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Loan Loss Reserves, Regulatory Capital, and Bank Failures: Evidence from the Recent Economic Crisis

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Abstract

Using a sample of bank failures over the period 2008-2010, we analyze the role of different types of regulatory capital in providing a buffer against failure risk. We report three key findings. First, we document that bank failure risk is negatively associated with Tier 1 capital, but positively associated with Tier 2 capital, which consists primarily of loan loss reserves. The results suggest that, contrary to the conventional notion of capital, a higher level of Tier 2 capital does not necessarily provide a buffer against deteriorating economic conditions. Second, the quality of Tier 2 capital is weaker (that is, its positive association with failure risk is higher) when banks report unusually large increases in loan loss reserves. Finally, the negative influence of unusually large loan loss reserves on the quality of Tier 2 capital is more pronounced for banks that are less constrained in adding back such reserves as Tier 2 capital, banks that have poorer audit quality and banks in which agency problems are more severe. Overall, our results suggest that Tier 2 capital is of low quality when banks use loan loss reserves to manage regulatory capital upwards.

Keywords: bank failure, bank risk, regulatory capital, capital adequacy, loan loss reserves, loan loss provisions, loan charge-offs

JEL Codes: G21, G28, G32, G38, M41, M48

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I. Introduction

In contrast to the common wisdom that greater capital lowers bank failure risk, this paper deals with the issue of whether certain components of bank regulatory capital can *increase* the probability of bank failure. In particular, we focus on the regulatory capital guideline that allows loss reserves to be considered as capital. Under this guideline, a bank can add back its loan loss reserves, which are cumulative accrued loan losses, as Tier 2 capital. Our paper documents that in contrast to Tier 1 capital, Tier 2 capital is positively associated with the risk of bank failure during the recent economic crisis that precipitated widespread bank failures from 2008 to 2010. The positive association between Tier 2 capital and bank failure suggests that, contrary to the conventional notion of capital, a higher level of Tier 2 capital does not necessarily provide a buffer against deteriorating economic conditions. Further, the positive association between Tier 2 capital and failure risk is stronger when banks report increases in loan loss reserves that (a) are larger than warranted given the banks' non-performing loans, and (b) are likely to reflect upward capital management.

For US commercial banks, Tier 2 capital primarily consists of loan loss reserves.[1] The treatment of loan loss reserves (i.e., accrued loan losses) as capital has received considerable attention in the wake of the financial crisis. In speaking at the American Bankers Association meeting on March 17, 2010, Comptroller of the Currency John Dugan argued for the relaxation of restrictions on the inclusion of loan loss reserves as capital, to encourage banks to report adequate and timely reserves. On the following day of that same meeting, Federal Deposit Insurance Corporation (FDIC) Chairperson Sheila Bair contested this view, arguing that "letting more reserves count [towards capital] could dramatically, in our view, dilute the quality of capital." She also referenced the late L. William Seidman, former chairman of the FDIC, in

[1] The primary component of Tier 1 capital for US commercial banks is shareholders' equity.

saying that the rationale for adding back reserves as capital was ambiguous. Bankers have lobbied vigorously in favor of increasing the limit to which loan loss reserves can contribute towards Tier 2 capital. In an oral statement to the Domestic Policy Subcommittee of the U.S. House Oversight and Government Reform Committee on November 2, 2009, Joe Brennan, President and CEO of the Georgia Bankers Association argued for a higher limit on the loan loss reserves to be counted as regulatory capital. He stated that "76% of all Georgia banks were adversely affected by the restriction" and "that billions in capital among Georgia banks would be freed up to support more lending if the limit were suspended".[2]

Increases in loan loss reserves generally reduce net income and consequently, Tier 1 capital. Bank regulations allow the add-back of reserves as Tier 2 capital under the regulatory philosophy that loan loss reserves represent capital that should be "built up" during good economic times, to absorb losses during bad times (Wall and Koch 2000). The reserves represent the recognition of losses in banks' loan portfolios that have not yet been realized. Thus, when a bank incurs actual cash flow losses upon defaults, it can draw down its reserves, as opposed to recognizing a decline in its net income. The presumption underlying the capital regulation is that since loan loss reserves allow a bank to recognize fewer losses at the time of defaults, they should be added back as Tier 2 capital.

The countervailing view is that the treatment of loan loss reserves as capital departs from standard accounting and economic principles. Note that this view does not question the importance of timely recognition of loan loss reserves. Indeed, evidence suggests that banks that recognize loan losses in a timely manner face fewer lending constraints during recessionary regimes (Beatty and Liao 2011). However, the inclusion of loan loss reserves as capital is still

[2] Other instances of bank lobbying to raise the limit on loan loss reserves that can added back to Tier 2 capital abound. For example, in its comment letter to the Federal Reserve Board on October 15, 2009 relating to bank regulators' proposed rule-making on risk-based capital guidelines and related issues, Discover Financial Services argues for the increase or elimination of the current cap on loan loss reserve amount eligible to qualify as Tier 2 capital (Federal Reserve Board 2009).

questionable, since the reserves represent accrued losses in the loan portfolio. Greater Tier 2 capital, especially when resulting from large unusual increases in loan loss reserves, may reflect significant unaddressed problems in the banks' assets and operations. Thus, higher Tier 2 capital is possibly predictive of greater failure risk, instead of providing a buffer against failure during times of economic crisis in line with the conventional notion of capital. The actual empirical effect of Tier 2 capital on bank failure is undocumented in the literature.

Our study directly examines the association between regulatory capital (total, Tier 1, and Tier 2) and bank failure risk. We obtain bank failure data from FDIC press releases. Data on banks' regulatory capital and other accounting information is obtained from the call reports that commercial banks file with the Federal Reserve, the FDIC, and/or the Office of the Comptroller of the Currency. As expected, we find that total regulatory capital (i.e., the sum of Tier 1 and Tier 2 capital) is negatively associated with bank failure risk. Next, we examine how Tier 1 and Tier 2 capital are individually associated with bank failure risk.

Our results reveal that bank failure risk is associated *negatively* with Tier 1 capital, but *positively* with Tier 2 capital. Note that increases in loan loss reserves via loan loss provisions recognized on the income statement would, by decreasing shareholders' equity, also result in lower Tier 1 capital. Thus, our results imply that larger loan loss reserves are associated with higher bank failure risk via both a reduction in Tier 1 capital and an increase in Tier 2 capital. In other words, Tier 2 capital reflects information about bank failure risk incremental to what is encapsulated in Tier 1.

In further analysis, we explore cross-sectional variation in the extent to which Tier 2 capital is positively associated with bank failure risk. Since loan loss reserves are the primary component of Tier 2 capital, we expect its positive association with failure risk to be more pronounced when loan loss reserve increases are abnormally large. It is well-documented that

banks attempt to manage regulatory capital upwards via abnormal loan loss provisions that increase loan loss reserves, in order to convey an impression of financial health to regulators (e.g., Moyer 1990; Beatty et al. 1995; Ahmed et al. 1999). If the unusually large loan loss reserve increases represent banks' attempts to escape regulatory scrutiny by managing capital upwards, then such increases may be indicative of more severe problems within banks, inclusive of low-quality management. To the extent that Tier 2 capital is built up via opportunistic loan loss reserve increases, we expect it to be of low quality (that is, we expect its association with bank failure risk to be more positive).

Our findings confirm that the positive association between Tier 2 capital and bank failure risk is indeed more pronounced when banks report abnormally large loan loss provisions. We acknowledge that it is possible for abnormal loan loss reserve increases to reflect factors other than mangers' opportunistic attempts to report higher capital. For example, unusually large loan loss reserve increases can reflect managers' identification of problems in the loan portfolio that are not completely captured by the stock of non-performing loans.[3] Therefore, we next test whether the documented association between Tier 2 capital and failure risk is at least partially the result of upwards capital management via loan loss reserve increases. Regulatory guidelines imply that an increase in the loan loss reserve translates into an increase in total capital as long as Tier 2 capital is below 1.25% of gross risk-weighted assets (we discuss this guideline in greater detail in Section 2.1). Above the 1.25% limit, an increase in loan loss reserves has no effect on regulatory capital. Unusually large loan loss reserves are more likely to reflect attempts to manage capital upwards for banks whose Tier 2 capital is below the 1.25% limit (see Ahmed et al. 1999). Further, we expect that unusually large loan loss reserves are more likely to reflect

[3] In other words, bank managers may use accruals to convey their private information about future performance, consistent with Dechow (1994).

capital management incentives among (a) banks that have poorer quality audits and (b) banks that exhibit other symptoms of agency problems.

