# The determinants of bank failures in the United States: Revisited[1]

by

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**Abstract:** This paper examines the determinants of bank failures in the US banking system during the recent financial crisis. The analysis employs a dataset on the financial statements reported by FDIC-insured commercial banks and their bank holding companies headquartered in the United States along with information on bank failures, mergers, acquisitions and individual bank rescues. Using limited-dependent variable regression techniques, we find that failed banks were characterized by significantly higher loan growth rates, well ahead of the financial crisis (3-5 years), with higher exposures to the mortgage market. We also find evidence that banks were more likely to fail when they were owned by less capitalized bank holding companies that relied to a higher extent on funding from money markets and from their non-bank subsidiaries. Regarding the appropriate regulation of banks, we provide evidence that capital requirements should be forward-looking and linked to banks' past loan growth.

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# 1 Introduction

The global financial crisis, which started with the Lehman collapse on the 15th September 2008, was associated with an unprecedented financial crash that affected the major banking systems world-wide. The authorities in a number of countries responded by rescue operations that involved both system-wide interventions (extended deposit insurance and monetary easing) and individually-targeted bank rescues (asset purchases, debt guarantees, and recapitalizations). The policy measures were aimed at ensuring the solvency of fragile banks and at restoring confidence in the financial system as a whole (Borio et al. (2010)). By end-2010, the governments of the G10 economies have injected close to $1,285 billion of capital into troubled banks (Brei et al. (2013)).

A few weeks after the Lehman collapse, the US government responded on the 3rd October to the increasing tensions in the banking system by implementing its largest rescue package, the TARP rescue (Troubled Asset Relief Program), allowing the Treasury to purchase or insure up to $700 billion of troubled assets or to purchase equity in distressed banks (Black and Hazelwood (2012)). Overall, the Treasury injected $257 billion of public funds in 531 holding companies that controlled 826 bank subsidiaries. The Federal Reserve for its part responded earlier to the crisis with both conventional monetary policy (interest rate cuts and liquidity provision through the discount window) and unconventional monetary policy that was aimed at providing funds to troubled banks and to calm down financial markets. The crisis response increased the Federal Reserve's balance sheet from $900 to 2,200 billion during September and November 2008.

Despite these massive interventions by the authorities, 301 commercial banks, 39 thrift institutions, and 10 bank holding companies have failed during 2008-10, and were placed into receivership by the Federal Deposit Insurance Corporation (FDIC), involving $670 billion of FDIC-insured assets.[2] The majority of failures occurred during the first and second quarter of 2009, affecting most the banking sectors of Georgia (55 failures), Florida (49), and Illinois (40). The largest bank failures are those of Lehman Brothers ($600 billion of assets) and Washington

[2] FDIC-insured institutions include commercial banks and saving institutions that operate in the US including subsidiaries of foreign deposit-taking institutions. This number does not include the failure of Lehman Brothers which was a not FDIC-insured investment bank.

Mutual Bank, a FDIC-insured thrift institution with $330 billion of assets. Problems in banks with financial difficulties have also been resolved with the aid of other banks, as exemplified by the acquisition of the investment bank Bear Stearns by JP Morgan Chase and Bank of America's acquisitions of Merrill Lynch and Countrywide Financial. In total, the US banking system experienced 723 mergers and acquisitions of FDIC-insured institutions during 2008-10, involving $1,400 billion of assets.

Against these backdrops, this paper investigates the determinants of bank failures during the recent financial crisis. The experience with over 300 bank failures that occurred in the US during 2008-2010, coupled with the fact that most bank information is publicly available, makes it a good laboratory for such an investigation. In particular, we examine whether and at which moment bank risks have been apparent in the financial statements of banks. To this purpose, we employ a dataset on the quarterly call reports of some 14,000 commercial banks and 8,400 bank holding companies that operated in the US during the period 1995-2010. The data has been complemented with information on mergers, acquisitions, bank failures, and TARP-related recapitalizations of bank holding companies. Using different measures of bank failure (ranging from outright receivership to acquisitions of undercapitalized banks), we find robust evidence that those banks that later came into serious troubles have been characterized by significantly higher loan growth rates, well ahead of the financial crisis, with higher exposures to the mortgage segment than banks that survived. At the same time, they operated with significantly lower regulatory capital ratios pointing to aggressive growth strategies. Once bank holding information is taken into account, we find that bank subsidiaries of low capitalized bank holdings with higher exposures to funding from money markets and their non-banking subsidiaries have been more likely to fail.

