How do banks react to increased credit risks? Evidence from Hurricane Katrina*

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Abstract

Numerous studies show that banks hold capital ratios exceeding the regulatory minimum. This, however, did not hinder the turmoil of the 2007-2009 crisis and stresses the importance of understanding how banks determine their capital ratios. This paper tests the hypothesis that an exogenous increase in the riskiness of banks' asset portfolios, which initially increases their bankruptcy risks, causes banks to adjust their capital ratios. Using exogenous variation introduced by Hurricane Katrina, which exposed banks in the U.S. Gulf Coast area to unexpected losses and increased credit risks in August 2005, we find that impacted banks act precautionary and increase their capital ratios. This shows that banks are also driven by risk concerns and not purely by regulatory requirements. However, when we examine low-capitalized and high-capitalized banks separately, we find that the precautionary behavior only holds for high-capitalized banks.

Keywords: bank regulation, capital requirements, natural experiment

JEL Classification: G21, G28

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1 Introduction

The 2007-2009 financial crisis demonstrated that the stability of the banking system is essential to economic welfare. Since the deposit insurance creates incentives for banks to become relatively risky, banking regulation is generally considered necessary. It builds on the idea that minimum capital ratios mitigate distortions from inefficiently priced deposit insurance and thus reduce bank moral hazard. With sufficiently equity "at stake", banks are expected to have less incentives to take excessive risks and thus to be more stable. The standard view is that capital requirements are binding for banks since banks try to economize on costly capital. Empirical evidence, however, shows that banks hold levels of capital well above the regulatory minimum. For example, U.S. banks held on average capital ratios exceeding the regulatory minimum by 75% during the 1990s (e.g., Flannery and Rangan, 2008). A recent study by Gropp and Heider (2010) which examines the capital structure of large U.S. and European banks during the period 1991 to 2004 argues that time-invariant bank fixed effects are the most important determinant of banks' capital structures and that capital regulations are of second-order importance. In summary, it is not well understood what determines capital ratios of banks.

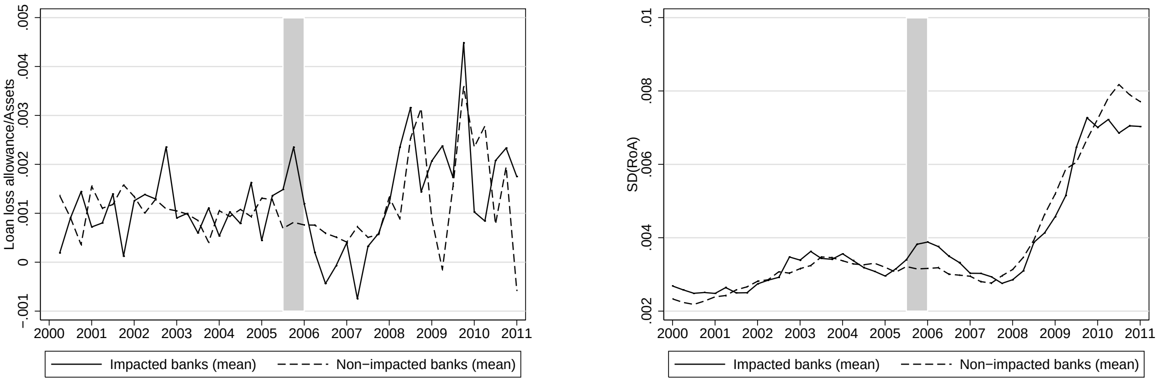
This paper tests the hypothesis that an exogenous increase in the riskiness of banks' asset portfolios, which initially increases their bankruptcy risks, causes banks to choose a new optimal capital ratio. No significant relationship would indicate that risk does not affect a bank's capital ratio decisions unless it has a direct effect on its (relatively static) regulatory measure for risk-weighted assets. A positive relationship would suggest that banks wish to mitigate bankruptcy risks. A negative relationship would point towards incentives of banks to exploit the deposit insurance guarantee.

In order to identify causality between a bank's asset risk and its capital ratio, we use Hurricane Katrina as a natural experiment that exposed banks in the U.S. Gulf Coast region to unexpected losses and increased credit risk in August 2005. Hurricane Katrina caused estimated damages to property in excess of $200 billion and ranks among the costliest natural disasters in the United States history. These damages immediately resulted in high charge-offs and provisions for banks in the impacted areas. Furthermore, Hurricane Katrina changed the (perceived) hurricane risks, as reflected in increases of 30% or more of property insurance premiums (USA TODAY, 2010). The higher hurricane risks implied higher credit risks for banks in the Gulf Coast area because a large part of potential damages of borrowers is not insured. Figure 1(a) illustrates the average development of loan loss provisions over assets for independent banks located in areas impacted by the hurricane ("impacted banks") and for banks located in areas not impacted ("non-impacted banks").[1] While there is generally some variety over the years and between both groups, it is clear that loan loss provisions over assets increased sharply for impacted banks in Q3 and Q4 2005. On the contrary, impacted banks were able to account for relatively low loan loss provisions over assets during 2006 and 2007. This hints to an economic recovery that was better than expected, and potentially also to lower engagements of impacted banks in risky credits. Figure 1(b) illustrates the average standard deviation of return over assets (RoA) of impacted and non-impacted banks, which reflects the uncertainty of banks' returns. Again, the effect of Hurricane Katrina is evident. The impact of the hurricane on the economy and banks in particular was also acknowledged by the Federal Reserve Bank of Atlanta. In their 2005 annual report they state that increased monitoring of banks' financial condition is necessary after the hurricanes (Federal Reserve Bank of Atlanta, 2005). Furthermore, the major rating agencies announced to closely watch capital adequacy and risk management processes of impacted banks in the aftermath of Hurricane Katrina (Guy Carpenter, 2006).

For the estimation of the effect of an exogenous increase in the riskiness of banks' asset risk on total risk-based capital, we employ a difference-in-difference estimation technique with bank fixed effects. All independent impacted banks in the U.S. Southeast region build our treatment group, and all independent non-impacted banks in the U.S. Southeast region build our control group. A first indication on how banks reacted to the increased asset risks is provided by the observation that impacted banks on average increase their capital ratios relative to the control group after the hurricanes, as shown in Figure 2.

The key findings of our analysis are as follows: A shock that increases banks' credit risk,

[1] Our classification builds on hurricane data from the Federal Emergency Management Agency (FEMA). Our classification also considers that there were two major storms immediately following Katrina: hurricane Rita in September 2005 and hurricane Wilma in October 2005. Consequently, the measure "impacted" comprises data from the FEMA on Hurricane Katrina, Rita and Wilma.