We find that the effect of abnormal loan loss reserve increases in weakening the quality of Tier 2 capital (i.e., increasing its positive association with failure risk) is evident only for banks below the 1.25% limit. Further, the negative effect of abnormal loan loss reserves on the quality of Tier 2 capital is significantly more pronounced among banks with poorer audit quality and banks with a higher level of agency problems.

Our paper has important implications. The results indicate that Tier 2 capital does not, on average, act as a buffer that protects banks against failure risk when an economic downturn occurs. In that sense, Tier 2 capital does not function in accordance with conventional notions of capital. Further, our evidence suggests that the quality of Tier 2 capital is weaker when managers report unusually large loan loss reserve increases with the objective of biasing reported capital upwards. This is presumably because upwards capital management leads to deadweight costs resulting from managers' attempts to avoid/delay regulatory intervention, rather than taking actions necessary to improve bank performance. These costs can eventually increase the risk of bank failure. The results are thus related to Bushman and Williams (2009), who argue that greater discretion in loan loss provisioning weakens regulators' ability to monitor and discipline banks.

Our findings speak to the ongoing regulatory debate on including loan loss reserves as regulatory capital. As noted earlier, in the wake of the economic downturn of 2008-2009, there have been calls to increase the limit to which loan loss reserves can count towards Tier 2 capital. For example, in response to intense bank lobbying at the time of the issuance of the Statement of Financial Accounting Standards (SFAS) 166 and SFAS 167 in late 2009, regulators allowed

"transitional relief" for banks from the 1.25% limit.[4] Our findings, however, question the very rationale for allowing the add-back of loan loss reserves as Tier 2 capital. At the very least, the results strike a cautionary note against expanding the add-back of loan reserves to regulatory capital.

The rest of the paper is organized as follows. Section 2 discusses our setting. Section 3 describes our sample construction and data. Our results are presented in Section 4, and Section 5 concludes.

II. Institutional setting

The recent economic crisis provides a rich setting to examine the relation between bank failure and regulatory capital because the crisis was characterized by a significant number of bank failures, and the most important role of regulatory capital is to protect banks from instability. Below, we discuss briefly two critical institutional factors, (a) the add-back of loan loss serves as regulatory capital and (b) the process of a bank failure.

Add-back of loan loss reserves as regulatory capital

The capital adequacy ratio, or the ratio of regulatory capital to risk-weighted assets, is the metric most widely relied on by regulators to monitor bank solvency (Estrella et al. 2000). There are two main sources of regulatory capital: Tier 1 and Tier 2. Tier 1 capital is "core" capital; it includes shareholders' equity (the primary component) and disclosed reserves. Tier 2 capital is "secondary" capital; it includes general loss reserves, undisclosed reserves, and subordinated term debt. The International Basel Committee requirements specify a minimum limit of 4% for Tier 1 capital, and 8% for total capital.

[4] In the first two quarters after the implementation of SFAS 166 and 167 in November 2009, a banking organization, under certain conditions, was permitted to include *without limit* in Tier 2 capital the full amount of the loan loss reserves.

In practice, Tier 2 capital consists primarily of loan loss reserves, with the restriction that the latter is limited to 1.25% of gross-risk-weighted assets (GRWA).[5] From an accounting perspective, loan loss reserves recognize expected losses in the loan portfolio. That is, losses are accrued when expected, as opposed to expensed when realized. Hence, loan loss reserves provide a buffer to absorb declines in the value of the bank's loan portfolio when the losses are realized in the future. In part, the add-back of loan loss reserves to regulatory capital is meant to serve as an incentive for the timely recording of loan losses (Wall and Koch 2000).

A simple example illustrates the role of loan loss reserve increases in influencing regulatory capital.[6] Assume that a bank increases its loan loss reserves by reporting a loan loss provision of $100, and that the statutory tax rate is 40%. This transaction, ceteris paribus, has two effects on regulatory capital: (i) a Tier 1 effect and (ii) a Tier 2 effect. The loan loss provision reduces after-tax income by $100*(1 - tax rate), or $60, which in turn reduces shareholders' equity, and hence Tier 1 capital by $60. Since banking capital regulations allow loan loss reserves to be considered as Tier 2 capital, Tier 2 capital increases by the provision amount of $100. Total regulatory capital (the sum of Tier 1 and Tier 2) increases by $40 as a result of the loan loss provision, that is, the tax rate times the provision amount. If loan loss reserves prior to the provision were already equal to or greater than 1.25% of GRWA, the $100 provision in the example would not increase Tier 2 capital. If loan loss reserves were below the 1.25% limit but

[5] Gross risk-weighted assets equal risk-weighted assets used in the computation of the capital ratios plus excess allowance for loan and lease losses plus the allocated transfer risk reserve. The limit of 1.25% of gross risk-weighted assets on the amount of the loan loss reserves that a banking organization may include in Tier 2 capital is a standard included in the first capital accord of the Basel Committee on Banking Supervision (Basel Accord). See the Basel Committee on Banking Supervision, International Convergence of Capital Measurement and Capital Standards (1988), paragraph 21.

[6] We thank the FDIC for confirming that our example correctly represents the effect of the regulations.

significantly close to it, it is possible that only a portion of the $100 loan loss provision would count towards Tier 2 capital, not the entire amount.[7]

The example highlights that an increase in loan loss reserves can increase regulatory capital. Furthermore, the effect of loan loss changes on regulatory capital is dependent on the size of total available Tier 2 capital relative to the maximum limit allowable under current regulations. As discussed in the Introduction, these institutional features can play an important role in influencing the relation between loan loss reserve changes and the likelihood of bank failure. The process of such a failure is discussed below.

Bank failure

A bank failure is an extreme event involving the chartering authority or the FDIC "closing" the bank.[8] Closing a bank involves shutting down its operations, re-distributing its assets and liabilities and, if necessary, paying off insured depositors. Generally, a bank is closed when the regulating authority determines that it is "critically undercapitalized" and deems it unable to meet its obligations to depositors and other creditors. The key attribute determining undercapitalization is insolvency, which occurs when the bank's assets are worth less than its liabilities according to either book or market values. The Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991 requires regulators to close banks *before* they reach book-value insolvency, since the market values of bank assets are uncertain and, for troubled banks, typically below their book values. Another reason for bank closure is illiquidity, which occurs

[7] Note that loan charge-offs have a slightly different effect relative to loan loss provisions. A charge-off of $100 would reduce loan loss reserves by $100, ceteris paribus. Since charge-offs do not affect the shareholders equity account, the sole effect of a $100 *reduction* in charge-offs would be to *increase* Tier 2 capital, and hence total regulatory capital, by $100 (to the extent that loan loss reserves were within the maximum allowable limit).

[8] The chartering authority for state-chartered banks is usually the state banking department; for national banks, the Office of the Comptroller of the Currency (OCC); and for federal savings institutions, the Office of Thrift Supervision (OTS). While it is much more common for the chartering authoring to close a bank, the FDIC has the authority, under the FDIC Improvement Act of 1991, to close any bank that it considers to be critically undercapitalized and that does not have a plan to restore capital to an adequate level.

when a bank is unable to meet its current obligations as they come due. For example, when depositors are concerned that a bank is failing, they may withdraw their deposits and precipitate a liquidity crisis at the bank (bank run). Illiquidity appears to drive bank failures more commonly in the European Union. Because of deposit insurance and the U.S. Federal Reserve's ability to provide liquidity, banks in the United States typically fail because they are insolvent as opposed to illiquid (Bennett 2001).

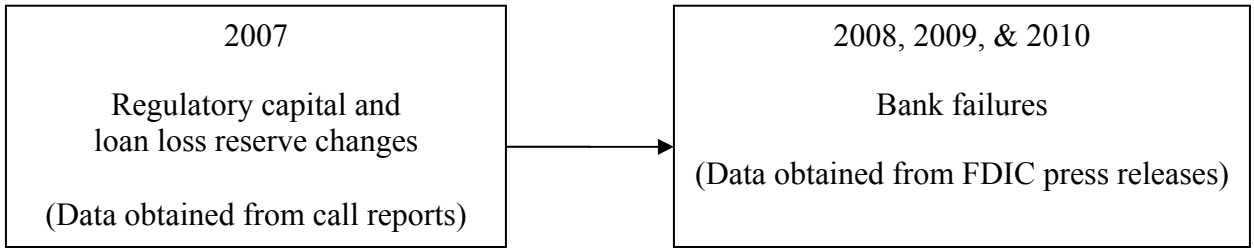
In the event of a bank failure, the FDIC acts as a receiver and is in charge of the failure resolution. FDICIA mandates the use of the least-cost resolution method for bank failures, the objective of which is to minimize the present value of the net losses incurred by the FDIC. There are two primary types of failure resolution methods: (1) purchase-and-assumption transactions and (2) deposit pay-offs. In a purchase-and-assumption transaction, a healthy bank acquires the failed bank by purchasing "some or all" of the assets and assuming "some or all" of the liabilities. The FDIC often provides assistance to the acquiring bank, e.g., in the form of loan-loss sharing agreements, and then liquidates the remaining assets and liabilities, internalizing the cost of doing so. The acquiring bank usually compensates the FDIC for the franchise value from the failed bank's established customer relationships, which helps reduce the insurer's resolution cost. In a deposit-payoff transaction, the FDIC pays the failed bank's depositors the full amount of their insured deposits. Typically deposit payoffs are observed when no other bank is interested in assuming the assets and liabilities of the failed bank.