Our results offer interesting insights to the debate on the regulation and supervision of banks, as well as to the academic literature on the determinants of bank failures. In response to the global financial crisis, bank regulation has been strengthened with a focus on capital adequacy, liquidity positions, and the treatment of systemically important financial institutions (BCBS (2010)). There has also re-emerged the debate about the separation of the traditional banking business from investment banking. Our results confirm that this was a move into the right

direction by increasing banks' loss-absorbing capacity and reducing the danger of contagion originating in financial markets. However, bank regulation should put more weight on containing excessive growth of financial institutions by, for example, requiring capital buffers that are linked to the average growth rate of loans in a forward-looking way. With regard to the empirical literature on bank failures (see, amongst others, Wheelock and Wilson (2000), Oshinsky and Olin (2006), and King et al. (2006)), we shed light on the determinants of bank failures during the most recent experience of a wave of bank failures, using a comprehensive dataset on commercial banks' financial statements combined with information on bank holding companies.

The paper is structured as follows. The next section overviews the literature on bank risks and puts it in the historical context of financial deregulation and innovation. Section 3 presents the data and discusses some summary statistics. Section 4 presents the econometric framework and discusses the main results, while Section 5 offers some robustness checks on the failure definition and estimation method. The final section concludes.

## 2 Risks at banks and regulation of bank failures

### 2.1. Historical context

Banking legislation has played an important role in the bank failure experience of the recent financial crisis. World-wide, there has been a trend towards the liberalization and deregulation of banking systems, motivated by the gains from increased competition among banking institutions. The recent financial crisis, however, has put this view into question and regulators have moved towards striking the balance better between encouraging bank competition and preserving financial stability.

In the early 1990s, the US legislation focused on the risks posed by geographic lending concentration and removed restrictions on interstate banking, an artifact of the *Glass-Steagall*

*Act* of 1933.[3] It then moved gradually towards increased banking liberalization and, by 1999, the legislation removed many restrictions imposed on a broad range of financial activities banks could engage in, including the underwriting and dealing of securities, insurance underwriting, and merchant bank activities.[4] As a result, the US banking system experienced important structural changes throughout the last two decades in the form a huge wave of (interstate) consolidation, and the emergence of large financial institutions that operate in a wide range of banking and investment activities. In response to the financial crisis, the US banking regulation has been strengthened and a number of restrictions have been imposed on the activities banks can engage in.[5]

The other major driver of the changing financial landscape, notably in the US, has been the rapid growth in financial innovation and financial markets. It made banks more interconnected with financial markets. The higher reliance on market funding opposed to the traditional deposit funding is one example. The wave of securitization of loan books is another example which allowed banks to commercialize and transfer credit risks to other parties. It opened, however, the door for more relaxed loan underwriting standards, as banks could simply sell their loans on secondary markets in complex bundles and different risk tranches (in the form of mortgage-backed securities).

### 2.2. The determinants of bank distress

The changes in the banking environment call for a re-examination of the causes of bank distress. The experience with over 300 bank failures that occurred in the US during 2008-2010, coupled with the fact that most bank information is publicly available, makes it a good laboratory for an investigation of the determinants of recent bank distress.

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[3] *Riegle-Neal Interstate Banking and Branching Efficiency Act*, 1994.

[4] *Gramm-Leach-Bliley Act*, 1999. See, amongst others, Avraham et al. (2012).

[5] With the *Dodd-Frank Act* of 2010, notably, provision 619, also known as the 'Volcker rule'. It prohibits banks from proprietary trading on many financial instruments and limits the ownership in private equity firms, hedge funds, and some types on investment vehicles.

The early literature on the causes of bank failures and bank distress dates back to the late 1960s.[6] Empirical studies at that time used primarily discriminant analysis on a limited number of financial ratios based on the seminal work of Altman (1968). With the advances in computer technology in the 1970s, a new strand of literature emerged employing discrete-response regression techniques. While some studies focused on the prediction of bank failures (such as Martin (1977), Bovenzi et al. (1983), and Lane et al. (1986)), others examined the determinants of changes in supervisory bank ratings (such as West (1985) and Whalen and Thomson (1988)).[7] The studies consistently pointed out some common determinants of bank distress (capital adequacy, asset quality, liquidity, and profitability) on which parts of the current early-warning system of banking supervision is based (such as the ratings system CAMEL: **C**apital adequacy, **A**sset quality, **M**anagement quality, **E**arnings, **L**iquidity).[8]