(a) Loan loss provisions

(b) Volatility (Standard deviation of RoA)

Figure 1: Impact of Hurricane Katrina on the Gulf Coast banking market

The figure shows the development of mean values of loan loss provisions (to assets) and the standard deviation of return over assets (RoA) for the first quarter of 2002 to the first quarter of 2011. The shaded area illustrates Q3 and Q4 of 2005, when Hurricane Katrina, Rita and Wilma hit the U.S. Gulf Coast area. The mean value for independent banks located in areas impacted by the hurricanes are represented with a solid line. The mean values for independent banks located in the U.S. South-East and not impacted by the hurricanes are represented with a dotted line.

measured as the impact of Hurricane Katrina, induces impacted banks to increase their capital ratios relative to the banks in the control group (not impacted by the hurricane). This shows that asset risk is an important determinant of bank capital ratios besides any regulatory requirements. Impacted banks presumably re-establish their bank specific cushion against insolvency and choose a capital ratio that corresponds to their risk-return profile before the hurricane. However, when we examine low-capitalized and high-capitalized banks separately, we find that the precautionary behavior only holds for high-capitalized banks. A potential explanation from the existing literature is that banks with a high franchise value and/or high bankruptcy costs have incentives to avoid bankruptcy, and are thus characterized by high-capital ratios (before a hurricane) and precautionary measures (after a hurricane). Further, our analysis shows that high-capitalized banks reacted to the higher asset risks by shifting investments from risky loans to risk-free U.S. government securities, and thereby increased their capital ratios.

Existing research on the role of capital requirements and the impact of bank regulation has studied a variety of issues. Kim and Santomero (1988) and Furlong and Keeley (1989) consider how capital requirements affect banks' risk taking. Whereas on the one hand higher capital

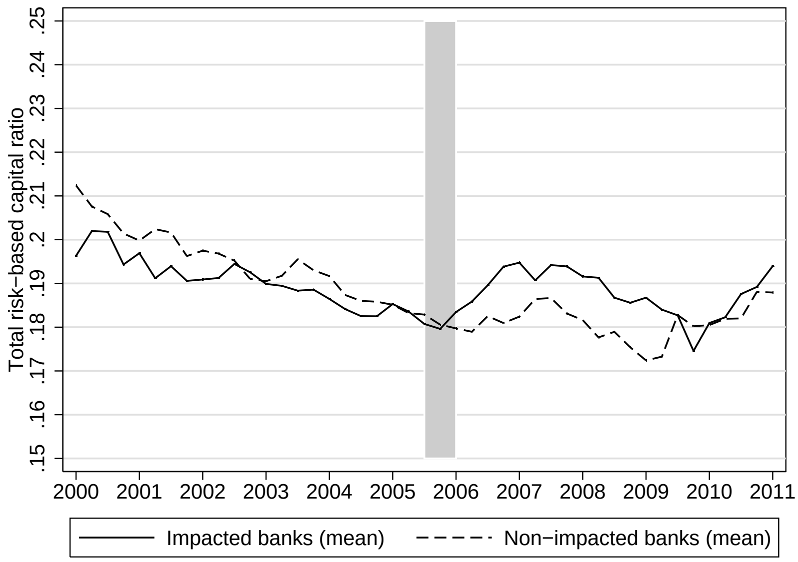


Figure 2: Total risk-based capital ratios

The figures show the development of mean values of total risk-based capital ratios for the first quarter of 2002 to the first quarter of 2011. The shaded area illustrates Q3 and Q4 of 2005, when Hurricane Katrina, Rita and Wilma hit the U.S. Gulf Coast area. The mean value for independent banks located in areas impacted by the hurricanes are represented with a solid line. The mean values for independent banks located in the U.S. Southeast region and not impacted by the hurricanes are represented with a dotted line.

requirements reduce incentives of banks to increase asset risk (Furlong and Keeley, 1989), there is a contrary effect of banks to invest in riskier projects as a consequence of the restricted risk-return profile. A prominent paper by Hellmann *et al.* (2000) studies the combined effect of financial liberalization and capital regulation on banks' risk taking. Morrison and White (2005) discuss the role of banks' risk taking in times of crisis of confidence towards the banking system which is apparent if reputation of the regulator is low. Diamond and Rajan (2000) show that bank capital reduces the probability of financial distress in times of crisis. They analyze how capital that serves as a buffer against shocks affects banks' liquidity creation. Marcus (1984) shows that when charter values are high, exploiting the deposit insurance is not optimal for the bank. Along these lines, Keeley (1990) analyzes how increased competition triggered a decline in banks' charter values and caused banks to increase their asset risk accompanied by reductions in capital levels. Allen *et al.* (2011) analyze the role of credit market competition for capital regulation and show that market discipline can be induced from the asset side. The empirical literature that explores the relationship between risk-taking and capital ratios of banks typically finds a positive relationship between risk and capital levels (see, e.g., Shrieves and Dahl, 1992; Rime, 2001).[2] However, these studies lack a clear causal identification for the relationship between asset risks and capital ratios. As capital and risk are both functions of regulation and are thus determined simultaneously, these studies need to rely on a simultaneous equations framework accordingly. Further, the change in risk weighted assets, a common measure for risk in these studies, only partially captures the risk a bank carries. It suffers from incongruencies between underlying economic risk and risk captured by regulatory ratios. We are able to depart from these traditional measures for asset risk through our study design, and thus circumvent the associated difficulties.

The paper proceeds as follows. Section 2 contains the data and summary statistics. Section 3 presents our identification strategy and empirical model. Section 4 shows the main estimation results. Section 5 explores differences between high- and low-capitalized banks. Section 6 further investigates mechanisms through which impacted banks change their *total risk-based capital ratios*. Section 7 concludes. All tables appear in the appendix.

2 Data and summary statistics

Our data come from two public sources. As regards the impact of Hurricane Katrina on the U.S. Gulf Coast area, we use data from the Federal Emergency Management Agency (FEMA). The FEMA is an U.S. agency established in 1979 with "the mission of helping communities nationwide prepare for, respond to and recover from natural and man made disasters" (FEMA, 2008). Following Hurricane Katrina, Wilma and Rita in the second half of 2005, the FEMA designated 110 out of 383 counties in Louisiana, Mississippi, Texas, Florida and Alabama as eligible for individual and public disaster assistance. Using this information we classify banks as impacted by a hurricane if their headquarter is located in a county that was eligible for individual and public disaster assistance (dark-grey shaded area in Figure 3). Next we classify banks as non-impacted if their headquarter is located in a county not affected by the 2005 hurricanes (light-grey shaded area in Figure 3). Last, we exclude banks from the

[2] Other related studies include Aggarwal and Jacques (1998); Jacques and Nigro (1997) and, for insurance companies, Shim (2010).

sample if their headquarter is located in a county eligible for public disaster assistance but not eligible for individual disaster assistance, because this criterion is ambiguous. It includes both counties that were somehow affected and counties that were very distant from the wind fields, e.g., counties in the Northwest Texas region that possibly were designated public assistance for political reasons. To guarantee that we are dealing with banks that were clearly affected or clearly not affected by the hurricanes, we exclude banks from these counties. Consequently, we are left with a clean identification of banks located in impacted counties and banks located in non-impacted counties.