Variations of the two primary methods exist. For example, in a deposit transfer transaction, the FDIC transfers the insured deposits to a healthy bank that is willing to be an agent of the FDIC. The depositors can either withdraw their deposits or keep them in the new bank. In a bridge transaction, the FDIC itself temporarily acquires the failed bank's assets and liabilities and takes over its operations while deciding on the least-cost resolution method. In a

more significant departure, the FDIC can engage in an open-bank transaction, in which it provides financial assistance to the bank while it continues operations. Open-bank transactions are not classified as bank failures in our sample, since they are implemented when banks' liquidity and/or solvency issues are perceived as temporary.

III. Sample construction

The timeline in our research design is shown below:



The National Bureau of Economic Research (NBER) identifies December 2007 as the beginning of the recent recession. Our empirical analysis focuses on the association between regulatory capital and changes in loan loss reserves that banks reported at the end of 2007 and the bank failures of the subsequent three years. The choice of this timeline for the research design is based on the idea that regulatory capital is supposed to act as a buffer that permits banks to insulate themselves against financial instability and failures when an economic crisis occurs.

Data on bank failures

We obtain data on bank failures from the FDIC website: http://www.fdic.gov. The FDIC, which is appointed as the receiver in the event of a bank failure, makes public a press release that provides details about the bank at the time of the failure, including the actions being taken to deal with it. We collect the following information from these press releases (available on the FDIC website): the name of the failed bank, the bank's estimated assets and deposits at the time of the

failure, and the failure's cost to the FDIC. As an example, the press release for the failure of Corus Bank is provided in Appendix A. Corus Bank's failure date was September 11, 2009; its estimated assets and deposits at the time of failure were both approximately $7 billion, and the cost of the failure to the FDIC was assessed at $1.7 billion.

Table 1 provides descriptive information about the failure of commercial banks and thrifts (which includes savings and loans associations and savings banks) from 2001 to 2010. While, for the reasons discussed below, the focus of this paper is the failure of commercial banks, we also provide descriptive information about the failure of thrifts to provide a broader overview of bank failures and to highlight the enormity of the problems facing the banking industry in general. Failures of commercial banks and thrifts, which were relatively infrequent prior to the economic recession, increased dramatically as a result of the economic crisis. A total of 21 commercial banks and 4 thrifts failed between the seven years from 2001 to 2007, compared to a total of 279 commercial banks and 42 thrifts in 2008, 2009, and 2010. Consistent with theories on regulatory capital (e.g., Diamond and Rajan 2000) and bank regulatory guidelines, we expect that it is during periods like 2008 to 2010 when regulatory capital would play an important role in ensuring banks' survival and reducing the direct and indirect costs of bank failure. In terms of direct costs, available data indicates that the FDIC insurance fund largely bore the costs that arose from the bank and thrift failures of 2008 and 2009. For example, the total cost to the fund on account of failed commercial banks was $4.58 billion in 2008, $24.1 billion in 2009, and $20.2 billion in 2010. In fact, failure costs were significant enough to deplete the FDIC insurance fund to the point of insolvency during 2009.

[Insert Table 1 here]

In this paper, we focus on commercial banks because (i) commercial banks and thrifts file different regulatory reports, (ii) detailed regulatory report data for individual commercial banks, both private and public, are publicly available in a machine-readable form, and (iii) the number of failed commercial banks is significantly larger than the number of thrifts, facilitating wide-sample empirical analyses. For brevity, we henceforth use the term "banks" to refer to the commercial banks in our sample.

Data from call reports

We obtain data on loan loss reserves, loan loss provisions, and net charge-offs, as well as other accounting variables, from the call reports filed by banks with the Federal Reserve, the Federal Deposit Insurance Corporation, or the Office of the Comptroller of the Currency. The data is available in machine-readable form at the Chicago Federal Reserve website.[9] We begin with the 8,076 call reports filed by banks in the 50 states and Washington D.C. for the fiscal year ending in December 2007. To be included in our sample, the bank must have positive total assets and total loans for the fiscal years ending in December 2006 and December 2007; we require data from both 2006 and 2007 to construct variables that measure changes from 2006 to 2007. This requirement reduces the sample to 7,383 banks. To merge the bank failure data with the call report data, we obtain the RSSD ID of the banks in the bank failure dataset. The RSSD ID is the unique identifying number assigned by the Federal Reserve for all financial institutions, main offices, and branches. Of the 7,383 banks in our sample, 269 banks failed between 2008 and 2010. Thus, after imposing the data availability constraints, our sample captures 269 of the 279

[9] http://www.chicagofed.org/webpages/banking/financial_institution_reports/commercial_bank_data.cfm

failures during this period. A bank failure rate of 3.6% is clearly significant by historical standards, and we note that many banks have continued to fail after 2010.[10]

Table 2 presents the distribution of the 7,383 banks across the different states and regions of the United States. The states with the most number of bank failures are Georgia, Illinois, and California, with 49, 36, and 27 failures, respectively. Nevada has the highest failure rate (the percentage of all banks that failed), at 29%. From a regional perspective, while there were more bank failures in the south, the failure rate is higher in the west, at 8.7%. The uneven distribution of bank failures across different states and regions is consistent with the fact there was significant variation in the impact of the economic crisis across the United States.

[Insert Table 2 here]

Table 3 provides some descriptive information on the regulatory capital ratios and loan loss reserves in 2007 for the 7,383 banks. The mean total risk-based capital ratio and the Tier 1 risk-based capital ratio are 16.69% and 15.59%, respectively. The inclusion of Tier 2 capital adds, on average, 1.086% of risk-weighted assets to the total risk-based capital ratio.[11] The median total risk-based capital ratio and Tier 1 risk-based capital are 14.13% and 13.05%, respectively. Given that the minimum required total risk-based capital ratio and the Tier 1 capital ratio are, respectively, 8% and 4%, a typical bank in 2007 meets the minimum requirements, as expected. However, the total risk-based capital for a bank at the 25th percentile is 11.69%, which is just 2.69% above the requirement of 8%. Finally, Table 3, Panel A demonstrates that in

[10] The fact that there were 21 more commercial bank failures and 2 thrift failures in the first two months of 2011 suggest that many banks are still facing difficulties despite some indications of economic stabilization in 2010.

[11] Note that the allowable Tier 2 capital (i.e., the capital that can be considered as part of total capital) is the lesser of Tier 1 and Tier 2 capital. In untabulated analyses, we find that the allowable Tier 2 capital is the same as the actual Tier 2 capital for all commercial banks in our sample because Tier 2 capital is always less than Tier 1 capital.

practice, Tier 2 capital is almost entirely made up of loan loss reserves. Mean loan loss reserves scaled by risk-weighted assets used in Tier 2 capital is 1.036%, relative to a mean Tier 2 capital ratio of 1.086%. Loan loss reserves make up about 95% (1.036/1.086) of Tier 2 capital, and about 6% (= 1.036 / 16.685) of total risk-based capital. Table 3, Panel B provides some univariate analyses between banks that failed and those that did not. We observe that banks that failed have lower Tier 1 capital but higher Tier 2 capital in 2007. In addition, these banks also have higher loan loss reserves that are used as Tier 2 capital.

[Insert Table 3 here]

IV. Research design and results

Bank failure and regulatory capital

In this paper, we rely on survival analyses that use hazard models to study the relation between bank failure and loan loss reserve accounting. Hazard models are appropriate to our context since they incorporate information about the time that elapses before an event (in our case, a bank failure) occurs. These models have been used in numerous research contexts, especially when the "hazardous" event of interest is rare (e.g., Lee and Urrutia 1996; Shumway 2001; Carpenter and Lewis 2004). For example, Shumway (2001) demonstrates that hazard models outperform static models such as logit models in predicting bankruptcy.