The recent supervision of banks is based on two early-warning systems of bank distress, the System to Estimate Examination Ratings (SEER) and the Statistical CAMELS Offsite Rating (SCOR), see King et al. (2006). The SEER framework combines a failure model that estimates the probability of failure with a rating model that estimates the CAMELS scores (ranging from 1 (= healthy bank) to 5 (= most vulnerable bank). While the rating model is updated on a quarterly basis, the failure model has been subject to very few changes, since its establishment in the early 1990s, due the few observations on bank failures. The SCOR framework combines a rating forecast with a CAMELS downgrade forecast (Collier et al. (2003)). As suggested by Gilbert et al. (2002), the SEER and SCOR frameworks tend to identify the same group of financial ratios as predictors of bank distress. According to this study, however, the SCOR system offers the advantage that the CAMELS downgrade model can be updated periodically opposed to the SEER model for bank failures (at least prior to the recent financial turmoil).

[6] King et al. (2006) provide an extensive overview of the development of this literature.

[7] The most common estimation methods for predicting bank failures have been the Logit and Probit frameworks that model the probability of failure (used in Martin (1977) and Bovenzi et al. (1983)) and the Cox (1974) proportional hazard framework that models the time to failure (used in Lane et al. (1986) and Wheelock and Wilson (1995, 2000)). With regard to the prediction of rating changes the most commonly used estimation method is the ordered Logit framework.

[8] In 1997, sensitivity to market risk was included resulting in the CAMELS framework.

The supervisory framework suggests that it can be a long process from becoming a problem bank with a high probability of being downgraded to a bank that fails. Indeed, the two issues are interdepended, as will be discussed in the following.

### 2.3. From a problem bank to the bankruptcy

Before a bank is closed and placed into receivership by the FDIC, it is typically already under closer monitoring by the Office of the Comptroller of the Currency (OCC), the major supervisory authority in the United States.[9] The objective of the OCC is the early identification of problem banks to enable their rehabilitation using a number of possible enforcement actions (corrective action plans). Only if the remedial action has been ineffective and a bank's condition gets so severe that it is no longer viable, the OCC and FDIC collaborate to achieve a timely resolution in a way that results in the least cost to the deposit insurance fund (OCC (2001)).[10]

For the early identification of problem banks, the OCC uses an early warning system that brings together a number of statistical and econometric tools as discussed before (also known as the *Canary system*).[11] In addition to these off-site examination tools, the OCC examiners visit periodically banks on-site to ensure that financial statements are correctly reported (such as asset valuations), and to collaborate with the management and directors in the rehabilitation plan, once a bank is classified as being vulnerable to downgrades. If no improvement in a problem bank occurs, the OCC adapts a capital-based regulation that places increasingly stringent restrictions on the bank's activities, as regulatory capital levels decline (OCC (2001)). In

[9] Though, there exists evidence of some exceptions in which the OCC did not detect problem banks early enough, including the cases of the United States National Bank and Franklin National Bank in the early 1970s (White (1992)). In the more recent crisis period, the Office of Thrift Supervision (OTS) has been at the centre of criticism caused by the unexpected collapse of some important thrift institutions. In response, the responsibilities of the OTS have been transferred to the OCC in 2012.

[10] The resolution process is financed by the deposit insurance fund who itself is funded by insurance premiums from banks and saving institutions.

[11] The components of this system can be classified into four categories: benchmarks (on credit, interest rate, and liquidity positions), credit scope (on credit assessment and loan concentration), market barometers (on risks in credit and financial markets), and predictive models (such as the SEER and SCOR systems and peer group risk models).

the extreme case which typically occurs, when a bank's tangible equity ratio falls below 2 percent, the bank is given 90 days to take *prompt corrective action*.[12] The two available options are either a major recapitalization or the sale of the bank.

If a bank does not solve its problems with the prompt corrective action plan, then the FDIC (appointed as the receiver of the bank's assets) declares the bank insolvent and takes over the management. After a bank's assets are placed into receivership, the FDIC starts the resolution process encompassing the repayment (or transfer) of deposits up to the insurance limit, the liquidation and sale of assets, and the settlement of other debts (including claims for deposits in excess of the insured limit).[13] To minimize the costs to the deposit insurance fund, the FDIC estimates the liquidation value of the bank's assets, identifies potential buyers (banks with good ratings and adequate size), and decides about the assets that could be included in the sale. The interested parties submit in response a three-part bid that includes the premium for taking over the deposits, the amount they would pay for the assets, and whether they will assume all or only the insured deposits.