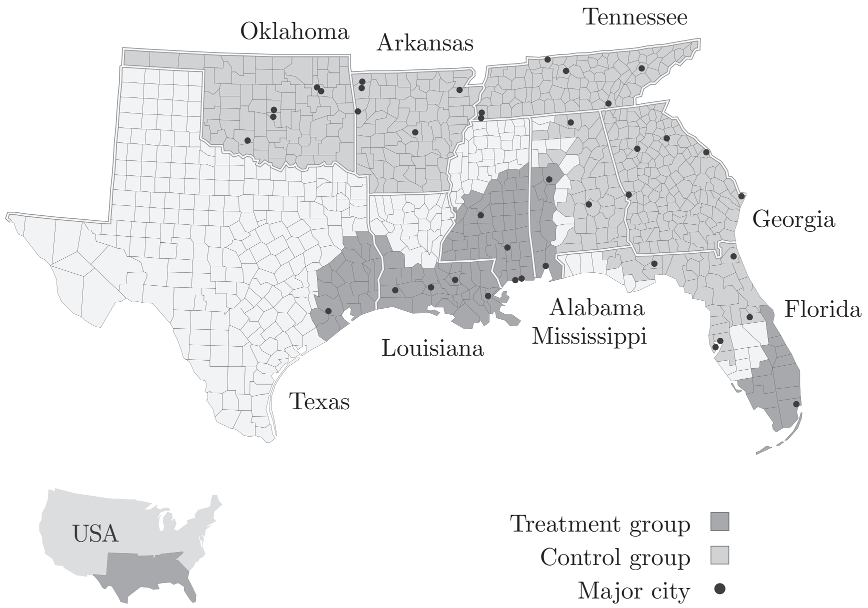


Figure 3: 2005 hurricane disaster areas

This figure shows counties in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that were impacted by Hurricane Katrina, Rita or Wilma. The dark-grey shaded area comprises counties that were eligible for individual and public disaster assistance. The light-grey shaded area comprises counties that did not get disaster assistance. The white shaded area includes counties that were eligible only for public disaster assistance.

Further, we use quarterly financial and regulatory data from the FDIC. The FDIC provides "Reports of Income and Condition" (Call Reports) that include detailed balance sheet and income statement data for all commercial and domestic banks in the United States (FDIC, 2010). The data refer to individual FDIC-insured institutions and are not consolidated for banking groups. We are interested in the banks in Louisiana, Mississippi, Texas, Florida, Alabama, Oklahoma, Georgia, Arkansas and Tennessee that existed when the hurricanes occured in the third and fourth quarters of 2005. Our main analysis covers the period from the third quarter of 2003 to the fourth quarter of 2007. We exclude observations after 2007 to avoid measuring effects of the financial crisis 2007-2009.

Previous studies that also used the FDIC data set found that some of the data is erroneous or includes banks that are not "viable". Therefore, we follow Berger and Bouwman (2009) and exclude banks that (1) have no commercial real estate or commercial and industry loans outstanding, (2) have zero or negative equity capital, (3) hold assets below $25 million or (4) hold consumer loans exceeding 50 % of gross total assets.[3] Further, we winsorize very high *total risk-based capital ratios* at 40 percent, which represents five times the regulatory requirement of 8 percent. We also want to exclude biases from newly founded banks and therefore require banks' existence 2 years before the event took place.

Finally, we believe that capital decisions are largely taken on the bank holding level and not on the individual institution level.[4] Accordingly, we do not expect a significant impact of the hurricane on capital decisions of banks that are part of a larger banking group such as Bank of America, Citigroup or Wachovia. Our main regressions therefore only include independent banks that are not part of a bank holding group. The independent banks in our sample typically operate regionally. Technically, we require that the FDIC data field that denotes a bank holding company is left blank. The final data set includes 317 banks of which we classify 118 as impacted and 199 as non-impacted by the 2005 hurricanes.

2.1 Bank asset risks

Our main explanatory variable for bank capital ratios is bank asset risk. Measures for bank asset risks that are frequently used in the literature are the change in *risk-weighted assets* (e.g., Avery and Berger, 1991), the standard deviation of *return over assets* (e.g., Laeven and Levine, 2009, who then calculate a bank z-score) or the standard deviation of *(unlevered)*

[3] Some further exclusion criteria used by Berger and Bouwman (2009) are not relevant for our sample.

[4] Bank holding companies function as an internal capital market that permits banks to "allocate scarce capital among their various subsidiaries" (Houston *et al.*, 1997). Further, capital allocation within bank holding groups is also based on explicit and implicit guarantees (James *et al.*, 1996; Froot and Stein, 1998).

stock price returns (e.g., Gropp and Heider, 2010). In our study we depart from using these traditional measures because these measures cause endogeneity concerns. For example, *total risk-based capital ratio* on the left hand side of the model by definition reflects *risk-weighted assets*. Further, banks typically determine their asset risk and capital ratio simultaneously.

The measure we use for bank asset risk, or, more precisely, changes in a bank's asset risk, is the exogenous variation introduced by Hurricane Katrina, Rita and Wilma, which exposed banks in the U.S. Gulf Coast areas to unexpected losses and increased credit risk in the second half of 2005. We are thus able to identify the causality of the relationship, and we are able to evaluate whether a shock on the banks' portfolio risk induces banks to adapt their *total risk-based capital ratio*.

2.2 Bank capital ratios

The main dependent variable that we use in our estimations is the *total risk-based capital ratio* as reported for each bank at the end of each quarter in the FDIC database. The regulatory capital ratio is represented by the sum of the bank's *Tier 1 capital* and *Tier 2 capital* divided by its *risk-weighted assets*.[5] Risk weights are defined by risk-sensitivity in accordance with the relevant Basel accord. The banks in our sample operate in a Basel I environment. Consequently they can assign risk weights corresponding to five different categories which range between zero and 100 percent. For example, U.S. government securities have a risk weight of zero, uncovered mortgage loans have a risk weight of 50 percent, and commercial loans have a risk weight of 100 percent. Banks are required to hold capital equal to 8% of risk-weighted assets.

2.3 Summary statistics

We present the mean values and standard deviation for all variables used in the analysis in Table 1.[6] The descriptive statistics are calculated separately for impacted and non-impacted

[5]For some banks, the denominator also includes Tier 3 capital allocated for market risk, net of all deductions. For details, see "Schedule RC-R – Regulatory Capital" by the FDIC.

[6]A description of the FDIC data that we use in our study is provided in the appendix in Table 10.

banks. We observe that both, impacted and non-impacted banks, hold relatively similar levels of *total risk-based capital ratio* for the ± 2 year period around the event. We observe the same pattern for the *tier capital to asset ratio* whereas the mean value for banks' *risk-weighted assets to assets* is higher for the non-impacted group. Concerning profitability (RoA) banks that were not impacted by the hurricanes were more profitable during this period. While we find very similar ratios of non-performing loans for both groups, banks in the impacted regions tend to hold a larger share of their assets in U.S. government securities and a smaller part in loans than banks in the non-impacted regions. Last, the banks that were hit by the hurricanes in 2005 are larger measured by the number of employees.

In general we see that banks hold levels of capital exceeding the regulator minimum of 8 percent. The banks in our sample hold substantial buffers as a cushion against insolvency. *Total risk-based capital ratios* range around 19 percent. This observation is in line with Flannery and Rangan (2008) who report high ratios for the U.S. and Barth *et al.* (2005); Berger *et al.* (1995) who examine high cross-country ratios. Barrios and Blanco (2003) point market forces rather than the implicit cost of regulation as a possible explanation for recent developments and thus the high ratios in our sample.