Our tests rely on the widely used Cox proportional hazard model (Cox 1972; Cox and Oakes 1984), which has the following form:

$$h(t) = h_0(t) exp(X_i \beta_i) \quad (1)$$

where X_i is a vector of explanatory variables and β_i is a vector of coefficients. Note that no explicit intercept parameter is estimated for the proportional hazards model. As the log-

likelihood function and survival function estimators are invariant with respect to translations of any of the independent variables, no intercept is needed. The hazard rate is the risk of failure at a certain point in time, conditional on survival until that point in time. $h_0(t)$ represents the baseline hazard rate that is exclusively a function of time, while $exp(X_i\beta_i)$ represents the dependence of the hazard rate on a vector of explanatory variables X. In the Cox model, the coefficient on the explanatory variable represents the proportional change in the hazard rate for a one-unit change in the explanatory variable.

The focus of this paper is to examine how bank failure hazard is associated with changes in loan loss reserves and its components: (i) loan loss provisions and (ii) net charge-offs. To examine the above, we use the following hazard models:

$$h(t) = h_0(t) \exp (\beta_1 CAPITAL + \sum_i \beta_i CONTROL_i + \varepsilon) \quad (2)$$

The initiation date for the survival analysis is January 1, 2008, and the final date is December 31, 2010. $h(t)$ is the hazard of bank failure at time t. t is the number of days from January 1, 2008 to the failure date; for banks that did not fail, t is the number of days from January 1, 2008 to December 31, 2010.

The independent variables of interest are *TOTAL_RBC, TIER1_RBC,* and *TIER2_RBC*, which are, respectively, the total capital, Tier 1 capital, and Tier 2 capital, expressed as a percentage of risk-weighted assets. *CONTROL* is a set of control variables added to mitigate omitted correlated variable bias: *REAL_ESTATE_LOAN*, *NPL*, *ROA*, *UNINSURED_DEPOSIT*, *LIQUIDITY*, *TOTAL_ASSETS*, and various regional dummies as fixed effects. All the independent variables are measured at the end of 2007, i.e., before the occurrence of the bank failures.

If regulatory capital is indeed acting as a buffer against bank failure, we expect the coefficients on the various types of capital (i.e., *TOTAL_RBC, TIER1_RBC,* and *TIER2_RBC*) to

be positive. *REAL_ESTATE_LOAN* is loans and leases as a percentage of average beginning and ending total assets. Exposure to real estate loans was a key factor behind the financial difficulties that many banks faced during the crisis. We expect banks with relatively more real estate loans to be at a greater risk of failure. *NPL* is non-performing loans as a percentage of total loans; we expect banks with relatively greater *NPL* to exhibit greater failure risk. *ROA* is net income as a percentage of average beginning and ending total assets. We expect more profitable banks to be less likely to fail.

UNINSURED_DEPOSIT represents uninsured deposits as the percentage of total deposits. The FDIC places a cap on maximum insurable deposits. We expect banks with more uninsured deposits to be at a greater risk of failure during times of crisis due to the greater possibility of "deposit runs". *LIQUIDITY* denotes the cash and balances due from depository institutions as a percentage of total deposits. Cash and balances due from depository institutions provide liquidity during deposit withdrawals, which tend to be higher during economic crises. Hence, a bank with higher *LIQUIDITY* is likely to face fewer difficulties in meeting withdrawal requests, and be less likely to fail. *TOTAL_ASSETS* is the total assets of the bank in millions, a proxy for bank size. From casual observation of the failed banks, it becomes apparent that both small and large banks have failed. However, we control for size because it is an important consideration when closing a bank, particularly in light of the possibility of governmental support if the bank is "too big to fail".

REGION2 is an indicator variable equaling one if a bank is in the Midwest region, and zero otherwise; *REGION3* and *REGION4* are defined analogously for the Southern and Western regions respectively. By construction, the Northeast serves as the benchmark region. We include region dummies to mitigate concerns that the empirical results are driven by heterogeneous

regional characteristics. Examples of such heterogeneity include differences in the expansion of the property sector, or unemployment differences.[12]

Table 4 presents the descriptive statistics of the variables in the hazard model; the descriptive statistics for *TOTAL_RBC*, *TIER1_RBC*, and *TIER2_RBC* are in Table 3. The mean value of *FAIL* indicates that 3.6% of the banks in our sample failed in 2008, 2009, or 2010. The remaining variables measure various characteristics of the banks as indicated in their December 2007 call reports. On average, 69.27% of the total loans made by the banks are real estate loans. Non-performing loans constitute, on average, 2.525% of total loans. At the end of 2007, the banks are generally profitable, with a mean and median return-on-assets of 0.863% and 0.921%, respectively. The average uninsured deposits as a percentage of total assessable deposits are high, at 40.5%. The average cash-to-deposit is 5.309%. Finally, the mean and median total assets of the banks are $0.465 billion and $0.133 billion.[13]

[Insert Table 4 here]

Table 5 presents the results of the hazard models that examine how the likelihood of bank failures is associated with regulatory capital. Panel A presents the regression coefficients along with associated standard errors. Panel B presents the hazard ratios. In Panel A, the coefficients of interest are those on total capital (*TOTAL_RBC*) in the first column, and those on Tier 1 capital (*TIER1_RBC*) and Tier 2 capital (*TIER2_RBC*) in the second column. In the first column, the

[12] We are not able to include state dummies because there are many states with no bank failures. Hence, it is not possible to examine how within-state variation in loan loss reserve accounting is associated with within-state variation in the risk of bank failure.

[13] The current tax code requires the deferral of tax benefits from loan loss reserve increases via loan loss provisions only if the bank's total assets are above $0.5 billion. Given that the 75th percentile of total assets is $0.303 billion in our sample, the banks in our sample largely need not defer the tax benefits of loan loss reserve increases via provisions.

coefficient on *TOTAL_RBC* is negative and statistically significant at the 1% level, suggesting that a higher level of total regulatory capital is associated with a lower failure risk on average. This result is consistent with regulatory capital serving as a buffer against bank failure. In the second column, the coefficient on *TIER1_RBC* is negative and statistically significant at the 1% level, suggesting that a higher level of Tier 1 capital is associated with a higher likelihood of bank failure. In sharp contrast, the coefficient on *TIER2_RBC* is positive and statistically significant at the 5% level, suggesting that a higher level of Tier 2 capital is associated with a higher likelihood of bank failure.

Panel B of Table 5 reports the hazard of bank failure in terms of the hazard ratio, which is the effect of an explanatory variable on the hazard of bank failure. For each continuous explanatory variable (i.e., all variables except the region dummies), we use a single-standard deviation increase in the variable to assess its economic effect on bank failure risk.[14] For each region dummy, we examine the effect of a one-unit increase; this effectively compares the bank failure risk for a particular region with that of the Northeast region. The hazard ratio for *TOTAL_RBC* in the first column indicates that a single-standard deviation increase in total capital reduces the risk of bank failure by 66.1% (= 100% - 33.9%). The results in the second column indicate that a single standard deviation increase in Tier 1 capital reduces the risk of bank failure by 65.9%. In contrast, a single standard deviation increase in Tier 2 increases the risk of bank failure by 11.8% (= 111.8% - 100%). Hence, as expected, Tier 1 capital has an economically significant effect in reducing bank failure risk. Importantly, after controlling for the effect of Tier 1 capital, our results suggest that Tier 2 capital is actually associated with an

[14] To compute the hazard ratio for a one standard-deviation increase, we first multiply the coefficient on the explanatory variable from Table 4, Panel A by the standard deviation of the variable from Table 3, Panel A. We then take the exponential of this result. For example, the hazard ratio of *TOTAL_RBC* is the exponential of the coefficient of 0-0.141 on *TOTAL_RBC* multiplied by its standard deviation of 7.668%.

increase in bank failure risk, instead of acting as a buffer against the risk of failure in accordance with its designation as capital.

Among the control variables, exposure to real estate has a very significant economic effect on bank failure risk. A single standard-deviation increase in *REAL_ESTATE_LOAN* increases the risk of bank failure by 112.3% (= 212.3% – 100%); this result is consistent with conventional wisdom that the collapse of the real estate market was a key driver of banks' financial problems. We also observe economically significant effects for liquidity. A standard-deviation increase in *LIQUIDITY* reduces the bank failure risk by 43.3% (= 100% – 56.7%).

[Insert Table 5 here]

In sum, we find that Tier 1 capital has a significant effect in reducing bank failure risk. However, Tier 2 capital seems to fail to perform its role as capital that buffers the bank against failure. We investigate the underlying reasons for this phenomenon in the next section.

