using equally weighted portfolios of firms with similar event windows. See Internet Appendix for the details of the abnormal return estimation. The economic gain is the implicit average change in market value corresponding to the ACAR expressed as a percentage of total assets. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Group	N (firms)	N (portfolios)	ACAR (%)	*Z*	Economic gain (% of assets)
Neighbor	2,583	15	-0.04%	(-0.16)	-0.10%
Disaster zone	1,991	74	-0.82%**	(-2.23)	-1.03%
Control (Rest of US)	30,350	15	-0.08%	(-0.56)	-0.11%

Table 9 – Change in Sales Growth Volatility after the Hurricane Landfall

This table presents difference-in-differences estimates of the effect of the hurricane proximity on sales growth volatility. In panel A, we estimate the volatility of the growth in revenues at the firm level after (before) the hurricane by measuring the standard deviation of sales growth over the four quarters following (preceding) the occurrence of the disaster. In panel B, we estimate the volatility of the growth in revenues at the county level using the standard deviation of sales growth across firms for each quarter around the hurricane. The specification in panel B is weighted by the average number of firms in the county. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Panel A: Impact of Hurricane Proximity on Sales Growth Variance at the Firm level

Dependent variable: Sales Growth Standard Deviation (in percentage points)

	Coefficient	Standard Error
Neighbor	0.21	(0.56)
Disaster zone	-1.24*	(0.67)
Firm Fixed Effects	Yes	
Time Fixed Effects	Yes	
N	89,990	

Panel B: Impact of Hurricane Proximity on Sales Growth Variance at the County level

Dependent variable: Sales Growth Standard Deviation at the County Level (in percentage points)

	Coefficient	Standard Error
Neighbor_q-1	-0.95	(1.78)
Neighbor_q0	0.98	(2.65)
Neighbor_q+1	1.24	(2.47)
Neighbor_q+2	2.94	(2.79)
Neighbor_q+3	3.10	(3.03)
Neighbor_q+4	-1.70	(2.42)
Neighbor_q+5	-1.85	(2.11)
Neighbor_q+6	-1.84	(2.41)
Neighbor_q+7	-2.26	(2.20)
Disaster zone_q-1	0.70	(2.60)
Disaster zone_q0	-2.83*	(1.49)
Disaster zone_q+1	-2.97*	(1.62)
Disaster zone_q+2	-4.26	(3.27)
Disaster zone_q+3	-3.88	(2.72)
Disaster zone_q+4	-0.85	(3.31)
Disaster zone_q+5	0.21	(3.14)
Disaster zone_q+6	0.75	(1.89)
Disaster zone_q+7	-1.18	(2.18)
County Fixed Effects	Yes	
Year-Quarter Fixed Effects	Yes	
N	42,540	

Table 10 –Change in Stock Returns Volatility after the Hurricane Landfall

This table presents results of two tests examining the effect of the hurricane proximity on stock returns volatility. Panel A presents results of an F-test of the equality of stock return variances around the hurricane period for each group of firms (Neighbor, Disaster Zone, and Control). Stock return variances are estimated over two 30-days periods, one before the start of the hurricane period and the other after the end of the hurricane period. Column 1 (2) reports the percentage of firms experiencing a decrease (increase) in stock return variance that is statistically significant at the 5% level. Column 3 reports the percentage of firms for which the F-test cannot reject the null hypothesis of stock variances equality between the two periods at the 5% level. In Panel B, we presents difference-in-differences estimates of the effect of the hurricane proximity on stock returns volatility. The dependent variable is the (annualized) stock returns volatility measured by the standard deviation of daily stock returns over the quarter. *Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the neighborhood of an area hit by a hurricane over the past 12 months. *Disaster_zone* is a dummy variable equal to 1 if the county of the firm headquarters is in the area hit by a hurricane over the past 12 months. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Panel A: F-test of the Equality of Stock Returns Variances

		Change in Stock Returns Variance		
Group	# Firms	% Down	% Up	% No change
		[1]	[2]	[3]
Neighbor	1,773	16.6%	18.6%	64.8%
Disaster zone	2,299	16.7%	19.7%	63.5%
Control	27,539	16.4%	17.9%	65.8%

Panel B: Impact of Hurricane Proximity on Stock Returns Volatility

	Dependent variable: Stock Returns Volatility (in percentage points)
Neighbor	0.95
	(1.01)
Disaster zone	1.33**
	(0.60)
Firm-Quarter Fixed Effects	Yes
Year-Quarter Fixed Effects	Yes
N	317,949