[Table 1]

3 Identification strategy and empirical model

To assess how a shock on a bank's asset risk affects a bank's capital structure decision, we need to consider potential parallel macroeconomic and industrywide factors that effect all banks, independent from the shock. It would be misleading to simply test how impacted banks adapt their *total risk-based capital ratios* after the event. Another concern is that unobservable bank characteristics may influence our analysis. To account for both aspects, we use a difference-in-difference estimation technique with bank fixed effects.

3.1 Difference-in-difference identification

Ideally, we could compare our observations on the capital ratios of a bank impacted by Hurricane Katrina with a bank's hypothetical capital ratio in case the bank had not been exposed to the hurricane. To do so, let DIS be a binary variable indicating whether the bank i is impacted ($DIS = 1$) or is not impacted ($DIS = 0$) at time t. Let $y^1_{i,t+1}$ represent the value for the *total risk-based capital ratio* of bank i in $t+1$ after Hurricane Katrina (Rita and Wilma) at time t. $y^0_{i,t+1}$ represents the hypothetical adaption of *total risk-based capital ratios* of bank i in time $t+1$ had the bank not gone through a hurricane. The effect of Katrina on average *total risk-based capital ratios* for bank i, classified in the evaluation literature as the average treatment effect on the treated (see, for example, Angrist and Pischke, 2009), can be formally stated as:

$$ATT = E(y^1_{i,t+1}|DIS = 1) - E(y^0_{i,t+1}|DIS = 1).$$

The term $E(y^1_{i,t+1}|DIS = 1)$ represents the expected value for the *total risk-based capital ratio* of an impacted bank i in $t + 1$ after Hurricane Katrina at time t. This term can be identified through the observed average effect on total risk-based capital for banks that were impacted by Katrina. For this sample of impacted banks, the term $E(y^0_{i,t+1}|DIS = 1)$ represents the counterfactual expected mean or hypothetical effect on the *total risk-based capital ratio* assuming these banks were initially not impacted by the hurricane. This effect being unobservable represents the central problem of causal inference (Holland, 1986). Therefore, $E(y^0_{i,t+1}|DIS = 1)$ needs to be approximated.

In experimental studies, the identification problem is typically solved through random assignment for both groups, the treated and the control group. When treatment is randomized across individuals, self selection biases are excluded such that the mean independence assumption holds:

$$E(y^1_{i,t+1}|DIS = 1) = E(y^1_{i,t+1}) = E(y^0_{i,t+1}|DIS = 1) = E(y^0_{i,t+1}).$$

In non-experimental studies, there is no "direct estimate of the the counterfactual mean", such that researchers must construct quasi-experiments to identify the causal effect (Dehejia and Wahba, 2002). We do so by exploiting exogenous variation from Hurricane Katrina. This natural disaster randomly selected banks into a treatment group (impacted by Katrina) and a control group (not impacted by Katrina), such that $E(y^0_{i,t+1}|DIS = 1)$ can be identified by measuring the observed average effect on *total risk-based capital ratios* of the control group.

Now, simply comparing both the treatment and the control group post the event could be misleading because trajectories of total risk-based capital could already point in different directions for the treatment and control group before the hurricane. Therefore, we rely on a difference-in-difference estimation that compares the ratio of the total risk-based capital after treatment both to the treatment group before treatment and to the control group.

To alleviate potential biases we have to guarantee that the parallel trend assumption prior to the treatment is satisfied. In other words, the *total risk-based capital ratios* should follow a similar trend for the treatment group and the control group. Analogous to previous studies (see, e.g., Meyer *et al.*, 1995; Zarutskie, 2006), we graphically inspect the trend of mean total risk-based capital for both groups, as shown in Figure 2, and confirm the parallel trend assumption.

3.2 Baseline estimation

In applying a difference-in-difference estimation technique, we estimate whether higher capital ratios are systematic and can be attributed to the hurricane. Formally, we estimate the following equation:

$$CAP_{it} = \beta_0 + \beta_1 Event_t + \beta_2 Impacted_i + \beta_3 (Event_t * Impacted_i) + \tau_\gamma + \epsilon_{it}. \qquad (1)$$

For our baseline estimation, the dependent variable CAP_{it} is the *total risk-based capital ratio* of bank i at time t. Our event window is the third and fourth quarter of 2005. Thus, the variable $Event_t$ is a time dummy with a value of zero for all quarters before the hurricane season ($t \leq$ Q2 2005) and a value of one for all quarters after the hurricane season ($t \geq$ Q1 2006).

The variable $Impacted_i$ is a dummy variable of bank i that is one if the bank is located in a county classified by the FEMA as "disaster area" and thus belongs to the treatment group, and zero otherwise such that the bank is assigned to the control group. The interaction term $Event_t * Impacted_i$ is one if both the variable $Event_t$ and the variable $Impacted_i$ amount to one, and zero otherwise. The corresponding coefficient β_3 is our main interest. It captures the average effect of the hurricane on the *total risk-based capital ratios* of impacted banks.

The variable τ_γ represents yearly time fixed effects (Time FE), and ϵ_{it} is the idiosyncratic error term. To account for heterogeneity at the bank level, we use clustered standard errors at the bank level.

Further, we are concerned that unobserved differences between banks may influence our results. Thus, we include fixed effects ν_i for each bank i (Bank FE). Inclusion of bank fixed effects interferes with the dummy variable $Impacted_i$. Hence, compared to our baseline estimation in Equation 1, bank fixed effects ν_i replace $Impacted_i$:

$$CAP_{it} = \beta_0 + \beta_1 Event_t + \beta_3 (Event_t * Impacted_i) + \tau_\gamma + \nu_i + \epsilon_{it}. \tag{2}$$

Finally, we reestimate our baseline estimation by including control variables that are common in the banking literature (see, e.g., Gropp and Heider, 2010; Rime, 2001; Shrieves and Dahl, 1992). In particular, we include bank size represented by the *log of total number of employees*, the ratio of *non-performing loans to assets* and the *return over assets* (RoA).[7,8] Note that these control variables only matter for the estimation to the degree that they are time-variant because they are otherwise already included in the bank fixed effects.

[7]For example, bank size is generally found to be an important factor for banks to operate with less capital (Demsetz and Strahan, 1997; Jayaratne and Morgan, 2000).

[8]Results remain remain qualitatively the same if we use total assets instead of employees for size effects and RoE instead of RoA as performance indicator.

4 Effects of asset risks on regulatory capital ratios

4.1 Main results

We present our main results in Table 2. The difference-in-difference estimation of Equation 1 is shown in Column 1. As regards our main variable of interest, the interaction term $Event * Impacted$, we observe a positive and significant coefficient which shows that impacted banks increase their capital ratios after the hurricane. This effect is also highly economically significant. Impacted banks have a *total risk-based capital ratio* that is on average 1.15 percentage points higher than the ratio of non-impacted banks after the hurricane events, as shown by the point estimate of the interaction term.