The role of loan loss reserve accounting

In this section, since loan loss reserves constitute the primary component of Tier 2 capital, we examine how changes in loan loss reserves just prior to the crisis (i.e., in 2007) influence the relation between bank failure and Tier 2 capital. To better identify the underlying reasons that changes in loan loss reserves influence this relation, we decompose changes in loan reserves into normal and abnormal changes in loan loss reserves. To do so, we use the following regression model to decompose changes in loan loss reserves in 2007 and 2006:

$$CH\_LLR = \beta_0 + \beta_1 CH\_NPL + \beta_2 LOAN + \beta_3 REAL\_ESTATE\_LOAN + \beta_4 OTHER\_LOAN + \varepsilon \quad (3)$$

where *CH_LLR* is the change in loan loss reserves as a percentage of total loans, *CH_NPL* is the change in non-performing loans as a percentage of total loans, *LOAN* is the loans as a percentage of total assets, *REAL_ESTATE_LOAN* is real estate loans as a percentage of total loans, and *OTHER_LOAN* is the sum of commercial and industrial loans, loans to depository institutions, agricultural loans, loans to individuals, and loans to foreign governments as a percentage of total loans.[15] In untabulated analyses, we find that the average *REAL_ESTATE_LOAN* (*OTHER_LOAN*) is 69.2% (18.7%) and 68.7% (19%) in 2007 and 2006, respectively.

Table 6 presents the results of regressions used to model changes in loan loss reserves. These results are consistent across 2007 and 2006. They indicate that, as expected, changes in loan loss reserves are highly positively associated with non-performing loans. Banks with more loans as a percentage of total assets also have higher changes in loan loss reserves. Interestingly, we find that having more real estate loans as a percentage of total loans is associated with lower changes in loan loss reserves. This result appears to reflect the notion that prevailed prior to the current economic crisis— real estate loans were typically considered "safe loans" due to the perceived low likelihood of a downturn in the real estate market. We also find that the loans included in *OTHER_LOAN* are negatively associated with increases in loan loss reserves. We term the residual and predicted value from the regressions as an abnormal change in loan loss reserves and a normal change in loan loss reserves, respectively.

[Insert Table 6 here]

To examine the effect of changes in loan loss reserves prior to the crisis on the relation between bank failure and Tier 2 capital, we test whether the positive association between bank

[15] Both *REAL_ESTATE_LOAN* and *OTHER_LOAN* exclude loans for purchasing or carrying securities and lease financing receivables.

failure and Tier 2 capital is more pronounced when banks increase their loan loss reserves in 2007. Because we are examining the moderating effects of changes in loan loss reserves, we modify Eq. (2) by introducing the change in loan loss reserves and its components as interaction terms with regulatory capital. To reduce the effect of outliers and to ease the exposition when interaction terms are present, we make use of the following dummy variables in our analyses: *CH_LLR* is an indicator variable equaling one if there is an increase in loan loss reserves in 2007, and zero otherwise. *ABN_CH_LLR* is an indicator variable equaling one if there is an abnormal increase in loan loss reserves in 2007, and zero otherwise. The focus of the analyses is on what happens when there is an unusual increase in loan loss reserves in 2007. Our results are robust to identifying unusual changes in loan loss reserves using an indicator variable equaling one if the underlying continuous variable is in the top quartile, and zero otherwise.

Table 7 begins the analyses by examining how *CH_LLR* influences the relation between bank failure and Tier 2 capital. The coefficient on *TIER2_RBC x CH_LLR* is positive and significant at the 5% level. This suggests that the association between Tier 2 capital and bank failure risk is more positive for banks that increased their loan loss reserves in 2007. In the next two columns, we examine whether this effect is driven by an abnormal increase in loan loss reserves in 2007. In the second column, we find that the coefficient on *TIER2_RBC x ABN_CH_LLR* is positive and significant at the 5% level, consistent with an abnormal increase in loan loss reserves driving the association between bank failure and Tier 2 capital. We show in the third column that this result is robust to the inclusion of abnormal changes in loan loss reserves in 2006 (*ABN_CH_LLR_LAG*) as a control variable; for completeness and consistency, the main and interaction effects of *ABN_CH_LLR_LAG* are also included.

[Insert Table 7 here]

As an aside, in untabulated analyses, we examine whether we find similar results with abnormal changes in loan loss reserves after controlling for normal changes in loan loss reserves. We construct an indicator variable, *N_CH_LLR*, indicating whether the bank had a normal increase in loan loss reserves in 2007, and zero otherwise; the normal increase in loan loss reserves is based on the predicted loan loss reserves from Eq. (3). *N_CH_LLR* is included in the regression with interaction and main effects, as well as with a lag. While we find that *TIER2_RBC x ABN_CH_LLR* is positive and significant at the 1% level, we find that *TIER2_RBC x N_CH_LLR* is statistically insignificant.

In robustness tests, we identify banks as reporting abnormally large loan loss reserve increases when *ABN_CH_LLR* is in the top quartile, rather than when it is simply above zero. Our results are robust to this specification. Overall, the findings indicate that the quality of Tier 2 capital is lower (that is, its association with bank failure risk is more positive) when banks report abnormally large loan loss reserve increases.

Cross-sectional analyses

In this section, we rely on some further cross-sectional analyses to examine whether abnormal loan loss reserve increases weaken the quality of Tier 2 capital when they are used to opportunistically manage capital upwards. All analyses in this section are performed using the full regression specification in the third column of Table 7. Thus, the sample size for the analyses is 7,196 firms.

First, we rely on the fact that there is a constraint on the extent to which banks can add back loan loss reserves as regulatory capital. The add-back is limited to 1.25% of gross risk-weighted assets and banks have to report the excess amount of the allowance for loan and lease losses over 1.25% of gross risk-weighted assets (this item is known as "excess allowance for

loan and lease losses" in the call reports). Abnormal loan loss reserve increases are more likely to reflect upward capital management incentives for banks below this limit rather than those above it. We hypothesize that unusually large loan loss reserve increases impair the quality of Tier 2 capital only when managers are not constrained from opportunistically using the add-back provision to boost Tier 2 capital. Second, we hypothesize that unusual loan loss reserve increases are more likely to reflect capital management incentives and are hence more likely to impair the quality of Tier 2 capital in banks with poor audit quality. To the extent that poor audit quality increases opportunistic actions, then it is more likely that the abnormal change in loan loss reserves is driven by opportunism. Second, we hypothesize that when banks increase their loan loss reserves, the quality of Tier 2 capital will be more likely to be impaired by the add-back if there are more agency problems in the firm.

We construct an indicator variable, *1.25% LIMIT*, equaling one if the bank reports excess loan loss reserves at the end of 2006, and zero otherwise. Of the 7,196 banks in the sample, 2,581 banks are constrained from adding back loan loss reserves as Tier 2 capital in 2007. We then examine whether there is a difference in the effect of an abnormal change in loan loss reserves on the relation between bank failure and Tier 2 capital by running separate regressions for banks below and above the 1.25% limit.

Table 8 reports the results of the analysis. The first (second) column reports the results for firms with loan loss reserves below (above) the 1.25% limit. As Table 8 demonstrates, we find that Tier 2 capital is associated with a higher probability of bank failure, and is thus of lower quality, in both subsamples. More importantly, in the first column, we observe that the coefficient on *TIER2_RBC x ABN_CH_LLR* is positive and significant at the 5% level. In contrast, we observe that this coefficient is insignificant in the second column. Hence, the

evidence suggests that abnormal loan loss reserve increases weaken the quality of Tier 2 capital when they are likely driven by capital management incentives.

In subsequent tests, we proxy for audit quality using the reported level of audit work performed for the bank. In their March 2008 call reports, banks are required to report the most comprehensive level of auditing work performed for the bank by independent external auditors during 2007. The possible levels are indicated in Appendix C. We construct an indicator variable, *AUDIT_QUALITY*, equaling one if there was an independent audit of the bank conducted in accordance with generally accepted auditing standards by a certified public accounting firm that submits a report on the bank, and zero otherwise. Of the 7,196 banks in the sample, 2,727 banks are considered as having a high audit quality.

To proxy for agency problems, we rely on the level of overhead expenses. High overhead costs can signal unwarranted managerial perquisites, poor internal controls, and operating inefficiencies that are common symptoms of agency problems (e.g., Claessens, Demirgüç-Kunt, and Huizinga 2001; Betrand and Mullainathan 2003; Barth et al. 2008; Giroud and Mueller 2010). In the call reports, these expenses are recorded as "total non-interest expense" in the income statement. "Non-interest expense" excludes loan loss provisions, but includes expenses on salaries and employee benefits as well as expenses on premises and fixed assets. We construct an indicator variable, *AGENCY PROBLEM*, equaling one if the bank has, in 2007, overhead expenses as a percentage of total assets that is above the median.

Table 9 reports the results of the regressions that examine whether the influence of abnormal loan loss reserves on the quality of Tier 2 capital varies with audit quality and agency problems. From the first two columns, we observe that the coefficient on *TIER2_RBC x ABN_CH_LLR* is positive and significant at the 1% level but is insignificant when audit quality is high. In the next two columns, we find that this coefficient is positive and significant at the 1%

level when there is a high level of agency problems but that it is insignificant when the level of agency problems is low. Taken together, the results indicate that the impairment of Tier 2 capital due to opportunistic management occurs only when there is poor audit quality and a higher level of agency problems.