Table 11 – Hurricane Strike and Firms Operating Outside the Neighborhood Area

This table presents difference-in-differences estimates of the effect of the occurrence of a hurricane strike on the level of corporate cash holdings for firms whose operations are less dependent on the local economy affected by the hurricane. *Cash* is the total amount of cash and cash equivalents expressed in percentage points of the total assets of the firm at the end of the quarter. *Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the neighborhood of an area hit by a hurricane over the past 12 months. *Disaster_zone* is a dummy variable equal to 1 if the county of the firm headquarters is in the area hit by a hurricane over the past 12 months. In column 1, we restrict the sample to firms that do have not significant connections (main provider or customer) with the disaster zone. In column 2, *Remote Neighbor* is a dummy variable equal to 1 if the county of the firm headquarters is in the remote neighborhood of an area hit by a hurricane over the past 12 months. In column 3, *Vulnerable* is a dummy variable equal to 1 if a hurricane occurred during the past 12 months, if the firm is vulnerable to the risk of hurricane disaster, and if the headquarters of the firm are located outside the disaster area and its neighborhood. Standard errors corrected for clustering of the observations at the county level are reported in parentheses. ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent variable: Cash / Assets (in percentage points)

	[1] Unconnected Firms	[2] Remote Neighbors	[3] Vulnerable Firms Outside the Neighborhood area
Neighbor	0.90***	0.71***	0.89***
	(0.25)	(0.26)	(0.23)
Remote Neighbor		0.48*	
		(0.26)	
Vulnerable			0.66**
			(0.31)
Disaster zone	-0.25	-0.40*	-0.20
	(0.23)	(0.23)	(0.24)
		(0.34)	(3.58)
Firm Fixed Effects	Yes	Yes	Yes
Year-Quarter Fixed Effects	Yes	Yes	Yes
N	392,734	411,490	411,490

Table 12 – Determinants of Disaster Likelihood

This table presents panel regressions examining the effects of hurricane proximity on future probability to be affected by a hurricane. The analysis is performed at the county level. The dependent variable is a dummy equal to 1 if the county is hit by a hurricane (Only one of the 15 major hurricanes in column 1 and any hurricane in column 2). *Neighbor* is a dummy equal to 1 if the county is in the neighborhood of an area hit by a hurricane over the past 12 months. Standard errors are clustered at the state level and reported between parentheses. All specifications include four quarter dummy variables for every county in the sample to control for seasonality within the year (county-season fixed effects). ***, **, and * denote significance at the 1%, 5% and 10% levels.

Dependent Variable	Major Hurricane [1]	Any Hurricane [2]
Neighbor	0.01	0.00
	(0.007)	(0.009)
County-Season Fixed Effects	Yes	Yes
N	65,604	94,600

Appendix 1: Variables used in tests

Variables used in difference-in-difference estimations (in alphabetical order). All variables are quarterly variables

Age	Number of years between the date of the current quarterly financial accounts and the date of the first quarterly financial accounts reported in Compustat
Assets	Total assets
Cash	Cash and cash equivalents scaled by total assets
Debt	Total debt: short term debt + long term debt scaled by total assets
Dependence on External Finance	SIC3 average ratio of capital expenditures minus operating cash flow over capital expenditures. Operating cash flow: income before extraordinary items + depreciation and amortization - change in working capital - capital expenditures
Disaster zone	Dummy equal to 1 if the county location of the firm headquarter is in an area hit by a hurricane over the past 12 months
Dividend	Total dividends over last year net income
FC	Dummy variable equal to 1 if the firm is financially constrained and zero otherwise
High Sophistication	Dummy variable equal to 1 if the sophistication of the manager is high and zero otherwise
Intangible assets	Long term assets - Net property, plants, and equipment scaled by long term assets
Low Sophistication	Dummy variable equal to 1 if the sophistication of the managers is low and zero otherwise
Market-to-Book	Market to book ratio. Equity market value over total equity
Medium Sophistication	Dummy variable equal to 1 if both High Sophistication and Low Sophistication are equal to zero
Neighbor	Dummy variable equal to 1 if the county location of the firm headquarter is in the neighborhood of an area hit by a hurricane over the past 12 months
Ebit Margin	Income before interests and taxes over total revenues
Net Investments	Total net cash flow from investing activities (capital expenditures + acquisition expenditures + R&D expenses - disposals) scaled by net property, plant and equipment
Net Working Capital	Inventories + receivables - payables scaled by total revenues
New Financing	Issuance of long term debt + sale of new stocks scaled by equity market value
Sales growth	Growth in total revenues relative to the same quarter of the previous year
Repurchases	Purchase of common and preferred stocks over last year net income
R&D	R&D expenses over total assets
Size	Log of total assets
Vulnerable	Dummy variable equal to 1 if the firm is vulnerable to hurricane disaster and zero otherwise
ΔC&I Loans / Assets	Change in Commercial and Industrial Loans relative to the previous quarter scaled by total assets at the bank level

Variables used in the test on the value of cash reported in Table 7 (in alphabetical order)

Cash	Cash and cash equivalents
Earnings	Net income before extraordinary items

Dividends	Common dividends
Interest Expenses	Interests expenses
Non Cash Assets	Total assets minus all cash and cash equivalents
R&D	R&D expenses (set to zero if missing)
Leverage	Total debt (long term debt + short term debt) over total debt + equity market value
Lagged Cash	Cash and cash equivalents at time q-2 over equity market value at time q-2
Net Financing	New financing = Net new equity issue + Net new debt issue