Next, results including bank fixed effects (Equation 2) are shown in Column 2. Interestingly, we find that even when we include bank fixed effects in our regression that explain a lot of the variation in *total risk-based capital ratios* (note the adj. R2 of 0.885), the result remains robust. The inclusion of bank fixed effects even increases the significance of the interaction term compared to our baseline estimation. The significant average effect of the hurricane on impacted banks' *total risk-based capital ratios* is slightly reduced to 1.0 percentage points, which is within the same range as before. This suggests that though unobserved time-invariant bank-specific factors are important, a change in the risk environment of the bank is highly relevant for a bank's capital ratio.

Last, we include additional bank characteristics regarded as the relevant for banks' *total risk-based capital ratios*. We find that size approximated by employees and profitability (RoA) slightly add explanation to our regression, but foremost, they leave the effect of the interaction term intact.

This first set of results strongly advocates that banks react when confronted with a shock that increases the economic risk in their business region. They do this by increasing their (regulatory) capital ratio relative to banks that do not experience this shock. Relating this observation to the regulatory required lower bound of 8%, the results suggest that banks are driven by motives besides the rules set by the regulator. With some caution, the attained higher *total risk-based capital ratios* may reflect the same risk-return profiles banks had before the 2005 hurricanes. In other words, our results suggest that banks re-establish their bank specific cushion against insolvency, and they are not purely reacting to regulatory capital requirements.

[Table 2]

4.2 Relevance of different time horizons

In the previous section, we established our main result for the period of ± 2 years around the event. An intuitive next step is to further investigate whether this effect differs for different time horizons around the event. Therefore, Table 3 shows results for the estimation of Equation 2 for the periods of 4, 6, 8 and 10 quarters around the hurricane event.

We find that the effect on banks' *total risk-based capital ratios* disappears for the shortest period (the coefficient is positive but not statistically significant). Expanding the time period around the event to periods larger than one year, the effect is significant. This suggests that banks require some time to adjust to the new risk environment and to build up their *total risk-based capital ratios.* Furthermore, we find that the statistical significance is weaker for a period of ± 10 quarters. This can be explained by two aspects. First, uncertainty about the economic prospects of the region may have diminished more than two years after the hurricanes. Second, effects of the financial crisis that started in 2007 affected both the banks in our treatment as well as the banks in our control group. Thus, it is likely that the consequences of the financial crisis dominated externalities of the 2005 hurricanes.

[Table 3]

4.3 Time placebo estimation

The possibility that the results are driven by time trends unrelated to Hurricane Katrina, Wilma or Rita needs to be ruled out. We therefore run a "placebo estimation" where we shift our treatment from the third and fourth quarter of 2005 to the third and fourth quarter of 2002. We then re-run the estimation for observations two years before and after this "2002 pseudo hurricane". Table 4 shows the results for this analysis, which can be directly compared to our baseline results in Table 2. We do not find an effect for the 2002 pseudo hurricane in any of our baseline specifications. This supports our assumption that our results are not driven by factors unrelated to the 2005 hurricanes.

[Table 4]

4.4 Relevance of potential credit demand effects

Because we are interested in bank behavior, we have to rule out that our results mainly reflect a shortfall in credit demand after the 2005 hurricanes, which technically would also lead to higher regulatory capital ratios for banks in impacted areas.[9] To mitigate such concerns, we make three observations: First, the Federal Reserve Bank of Atlanta stated in its 2005 annual report that they expected credit demand to increase in the aftermath of the hurricanes (Federal Reserve Bank of Atlanta, 2005). Thus, a shortfall in credit demand is unlikely short-term and also over the two year period that we examine. Second, even if a shortfall in credit demand had taken place, the market for corporate securities and credit derivatives, which had grown substantially until 2005, allowed banks to substitute for a potential shortfall in regional credit demand. Third, as a robustness check, we examine the effect of the hurricane on the regulatory capital ratio of banks that belong to a bank holding company (BHC banks). On the one hand, impacted BHC banks should be affected likewise as the impacted independent banks in our main sample, especially as regards a potential credit demand effect. On the other hand, we do not expect that BHC banks actively adjust their capital ratios, because implicit and explicit guarantees within the bank holding company make it unnecessary for the bank holding company to react on the level of the individual bank. In fact, when we re-estimate Equation 2 for the sample of BHC banks, we do not find a significant effect of the hurricane on the capital ratio of impacted banks (i.e., our coefficient of interest, β_3, is not significant).[10] In

[9] Remember that a bank's *total risk-based capital ratio* is calculated as its total Tier 1 and Tier 2 capital over its risk-weighted assets. Risk-weighted assets often substantially reflect consumer and commercial loans.
[10] The according table is not reported in this version of the paper but available upon request.

summary, these observations suggests that, besides immediate direct effects of the hurricane such as write-offs, independent banks actively chose new optimal capital ratios following the 2005 hurricanes.

4.5 Additional robustness checks

This sections briefly discusses further robustness checks that underpin the reliability of our main results.[11]

First, to show that our results do not only hold for the *total risk-based capital ratio*, we conduct an equivalent analysis as the above for an alternative measure of regulatory capital, the *Tier 1 risk-based capital.* Estimates for this measure remain robust.

Second, we examine if the composition of the control group changes our main results, which are based on a sample with 118 impacted banks in Louisiana, Mississippi, Texas, Florida and Alabama (the treatment group) and 199 non-impacted banks in Alabama, Florida, Georgia, Tennessee, Arkansas and Oklahoma (the control group). For the robustness check, we adapt the control group in the following way: First, we restrict the sample to banks in the core states of the hurricanes, i.e., Louisiana, Mississippi, Texas, Florida and Alabama, and thus exclude banks in Georgia, Tennessee, Arkansas and Oklahoma from the control group. Second, we extend the sample by banks in further U.S. Southeast neighbor states, i.e., South Carolina and North Carolina, and thus include banks from these states in the control group. We then re-run our main regression for both alternative control groups and find that the effect of Hurricane Katrina on the *total risk-based capital ratio* of impacted banks remains positive and significant.

Third, in order to show that the results are robust against problems with difference-in-difference technique in the presence of serial correlation, Bertrand *et al.* (2004) suggest to ignore the time structure of the data. Therefore, we average the data before and after the hurricane event and rerun the estimation for this collapsed sample. We collapse the sample for all three samples and four time periods available to us. We find that if we run the re-

[11] Again, the according tables are not reported in this version of the paper but available upon request.

gression for each collapsed sample and time horizon that our results remain intact. For the cross-section estimation we find that impacted banks increase their *total risk-based capital ratios* relative to banks not impacted by the hurricane. For a few specifications the results are signigicant at the lower level of 10%.

Fourth, results could be influenced by non-linear time trends (Bertrand *et al.*, 2004). Therefore, we re-estimate all regression and include squared time trends. Our results remain robust.

5 Behavior of low-capitalized and high-capitalized banks

Theory suggests that bank characteristics such as bankruptcy costs, franchise value and value of deposits guarantees are important determinants for bank risk-taking. Accordingly, banks choose to be more safe or more risky, which is (at least approximately) reflected in lower and higher capital ratios. Accordingly, we examine the low-capitalized banks and high-capitalized banks subsamples separately.