V. Conclusion

We rely on the recent economic crisis to test the effects of regulatory capital in mitigating the risk of financial instability for banks. To the best of our knowledge, our paper is the first to provide systematic evidence that regulatory departure from accounting and economic principles could have contributed to Tier 2 capital's adverse consequences during the economic crisis. Based on economic principles, loan loss reserves should not be added back as capital because they are accrued loan losses; however regulatory guidelines allow for them to be added back, up to a certain limit, so as to increase the incentives for banks to make loan loss reserves This add-back of loan loss reserves has recently been the subject of extensive regulatory debate and bank lobbying. Some regulators and banks have called for an increase in the limit, while other regulators have cautioned that such an action would reduce the quality of capital as a buffer against financial instability.

The evidence in this paper indicates that bank failure risk during 2008-2010 is associated negatively with Tier 1 capital, but positively with Tier 2 capital. Further, Tier 2 capital is more highly associated with failure risk when banks report unusually large increases in loan loss reserves. Existing literature suggests that banks can report abnormal loan loss reserve increases to manage regulatory capital upwards (Ahmed et al. 1999). We identify the extent to which abnormal loan loss increases are likely to reflect upward capital management incentives using three proxies: (a) whether banks are less constrained by regulation in adding back loan loss

reserves as Tier 2 capital, (b) the quality of bank audit and (b) the likely level of agency problems in the bank. We find that when abnormal loan loss reserve increases reflect upward capital management incentives, their influence on the positive association between Tier 2 capital and bank failure risk is more pronounced. Our results indicate that Tier 2 capital does not necessarily provide a buffer against the risk of failure during times of economic crises and is in fact associated with higher failure risk, in contrast to conventional notions of capital.

Recent proposals that were under consideration by regulators include calls to increase, even eliminate, the limit on the amount of loan loss reserves that can be added back as regulatory capital. In this context, our findings are important not just from a policy review perspective, but also from a policy-making perspective. To the extent that regulatory capital is meant to provide financial stability especially in times of crises, the findings question the rationale for considering loan loss reserves as Tier 2 capital, and strike a cautionary note against expanding the add-back of loan reserves to regulatory capital.

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Appendix A Example of an FDIC press release on bank failure

MB Financial Bank, National Association, Chicago, Illinois, Assumes All of the Deposits of Corus Bank, National Association, Chicago, Illinois

FOR IMMEDIATE RELEASE
September 11, 2009

Media Contact:
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Corus Bank, National Association, Chicago, Illinois, was closed today by the Office of the Comptroller of the Currency, which appointed the Federal Deposit Insurance Corporation (FDIC) as receiver. To protect the depositors, the FDIC entered into a purchase and assumption agreement with MB Financial Bank, National Association, Chicago, Illinois, to assume all of the deposits of Corus Bank, N.A.

The eleven branches of Corus Bank will reopen on their next normally scheduled business day as branches of MB Financial Bank. Depositors of Corus Bank will automatically become depositors of MB Financial Bank. Deposits will continue to be insured by the FDIC, so there is no need for customers to change their banking relationship to retain their deposit insurance coverage. Customers should continue to use their existing branches until MB Financial Bank can fully integrate the deposit records of Corus Bank.

This evening and over the weekend, depositors of Corus Bank can access their money by writing checks or using ATM or debit cards. Checks drawn on the bank will continue to be processed. Loan customers should continue to make their payments as usual.

As of June 30, 2009, Corus Bank had total assets of $7 billion and total deposits of approximately $7 billion. MB Financial Bank will pay the FDIC a premium of 0.2 percent to assume all of the deposits of Corus Bank. In addition to assuming all of the deposits of the failed bank, MB Financial Bank agreed to purchase approximately $3 billion of the assets, comprised mainly of cash and marketable securities. The FDIC will retain the remaining assets for later disposition. The FDIC plans to sell substantially all of the remaining assets of Corus Bank in the next 30 days in a private placement transaction.

Customers who have questions about today's transaction can call the FDIC toll-free at 1-800-823-5017. The phone number will be operational this evening until 9:00 p.m., Central Daylight Time (CDT); on Saturday from 9:00 a.m. to 6:00 p.m., CDT; on Sunday from noon to 6:00 p.m., CDT; and thereafter from 8:00 a.m. to 8:00 p.m., CDT. Interested parties can also visit the FDIC's Web site at http://www.fdic.gov/bank/individual/failed/corus.html.

The FDIC estimates that the cost to the Deposit Insurance Fund (DIF) will be $1.7 billion. MB Financial Bank's acquisition of all the deposits was the "least costly" resolution for the FDIC's DIF compared to alternatives. Corus Bank is the 90th FDIC-insured institution to fail in the nation this year, and the sixteenth in Illinois. The last FDIC-insured institution closed in the state was Platinum Community Bank, Rolling Meadows, on September 4, 2009.

# # #

Congress created the Federal Deposit Insurance Corporation in 1933 to restore public confidence in the nation's banking system. The FDIC insures deposits at the nation's 8,195 banks and savings associations and it promotes the safety and soundness of these institutions by identifying, monitoring and addressing risks to which they are exposed. The FDIC receives no federal tax dollars – insured financial institutions fund its operations.

FDIC press releases and other information are available on the Internet at www.fdic.gov, by subscription electronically (go to www.fdic.gov/about/subscriptions/index.html) and may also be obtained through the FDIC's Public Information Center (877-275-3342 or 703-562-2200). **PR-168-2009**

Appendix B Levels of auditing work.

1 = Independent audit of the bank conducted in accordance with generally accepted auditing standards by a certified public accounting firm which submits a report on the bank

2 = Independent audit of the bank's parent holding company conducted in accordance with generally accepted auditing standards by a certified public accounting firm which submits a report on the consolidated holding company (but not on the bank separately)

3 = Attestation on bank management's assertion on the effectiveness of the bank's internal control over financial reporting by a certified public accounting firm

4 = Directors' examination of the bank conducted in accordance with generally accepted auditing standards by a certified public accounting firm (may be required by state chartering authority)

5 = Directors' examination of the bank performed by other external auditors (may be required by state chartering authority)

6 = Review of the bank's financial statements by external auditors

7 = Compilation of the bank's financial statements by external auditors

8 = Other audit procedures

Table 1 Distribution of bank failures from 2001 to 2010

This table provides information on bank and thrift failures by calendar year from 2001 to 2010. Panel A (B) shows the failure of commercial banks (thrifts).

Panel A: Failure of commercial banks

Year	Failures	Total Assets ($m)	Total Deposits ($m)	Bank failures with FDIC cost info	Total Cost ($m)
2001	3	58.6	51.6	3	4.6
2002	10	2,656.4	2,291.6	4	361.9
2003	3	961.2	903.2	2	135.6
2004	3	150.8	140.1	3	14.1
2005	0	0.0	0.0	.	.
2006	0	0.0	0.0	.	.
2007	2	102.5	89.2	1	3.0
2008	20	17,963.8	14,898.6	19	4,580.5
2009	120	119,175.1	97,596.8	120	24,100.9
2010	139	84,811.4	71,956.4	139	20,243.7

Panel B: Failure of thrifts

Year	Failures	Total Assets ($m)	Total Deposits ($m)	Bank failures with FDIC cost info	Total Cost ($m)
2001	1	2,300.0	1,600.0	0	.
2002	1	52.0	40.0	0	.
2003	0	0.0	0.0	.	.
2004	1	12.3	9.8	0	.
2005	0	0.0	0.0	.	.
2006	0	0.0	0.0	0	0.0
2007	1	2,500.0	2,300.0	1	110.0
2008	5	401,694.6	224,332.1	5	12,842.0
2009	19	51,709.1	39,844.6	18	12,174.8
2010	18	11,494.6	8,837.4	18	1,909.5

Table 2 Within-sample distribution of commercial bank failures across the United States

This table shows the distribution of 269 commercial bank failures in 2008, 2009, and 2010 within our sample of 7,383 commercial banks. The sample is the number of commercial banks in existence at the end of 2007 that have the data needed to compute the variables used in our analysis (see Table 4). Within each parenthesis, the number of bank failures is indicated on the left; the total number of banks is indicated on the right.