In order to construct these subsamples, we first calculate the average *total risk-based capital ratio* for each bank during the 8 quarters pre Katrina (Q3 2003 to Q2 2005). We then calculate the according median value of all banks, which is a *total risk-based capital ratio* of 15.9 percent. Finally, we classify all banks with an average below the median as low-capitalized and all other banks as high-capitalized. Note that even in the low-capitalized subsample, more than 95 percent of banks held an average *total risk-based capital ratio* pre Katrina above 10 percent, which is well above the required 8 percent and considered as "well capitalized" by the FDIC.[12]

We then re-estimate our baseline regression for low-capitalized and high-capitalized banks separately. Table 5 shows that results are significantly different for both subsamples. We observe that banks in our low-capitalized subsample do not alter their *total risk-based capital ratios*. To the contrary, banks in the high-capitalized subsample significantly modify their capital ratios upwards.

[12]Further requirements to be classified as "well capitalized" by the FDIC is a Tier 1 risk-based capital ratio equal to or greater than 6 percent and a Tier 1 leverage capital ratio equal to or greater than 5 percent

The analysis yields an important result: it cannot be generalized how banks react to increased asset risks. Banks that ex-ante choose to be relatively conservative (our high-capitalized subsample) take higher risks into account for their capital ratio adjustments. They seem to be driven by the motive to avoid bankruptcy under all circumstances. Banks that ex-ante choose to be more risky (our low-capitalized subsample), however, do not adjust their capital ratios. Thus, higher asset risks does not seem to play a role for their capital ratio decisions. The low-capitalized banks, which are more likely to fail anyway, do not take precautionary measures following a negative shock on their asset risks.

[Table 5]

6 Mechanisms of capital ratio adjustments

This section examines the mechanisms that are responsible for the capital ratio adjustments of banks. Banks can adjust their capital ratios in two ways. First, they can adjust their capital level (the numerator of the ratio), e.g. by raising new capital or by increasing the share of retained earnings. Second, banks can cut back their risk-weighted assets (the denominator of the ratio), e.g. by restricting the provision of new loans. We are therefore interested whether banks adjust their total capital, their risk-weighted assets, or both.

Building on the results from the previous section that high-capitalized and low-capitalized banks behave differently, we continue to examine these groups separately in this section. We do not expect that low-capitalized banks significantly adjust their capital or risk-weighted assets, but we include both groups in our analysis to get a better understanding of the full picture.

We start our analysis by focussing on the numerator of banks' *total risk-based capital ratio*, and therefore use *total tier capital over assets* as the dependent variable. We re-run the baseline regression for low- and high-capitalized banks for the four different time horizons previously reported (see Table 3). We find no significant effects for banks in either the low-capitalized group or the high-capitalized group, as shown in Table 6.[13]

[Table 6]

Next, we use *risk-weighted assets over assets* as the dependent variable and re-run our baseline regression. As shown in Table 7, we find that impacted banks of our low-capitalized group do not adjust their risky assets. However, impacted banks of the high-capitalized group decrease their risk-weighted asset significantly in the aftermath of the 2005 hurricanes. This effect is significant and economically very strong for the shortest time period while it loses strength for longer observation periods. Ten quarters after the event, the effect for the impacted high-capitalized banks is no more significant.

[Table 7]

These results corroborate our previous finding that high-capitalized banks significantly increase their *total risk-based capital ratios*, and shows that they do this by decreasing their risk-weighted assets, and not by increasing their level of capital. Results are also in line with our previous result that low-capitalized banks do not adjust their capital ratios.

We further investigate whether a reduction in *risk-weighted assets* is associated with an overall decline in banks' activities or whether banks change the composition of their asset side to face the effects of the hurricanes in the post 2005 phase. To investigate this issue, we first use banks' *gross loans over assets* as the dependent variable. As shown in Table 8, we find that impacted high-capitalized banks decrease loan business in the aftermath of the hurricane event (results for low-capitalized banks are not significant and not reported). This effect is economically in a similar range as the risky asset reduction reported in Table 7 for those banks. Also, the reduction of loans takes place within an equal time horizon and becomes insignificant for the longest period that is $\pm$ 10 quarter around the event. These results suggest that high-capitalized impacted banks become more stable in terms of their *total risk-based capital ratio* after the event by reducing their loan supply.

[13] In unreported regressions we also check whether we find an effect on dividends or retained earnings after the hurricane events in 2005. Again, we do not find any significant effect for either low- or high-capitalized impacted banks.

[Table 8]

Next, we explore several other balance sheet figures that are related to a bank's *risk-weighted assets*. Interestingly, we find that impacted high-capitalized banks increase their investments in risk-free U.S. government securities post the 2005 hurricanes, as shown in Table 9 (again, results for low-capitalized banks are not significant and not reported). Economically this effect is very similar to the reduction of loans to assets but positive, and thereby roughly offsets the loan reduction.

[Table 9]

These results are also meaningful as regards potential concerns that the observed reduction of *risk-weighted assets* is demand driven, as already discussed in Section 4.4. Note that a shortfall of demand would be also present for low-capitalized banks that operate in the hurricane regions. As shown in this section, we find no such significant effect for impacted low-capitalized banks. Thus, this finding further strengthens the interpretation that our results reflect the behavior of banks, not the economic conditions in the hurricane regions.

To conclude, high-capitalized banks that were impacted by the 2005 hurricanes did not significantly adjust their capital levels. However, they reacted to the higher asset risks by shifting investments from risky loans to risk-free U.S. government securities, and thereby increase their capital ratios. We find that these effects are significant and economically relevant in a period of $\pm$ 2 years around the events. Over a longer horizon we do not find significant effects.

7 Conclusion

In this paper, we conduct the first empirical assessment of the impact of banks' asset risks on their capital ratios using a natural experiment. We therefore examine effects of Hurricane Katrina, which exposed banks in the U.S. Gulf Coast region to unexpected losses and increased credit risks in August 2005. This allows us to identify a causal relationship between asset risk and capital ratios, which is otherwise difficult because of mutual influences and feedback effects. A better understanding of this relationship is important because capital ratios are a key factor in banking regulation.

We find that a shock that increases banks' credit risk, measured as the impact of Hurricane Katrina, induces impacted banks to increase their capital ratios relative to the banks in the control group (not impacted by the hurricane). Impacted banks thereby strengthen their buffer against future income shocks and mitigate bankruptcy risks. This shows that asset risk is an important determinant of bank capital ratios besides any regulatory requirements.

However, when we examine low-capitalized and high-capitalized banks separately, we only find a significant effect for high-capitalized banks. This demonstrates that the risk-taking behavior of banks cannot be generalized for all banks but depends on bank characteristics. Based on existing research, relevant bank characteristics could be a bank's franchise value, its bankruptcy costs, and/or the value of its deposits guarantees.