Region 1: Northeast (9 / 670 = 1.34%)

New England

Connecticut (0 / 45)
Maine (0 / 24)
Massachusetts (1 / 156)
New Hampshire (0 / 16)
Rhode Island (0 / 8)
Vermont (0 / 12)

Middle Atlantic

New Jersey (3 / 84)
New York (3 / 128)
Pennsylvania (2 / 197)

Region 2: Midwest (80 / 3175 = 2.52%)

East North Central

Indiana (1 / 120)
Illinois (36 / 610)
Michigan (8 / 146)
Ohio (2 / 186)
Wisconsin (2 / 265)

West North Central

Iowa (0 / 366)
Kansas (6 / 337)
Minnesota (15 / 411)
Missouri (8 / 326)
Nebraska (1 / 232)
North Dakota (0 / 92)
South Dakota (1 / 84)

Region 3: South (107 / 2699 = 3.96%)

South Atlantic

Delaware (0 / 23)
District of Columbia (0 / 6)
Florida (35 / 252)
Georgia (49 / 320)
Maryland (2 / 55)
North Carolina (2 / 88)
South Carlina (3 / 67)
Virginia (0 / 98)
West Virginia (0 / 62)

East South Central

Alabama (3 / 143)
Kentucky (0 / 184)
Mississippi (1 / 92)
Tennessee (0 / 178)

West South Central

Arkansas (2 / 141)
Louisiana (1 / 138)
Oklahoma (2 / 252)
Texas (7 / 600)

Region 4: West (73 / 839 = 8.70%)

Mountain

Arizona (7 / 45)
Colorado (3 / 135)
Idaho (0 / 15)
New Mexico (1 / 46)
Montana (0 / 74)
Utah (5 / 59)
Nevada (9 / 31)
Wyoming (1 / 40)

Pacific

Alaska (0 / 5)
California (27 / 259)
Hawaii (0 / 7)
Oregon (6 / 36)
Washington (14 / 87)

Table 3 Bank failures and capital ratios

This table provides information on capital ratios. The sample consists of 7,383 commercial banks; the capital ratios are based on their call reports as of December 2007. *TOTAL_RBC* is total risk-based capital, i.e., total regulatory capital (i.e., sum of Tier 1 and Tier 2 regulatory capital) as a percentage of risk-weighted assets. *TIER1_RBC* (*TIER2_RBC*) is Tier 1 (Tier 2) regulatory capital as a percentage of risk-weighted assets. Panel A presents the summary statistics for all banks. In Panel B, tests of differences between non-failed and failed banks are conducted. All the variables have been winsorized at the 1st and 99th percentiles within the year. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Summary statistics for all banks

Variable	Mean	Std	P25	Median	P75
TOTAL_RBC	16.685	7.668	11.690	14.130	18.670
Components of total risk-based capital ratio:					
TIER1_RBC	15.590	7.693	10.600	13.050	17.570
TIER2_RBC	1.086	0.350	0.911	1.119	1.252
Deductions for *TOTAL_RBC* scaled by risk-weighted assets	0.001	0.032	0.000	0.000	0.000
Loan loss reserves in Tier 2 capital scaled by risk-weighted assets	1.036	0.247	0.897	1.103	1.251

Panel B: Univariate comparison of non-failed banks and failed banks

	FAIL = 0	*FAIL* = 1	Difference	
Number of banks	7,114	269		
TOTAL_RBC	16.837	12.670	-4.167	***
Components of total risk-based capital ratio:				
TIER1_RBC	15.748	11.414	-4.334	***
TIER2_RBC	1.080	1.223	0.142	***
Deductions for *TOTAL_RBC* scaled by risk-weighted assets	0.001	0.000	-0.001	
Loan loss reserves in Tier 2 capital scaled by risk-weighted assets	1.033	1.135	0.103	***

Table 4 Descriptive statistics

This table provides some descriptive statistics of the variables (other than *TOTAL_RBC*, *TIER1_RBC*, and *TIER2_RBC*, whose descriptive statistics are in Table 3) that are used in the analysis of bank failure. The sample consists of 7,383 commercial banks. *FAIL* is an indicator variable equaling one if the bank failed in 2008, 2009, or 2010, and zero otherwise. The values of the remaining variables are based on their call reports as at December 2007. *CH_LLR* is the change in loan loss reserves as a percentage of total loans. *REAL_ESTATE_LOAN* is real estate loans as a percentage of total loans. *NPL* is non-performing loans (i.e., loans past due 30 days, 90 days, and non-interest-accruing) as a percentage of total loans. *ROA* is net income as a percentage of total assets. *UNINSURED_DEPOSIT* is uninsured assessable deposits as a percentage of total assessable deposits. *LIQUIDITY* is the cash and balances due from depository institutions and securities as a percentage of total deposits. *TOTAL ASSETS* is total assets in billions. All the variables have been winsorized at the 1st and 99th percentiles within the year.

Variable	Mean	Std Dev	P25	Median	P75
FAIL	0.036	0.187	0.000	0.000	0.000
CH_LLR	0.106	0.337	-0.026	0.053	0.191
REAL_ESTATE_LOAN	69.272	19.809	58.176	72.948	83.870
NPL	2.525	2.588	0.771	1.806	3.380
ROA	0.863	0.888	0.520	0.921	1.296
UNINSURED_DEPOSIT	40.508	15.670	29.476	38.120	48.963
LIQUIDITY	5.309	4.804	2.812	3.933	5.894
TOTAL_ASSETS	0.465	1.418	0.063	0.133	0.303
CH_LLR_LAG	0.122	0.331	-0.009	0.065	0.193

Table 5 Bank failure and regulatory capital

This table presents Cox proportional hazard regressions that analyze the relation between bank failure and regulatory capital. The sample consists of 7,383 commercial banks. The definitions of all the variables can be found in Table 4. Panel A documents the results of the hazard regressions. The t-statistic of each coefficient is provided in brackets below the coefficient. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Panel B provides some analyses of the relative significance of the variables. For each continuous explanatory variable (i.e., all variables except the region dummies), a single-standard deviation increase in the variable is used to assess its economic effect on bank failure risk. For each region dummy, a one-unit increase in the variable is used; this compares the bank failure risk of a bank in a certain region relative to that of a bank in the Northeast region.

Panel A: Regression results

	Dependent variable is H(t), hazard of bank failure at time t	
TOTAL_RBC	-0.141***	
	[-6.86]	
TIER1_RBC		-0.140***
		[-6.85]
TIER2_RBC		0.320**
		[1.99]
REAL_ESTATE_LOAN	0.038***	0.038***
	[7.30]	[7.30]
NPL	0.200***	0.196***
	[12.77]	[12.36]
ROA	-0.326***	-0.318***
	[-5.77]	[-5.58]
UNINSURED_DEPOSIT	0.014***	0.014***
	[3.43]	[3.25]
LIQUIDITY	-0.117***	-0.118***
	[-4.00]	[-3.99]
TOTAL_ASSETS	0.051	0.016
	[1.40]	[0.42]
REGION2	1.146***	1.129***
	[3.21]	[3.17]
REGION3	1.151***	1.126***
	[3.28]	[3.22]
REGION4	2.113***	2.103***
	[5.87]	[5.84]

Panel B: Hazard ratios

TOTAL_RBC	0.339	
TIER1_RBC		0.341
TIER2_RBC		1.118
REAL_ESTATE_LOAN	2.123	2.123
NPL	1.678	1.661
ROA	0.749	0.754
UNINSURED_DEPOSIT	1.245	1.245
LIQUIDITY	0.570	0.567
TOTAL_ASSETS ($b)	1.075	1.023
REGION2	3.146	3.093
REGION3	3.161	3.083
REGION4	8.273	8.191

Table 6 Decomposition of change in loan loss reserves

This table presents the ordinary least squares regressions that decompose changes in loan loss reserves into normal and abnormal changes in loan loss reserves. The decomposition is done for changes in loan loss reserves in 2007 and 2006 for our sample of 7,383 banks. The dependent variable is *CH_LLR*, which is the change in loan loss reserves as a percentage of total loans. *REAL_ESTATE_LOAN* is real estate loans as a percentage of total loans. *CH_NPL* is the change in non-performing loans (i.e., loans past due 30 days, 90 days, and non-interest-accruing) as a percentage of total assets. *LOAN* is total loans as a percentage of total assets. *REAL_ESTATE_LOAN* is real estate loans as a percentage of total loans. *OTHER_LOAN* is the sum of commercial and industrial loans, loans to depository institutions, agricultural loans, loans to individuals, and loans to foreign governments as a percentage of total loans. The t-statistic of each coefficient is provided in brackets below the coefficient. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is *CH_LLR*	
	2007	2006
Intercept	-0.022	0.103***
	[-0.71]	[3.78]
CH_NPL	0.045***	0.025***
	[23.79]	[10.05]
LOAN	0.003***	0.003***
	[13.12]	[11.71]
REAL_ESTATE_LOAN	-0.001***	-0.002***
	[-4.13]	[-6.31]
OTHER_LOAN	-0.002***	-0.003***
	[-4.90]	[-9.63]
Observations	7,383	7,197
Adjusted R-square (%)	10.86	5.21