Furthermore, we find that the high-capitalized banks that increase their capital ratios do this by reducing their risk-weighted assets and not by increasing their capital levels. In particular, these banks shift their investments from risky loans to risk-free U.S. government securities. This has ambiguous effects for the economy: Banks become more stable, which has positive effects, but firms may suffer from a lower credit supply.

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A Tables

Table 1: Descriptive statistics

	Impacted		Non-impacted	
	Mean	SD	Mean	SD
Total risk-based capital ratio	0.1867	0.0771	0.1851	0.0804
Risk-weighted assets/Assets	0.6003	0.1754	0.6690	0.1556
Tier capital/Assets	0.1083	0.0409	0.1180	0.0417
RoA	0.0088	0.0094	0.0097	0.0091
Non-perf. loans/Assets	0.0013	0.0022	0.0014	0.0023
U.S. Gov. securities/Assets	0.1928	0.1606	0.1793	0.1588
Total loans/Assets	0.6321	0.1852	0.6642	0.1733
No. of employees	104	250	63	176
N. of Banks	118		199	
N. of Obs.	1814		3233	

Notes: This table shows descriptives statistics for all variables use in later analyses. We provide mean values and standard deviations for banks that belong to counties that were affected by the hurricanes (impacted) and banks operating in counties unaffected by the event (non-impacted). Variables are defined as follows: Total risk-based capital ratio represents bank's total risk based capital to its risk-weighted assets; Risk-weighted assets/Assets is the ratio of risk-weighted assets to total assets; Tier capital/Assets relates the sum of bank's tier 1 and tier 2 capital to total assets; RoA is bank's return over assets; Non-perf. loans/Assets shows the ratio of total assets past due 90 or more days and still accruing interest to bank's total assets; Total loans/Assets is the ratio of bank's total (gross) loans to total assets; No. of employees is the number of full-time employees on the payroll of the bank and its subsidiaries at the end of the quarter. The sample consists of 118 impacted banks and 199 non-impacted banks. Mean values are calculated for a window of ± two years around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. Furthermore, a very detailed description of all variables with FDIC codes is given in Table 10.

Table 2: Main results

	Total risk-based capital ratio		
Event	-0.0052*	-0.0104***	-0.0054*
	(0.0661)	(0.0005)	(0.0909)
Impacted	-0.0033		
	(0.7185)		
Event*Impacted	0.0115*	0.0101**	0.0092**
	(0.0543)	(0.0452)	(0.0404)
RoA			-0.6479*
			(0.0725)
Non-perf. loans/Assets			0.2056
			(0.6435)
Log (No. of employees)			-0.0544***
			(0.0000)
Constant	0.1855***	0.1868***	0.3915***
	(0.0000)	(0.0000)	(0.0000)
Bank FE	No	Yes	Yes
Time FE	Yes	Yes	Yes
N. of Obs.	4452	4452	4452
adj. R2	0.0012	0.885	0.8981

Notes: This table shows results for regressions of Equation 1 and 2 in which bank's Total risk-based capital ratio is the dependent variable. Event is a dummy variable that is 0 for the pre hurricane period and 1 after the event. Impacted is a dummy variable that separates bank's in counties that were affected by the hurricane (1) and those that were unaffected (0). Event*Impacted is a interaction term of the variables Event and Impacted. RoA is bank's return on assets. Non-perf. loans/Assets shows the ratio of total assets past due 90 or more days and still accruing interest to bank's total assets and Log (No. of employees) is the natural logarithm of bank's number of employees. A very detailed description of all variables with FDIC codes is given in Table 10. Regressions presented in this table are for the period of ± two years around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We also include bank fixed effect (Bank FE) and year dummies (Time FE) in the regressions.

Table 3: Relevance of different time horizons

	Total risk-based capital ratio			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	-0.0069***	-0.0097***	-0.0104***	-0.0137***
	(0.0013)	(0.0005)	(0.0005)	(0.0000)
Event*Impacted	0.0059	0.0078*	0.0101**	0.0102*
	(0.1565)	(0.0873)	(0.0452)	(0.0564)
Constant	0.1856***	0.1864***	0.1868***	0.1868***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N. of Obs.	2306	3391	4452	5479
adj. R2	0.9342	0.9112	0.8850	0.8710

Notes: This table shows results for regressions of Equation 2 in which bank's Total risk-based capital ratio is the dependent variable. Variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 4: Placebo event

	Total risk-based capital ratio		
Event	-0.0045	-0.0113***	-0.003
	(0.2080)	(0.0035)	(0.4281)
Impacted	-0.0063		
	(0.5385)		
Event*Impacted	0.0026	0.0011	0.0017
	(0.6857)	(0.8445)	(0.7428)
RoA			-1.3934***
			(0.0000)
Non-perf. loans/Assets			-0.5616
			(0.1985)
Log(No. of employees)			-0.0395***
			(0.0066)
Constant	0.1973***	0.1959***	0.3470***
	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
N. of Obs.	4284	4284	4284
adj. R2	0.0032	0.8490	0.8735

Notes: This table shows results for regressions of Equation 1 and 2 in which bank's Total risk-based capital ratio is the dependent variable. Event is a dummy variable that is 0 before the third quarter of 2002 and 1 after the fourth quarter of 2002 (the placebo event). Impacted is a dummy variable that separates bank's in counties that were affected by the hurricane (1) and those that were unaffected (0). Event*Impacted is a interaction term of the variables Event and Impacted. All other variables are defined as in Table 2. Regressions presented in this table are for the period of ± two years around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 5: Results for low- vs. high-capitalized banks (Total risk-based capital ratio)

	Low-capitalized banks Total risk-based capital ratio				High-capitalized banks Total risk-based capital ratio			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	0.0035	0.0029	0.0037	0.0034	-0.0163***	-0.0207***	-0.0225***	-0.0268***
	(0.1252)	(0.2706)	(0.1735)	(0.2707)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Event*Impacted	0.0002	0.0018	0.0033	0.0035	0.0128**	0.0145**	0.0175**	0.0169**
	(0.9625)	(0.7281)	(0.5422)	(0.5393)	(0.0288)	(0.0368)	(0.0276)	(0.0486)
Constant	0.1293***	0.1294***	0.1293***	0.1290***	0.2402***	0.2405***	0.2404***	0.2403***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of Obs.	1142	1667	2174	2810	1153	1703	2241	2887
adj. R2	0.5838	0.5321	0.4592	0.4244	0.9215	0.8831	0.8448	0.8154

Notes: This table shows results for regressions of Equation 2 in which bank's Total risk-based capital ratio is the dependent variable. The left side of this table includes banks that are low-capitalized banks, i.e., their level of Total risk-based capital ratios if below the sample median before the hurricane event. The right side includes all banks that show ratios above the median before the hurricane event. All variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 6: Results for low- vs. high-capitalized banks (Tier capital/Assets)

	Low-capitalized banks Tier capital/Assets				High-capitalized banks Tier capital/Assets			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	0.0023	0.002	0.0029*	0.0034*	-0.0055***	-0.0058**	-0.0060**	-0.0070***
	(0.1137)	(0.2076)	(0.0632)	(0.0666)	(0.0037)	(0.0143)	(0.0206)	(0.0079)
Event*Impacted	0.0001	0.0011	0.002	0.0022	0.0012	0.0024	0.0045	0.004
	(0.9766)	(0.7383)	(0.5385)	(0.5114)	(0.7706)	(0.6340)	(0.4333)	(0.5162)
Constant	0.0925***	0.0926***	0.0924***	0.0922***	0.1345***	0.1346***	0.1345***	0.1343***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of Obs.	1142	1667	2174	2810	1153	1703	2241	2887
adj. R2	0.8189	0.8029	0.7743	0.7327	0.8776	0.8413	0.7781	0.7399

Notes: This table shows results for regressions of Equation 2 in which bank's Tier capital to asset ratio is the dependent variable. The left side of this table includes banks that are low-capitalized banks, i.e., their level of Total risk-based capital ratios if below the sample median before the hurricane event. The right side includes all banks that show ratios above the median before the hurricane event. All variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 7: Results for low- vs. high-capitalized banks (Risk-weighted assets/Assets)

	Low-capitalized banks Risk-weighted assets/Assets				High-capitalized banks Risk-weighted assets/Assets			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	-0.0006	0.0036	0.0083	0.0121	0.0209***	0.0315***	0.0338***	0.0356***
	(0.9273)	(0.6494)	(0.3042)	(0.1546)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Event*Impacted	0.0012	-0.001	-0.0028	-0.0041	-0.0305**	-0.0292**	-0.0267*	-0.0215
	(0.9194)	(0.9322)	(0.8372)	(0.7823)	(0.0168)	(0.0396)	(0.0783)	(0.1636)
Constant	0.7135***	0.7136***	0.7134***	0.7134***	0.5760***	0.5755***	0.5752***	0.5742***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. of Obs.	1142	1667	2174	2810	1153	1703	2241	2887
adj. R2	0.9392	0.9256	0.9041	0.8838	0.9254	0.9016	0.8857	0.8632

Notes: This table shows results for regressions of Equation 2 in which bank's Risk-weighted assets to asset ratio is the dependent variable. The left side of this table includes banks that are low-capitalized banks, i.e., their level of Total risk-based capital ratios if below the sample median before the hurricane event. The right side includes all banks that show ratios above the median before the hurricane event. All variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 8: Results for high-capitalized banks (loans)

	High-capitalized banks Total loans/Assets			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	0.0283***	0.0357***	0.0394***	0.0456***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Event*Impacted	-0.0351***	-0.0317**	-0.0248*	-0.0165
	(0.0040)	(0.0206)	(0.0984)	(0.3074)
Constant	0.5568***	0.5562***	0.5560***	0.5555***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N. of Obs.	1153	1703	2241	2887
adj. R2	0.9491	0.9337	0.9192	0.9000

Notes: This table shows results for regressions of Equation 2 in which bank's Total loans to asset ratio is the dependent variable. The regressions only include banks that are high-capitalized, i.e., show ratios of Total risk-based capital above the median before the hurricane event. All variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 9: Results for high-capitalized banks (government securities)

	High-capitalized banks U.S. Gov. securities/Assets			
	± 4 quarter	± 6 quarter	± 8 quarter	± 10 quarter
Event	-0.0165**	-0.0323***	-0.0327***	-0.0514***
	(0.0151)	(0.0003)	(0.0003)	(0.0000)
Event*Impacted	0.0312**	0.0310**	0.0279*	0.0251
	(0.0117)	(0.0262)	(0.0606)	(0.1079)
Constant	0.2626***	0.2635***	0.2637***	0.2634***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N. of Obs.	1153	1703	2241	2887
adj. R2	0.9346	0.9184	0.9057	0.8885

Notes: This table shows results for regressions of Equation 2 in which either bank's Total loans to asset ratio (left panel) U.S. Gov. securities to asset ratio (right panel) is the dependent variable . Both panels only include banks that are high-capitalized, i.e., show ratios of Total risk-based capital above the median before the hurricane event. All variables are defined as in Table 2. Regressions presented in this table are for the periods of ± 4, 6, 8 and 10 quarters around the event. The sample includes all banks in Alabama, Louisiana, Mississippi, Florida, Texas, Georgia, Tennessee, Arkansas and Oklahoma that are independent, i.e., do not belong to a bank holding company. We include bank fixed effect (Bank FE) and year dummies (Time FE) in each regression.

Table 10: Detailed variable description

Variable name	FDIC code	Description
Total risk-based capital ratio	rbcrwaj	Total risk based capital to risk-weighted assets as defined by the appropriate federal regulator for prompt corrective action during that time period.
Risk-weighted assets/Assets	rwaj/asset	Risk weighted assets-adjusted is based on the risk-based capital definitions for prompt corrective action (PCA) and includes: Call Reporters: Gross risk weighted assets (includes mkt risk equivalent assets) - disallowed ln&ls allowance (allowance for ln&ls minus rbc-limited ln&ls allowance) allocated transfer risk reserve + unrealized loss on equity securities. Thrift Financial Reporters: Total risk based capital + fully capitalized items * 12.5 - unrelaized holding gains or losses on available-for-sale. The sum of all assets owned by the institution including cash, loans, securities, bank premises and other assets. This total does not include off-balance-sheet accounts.
Tier capital/Assets	(rbct1j+rbct2)/asset	Tier 1 (core) capital includes: common equity plus noncumulative perpetual preferred stock plus minority interests in consolidated subsidiaries less goodwill and other ineligible intangible assets. The amount of eligible intangibles (including mortgage servicing rights) included in core capital is limited in accordance with supervisory capital regulations. Risk-based capital-tier 2 is based on the risk-based capital definitions for prompt corrective action (PCA). Includible Tier 2 capital components consist of, but are not limited to, limited subordinated debt, cumulative perpetual preferred stock, allowance for loan and lease losses, total mandatory convertible debt and a portion of unrealized gains on available-for-sale equity securities. The maximum amount of supplementary capital elements that qualify as Tier 2 capital is limited to 100 percent of Tier 1 capital. In addition, the combined maximum amount of subordinated debt and intermediate-term preferred stock that qualifies as Tier 2 capital is limited to 50 percent of Tier 1 capital.
RoA	roa	Net income after taxes and extraordinary items (annualized) to average total assets.
Non-perf. loans/Assets	p9asset/asset	Total assets past due 90 or more days and still accruing interest. Total assets include real estate loans, installment loans, credit cards and related plan loans, commercial loans and all other loans, lease financing receivables, debt securities and other assets.
U.S. Gov. securities/Assets	scus/asset	Total U.S. Treasury securities plus U.S. Government agency and corporation obligations. Beginning January 1, 1994, this item consists of both securities designated as held-to-maturity, reported at amortized cost, and securities designated as available-for-sale, reported at fair market value. Includes U.S. government issued or guaranteed mortgage-backed securities. Includes securities held in trading accounts for TFR Reporters.
Total loans/Assets	lnlsgr /asset	Total loans and lease financing receivables, net of unearned income.
No. of employees	numemp	The number of full-time employees on the payroll of the bank and its subsidiaries at the end of the quarter.

Notes: The source for all variables as well as its descriptions is the FDIC.