Table 7 The effect of change in loan loss reserves on the relation between bank failure and Tier 2 capital

This table presents Cox proportional hazard regressions that analyze how a change in loan loss reserves in 2007 affects the relation between bank failure in 2008, 2009, or 2010 and regulatory capital in 2007. *CH_LLR* is an indicator variable equaling one if there is an increase in loan loss reserves in 2007, and zero otherwise. *ABN_CH_LLR* is an indicator variable equaling one if there is an abnormal increase in loan loss reserves in 2007, and zero otherwise. All the other variables are defined in Table 5. The t-statistic of each coefficient is provided in brackets below the coefficient. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is H(t), hazard of bank failure at time t		
TIER_2_RBC x CH_LLR	1.344**		
	[2.37]		
TIER_2_RBC x ABN_CH_LLR		1.021**	1.163***
		[2.45]	[2.62]
TIER_2_RBC x ABN_CH_LLR_LAG			0.134
			[0.44]
TIER_1_RBC x CH_LLR	-0.024		
	[-0.51]		
TIER_1_RBC x ABN_CH_LLR		0.254***	0.224***
		[4.31]	[3.60]
TIER_1_RBC x ABN_CH_LLR_LAG			0.097*
			[1.89]
TIER2_RBC	-0.925*	-0.566	-0.803*
	[-1.71]	[-1.49]	[-1.94]
TIER1_RBC	-0.118***	-0.344***	-0.392***
	[-2.90]	[-6.16]	[-6.20]
CH_LLR	-0.838		
	[-0.99]		
ABN_CH_LLR		-3.435***	-3.331***
		[-4.09]	[-3.72]
ABN_CH_LLR_LAG			-0.8
			[-1.06]
REAL_ESTATE_LOAN	0.038***	0.038***	0.036***
	[7.28]	[7.25]	[6.90]
NPL	0.198***	0.204***	0.220***
	[12.54]	[13.11]	[13.64]
ROA	-0.308***	-0.229***	-0.153**
	[-5.49]	[-4.00]	[-2.47]
UNINSURED_DEPOSIT	0.012***	0.011***	0.010**
	[2.93]	[2.68]	[2.26]
LIQUIDITY	-0.110***	-0.106***	-0.117***
	[-3.79]	[-3.68]	[-3.71]
TOTAL_ASSETS	0.005	0.002	0.017
	[0.12]	[0.05]	[0.43]
REGION2	1.146***	1.065***	1.122***
	[3.22]	[2.99]	[2.98]
REGION3	1.136***	1.052***	1.009***
	[3.24]	[3.01]	[2.71]
REGION4	2.107***	1.983***	1.944***
	[5.84]	[5.51]	[5.09]
Observations	7,389	7,389	7,196

Table 8 Cross-sectional variation with 1.25% limit on add-back of loan loss reserves as Tier 2 capital

This table presents Cox proportional hazard regressions that extend the analysis in Column 3 of Table 7. The regressions examine whether there is cross-sectional variation in how abnormal changes in loan loss reserves in 2007 influence the relation between bank failure in 2008, 2009, or 2010 and regulatory capital in 2007, conditional on constraints in adding back loan loss reserves as Tier 2 capital. *1.25% LIMIT* is an indicator variable equaling one if the bank is constrained in added back loan loss reserves as Tier 2 capital at the end of 2006, and zero otherwise; a bank is constrained if its excess loan loss reserves as a percentage of risk-weighted assets is above the 1.25% limit. The definitions of all other variables are found in Table 7. The t-statistic of each coefficient is provided in brackets below the coefficient. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is H(t), hazard of bank failure at time t	
	1.25% LIMIT	
	Low	High
TIER_2_RBC x ABN_CH_LLR	1.339**	0.378
	[2.38]	[0.45]
TIER_2_RBC x ABN_CH_LLR_LAG	0.178	-0.272
	[0.51]	[-0.38]
TIER2_RBC	0.214**	0.223***
	[2.38]	[2.61]
TIER_1_RBC x ABN_CH_LLR	0.149*	0.053
	[1.84]	[0.79]
TIER_1_RBC x ABN_CH_LLR_LAG	-1.134**	0.767
	[-2.16]	[0.85]
TIER1_RBC	-0.445***	-0.334***
	[-5.01]	[-3.67]
ΔLLR	-3.296***	-2.566*
	[-2.72]	[-1.68]
ΔLLR_LAG	-1.345	0.208
	[-1.24]	[0.16]
REAL_ESTATE_LOAN	0.042***	0.029***
	[6.00]	[3.59]
NPL	0.239***	0.191***
	[11.94]	[6.79]
ROA	-0.160**	-0.186*
	[-2.00]	[-1.83]
UNINSURED_DEPOSIT	0.003	0.230***
	[0.55]	[3.21]
LIQUIDITY	-0.112***	-0.103**
	[-2.78]	[-2.07]
TOTAL_ASSETS	0.036	-0.087
	[0.85]	[-0.71]
REGION2	2.016***	-0.077
	[3.37]	[-0.15]
REGION3	1.762***	0.03
	[2.96]	[0.06]
REGION4	2.655***	1.049**
	[4.39]	[2.02]
Observations	4,615	2,581

Table 9 Cross-sectional variation with audit quality and agency problem

This table presents Cox proportional hazard regressions that extend the analysis in Column 3 of Table 7. The regressions examine whether there is cross-sectional variation in how abnormal changes in loan loss reserves in 2007 influence the relation between bank failure in 2008, 2009, or 2010 and regulatory capital in 2007, conditional on audit quality and the level of agency problems. *AUDIT QUALITY* is an indicator variable equaling one if there was an independent audit of the bank conducted in accordance with generally accepted auditing standards by a certified public accounting firm which submits a report on the bank, and zero otherwise. *AGENCY PROBLEM* is an indicator variable equaling one if the bank has overhead expenses as a percentage of total assets that is above the median in 2007. The definitions of all the other variables are found in Table 7. The t-statistic of each coefficient is provided in brackets below the coefficient. Significance levels are based on two-tailed tests. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable is H(t), hazard of bank failure at time t			
	AUDIT_QUALITY		*AGENCY_PROBLEM*	
	Low	High	Low	High
TIER_2_RBC x ABN_CH_LLR	1.615***	0.637	0.596	1.978**
	[2.66]	[0.98]	[1.08]	[2.52]
TIER_2_RBC x ABN_CH_LLR_LAG	-0.061	0.186	-0.101	-0.315
	[-0.14]	[0.41]	[-0.25]	[-0.54]
TIER2_RBC	0.429***	0.056	-0.027	0.236***
	[3.99]	[0.82]	[-0.24]	[2.90]
TIER_1_RBC x ABN_CH_LLR	0.077	0.109	-0.109	0.127**
	[1.01]	[1.56]	[-0.94]	[2.13]
TIER_1_RBC x ABN_CH_LLR_LAG	-1.297**	-0.205	-0.626	-0.778
	[-2.33]	[-0.33]	[-1.20]	[-1.12]
TIER1_RBC	-0.550***	-0.273***	-0.306***	-0.376***
	[-5.15]	[-3.62]	[-3.34]	[-4.42]
ΔLLR	-6.099***	-0.654	-0.268	-4.235***
	[-4.33]	[-0.56]	[-0.18]	[-3.22]
ΔLLR_LAG	-0.319	-0.95	1.723	-0.725
	[-0.30]	[-0.87]	[1.18]	[-0.71]
REAL_ESTATE_LOAN	0.037***	0.034***	0.049***	0.025***
	[4.98]	[4.55]	[5.14]	[3.92]
NPL	0.221***	0.228***	0.219***	0.214***
	[9.43]	[9.96]	[8.93]	[9.96]
ROA	-0.066	-0.230**	-0.072	-0.203**
	[-0.74]	[-2.45]	[-0.60]	[-2.51]
UNINSURED_DEPOSIT	0.014**	0.006	0.008	0.012**
	[2.36]	[0.92]	[1.19]	[2.03]
LIQUIDITY	-0.132***	-0.106***	-0.189***	-0.077**
	[-2.73]	[-2.61]	[-3.22]	[-2.12]
TOTAL_ASSETS	0.032	0.049	0.064	-0.126
	[0.68]	[0.64]	[1.43]	[-1.30]
REGION2	2.053**	1.174***	1.371**	0.926*
	[2.02]	[2.73]	[2.24]	[1.92]
REGION3	1.798*	1.025**	1.334**	0.654
	[1.77]	[2.49]	[2.20]	[1.37]
REGION4	2.937***	1.724***	2.380***	1.530***
	[2.88]	[3.85]	[3.87]	[3.08]
Observations	4,469	2,727	3,648	3,548