In practice, the majority of bank resolutions (90% during 2008-10) have been *purchase and assumption* agreements in which the insured (and uninsured) deposits, other liabilities, and certain assets are sold to the acquiring institution. The remaining resolutions schemes included *assistance transactions* (in which the FDIC finances a part of the transaction) and *payout resolutions* (the FDIC pays out the insured depositors and closes the bank).

## 3 Description of the dataset

For the current study, we merge three datasets that are maintained by the Federal Reserve Bank of Chicago: (i) the quarterly *Reports of Condition and Income* (also known as the 'call

[12] The tangible equity ratio is defined as Tier 1 capital plus cumulative preferred stock and related surplus less intangibles (excluding qualifying purchased mortgage servicing rights) divided by total assets less intangibles (excluding qualifying purchased mortgage servicing rights).

[13] The Emergency Economic Stabilization Act of 2008 increased the deposit insurance limit from $100,000 to $250,000.

reports') submitted by FDIC-insured institutions[14]; (ii) the quarterly or semi-annual reports of bank holding companies; and (iii) information on bank failures, mergers and acquisitions. The specific reporting requirements depend on bank size and whether a bank has foreign offices.[15] In general, the reports that apply to large banks and those with foreign offices are more detailed (reporting form FFIEC-031 instead of FFIEC-041 for smaller banks). The statements are on a consolidated basis, which implies that headquarters integrate the positions of any majority-owned subsidiary into their financial statement. Bank holdings' financial report can be merged with that of commercial banks using the information on the top regulatory holding company. Large bank holdings are required to report both consolidated and unconsolidated statements (reporting forms FR Y-9C and FR Y-9LP, respectively).[16] For example, the statement of *Citigroup INC* (the bank holding company) can be matched with the statements of the two national banks *Citibank NA* (60% of the BHC's consolidated assets) and *Citibank South Dakota NA* (10%), the Edge Corporation Citibank *Overseas Investment Corporation* (22%), and two small non-deposit trust companies.

The sample consists in total of 14,131 commercial banks that operated in the US during the period 1995-2010 of which 7,257 institutions have been active at end-2010 (Figure 1, left-hand panel). Most of this evolution can be explained by a huge wave of consolidation (mainly in the late 1990s) that involved some 6,000 mergers and acquisitions (Figure 1, right-hand panel) and $7 trillion of assets (Table 1). Acquisition activities have been more frequent in normal times slowing down with the advent of the economic downturns in 2000-01 and 2008-09 (Jones and Critchfield (2004) and Hannan and Pilloff (2009)). As of end-2010, a total of 4820 bank holding companies controlled 5607 commercial banks (77% of all banks) holding $13.1 trillion of assets (85% of the banking system). Taken on their own, bank holding companies owned $3 trillion of

[14] Every national bank, state member bank, and insured non-member bank is required to file consolidated Reports of Condition and Income. The database does not, however, include the Thrift Financial Reports (which are available one-by-one and date-by-date on the FDIC webpage).

[15] The threshold for large banks is $500 million of assets. Foreign offices include international banking facilities, branches, majority-owned subsidiaries, or majority-owned Edge or Agreement subsidiaries.

[16] As for commercial banks, the reports of small bank holdings (with less than $500 million of assets) are less detailed, and they only report on an unconsolidated basis (reporting form FR Y-9SP).

unconsolidated assets in, on average, one FDIC-insured banking subsidiary (the highest number of controlled bank subsidiaries is 20).

**[Figure 1 around here]**

Over the period 1995-2010, 383 institutions failed and had to be intervened by a regulatory agency (most often the FDIC). The majority of bank failures (342 cases) occurred during 2008-10 involving $670 billion of total assets (Figure 1, right-hand panel, and Table 1). The largest failure of a FDIC-insured institution represents Washington Mutual Bank ($300 billion of assets) classified as a thrift institution.[17] Out of the 342 bank failures associated with the financial crisis, 39 cases involved thrift institutions, 51 independent commercial banks and 252 banking subsidiaries of bank holding companies.

**[Table 1 around here]**

The consolidation of the banking sector occurred despite the important increase in the US banking sector's total assets which tripled during 1995-2010 (from $5 to 15 trillion) indicating that the average size of banks has increased over time. Only in 2009 bank assets have fallen which can be explain by a reductions in non-deposit funding and the volume of loans (Figure 2). Interest-bearing deposits, the major funding source of banks, remained stable with the advent of the financial crisis. The share of securities in total bank assets has increased importantly since 2003 associated with the surge in securitization. There is an important increase in liquidity held in banks with the onset of the financial crisis in 2008, affirming the difficulty of liquidity circulation on the market and the withholding of liquid funds within banks resulting from the risky and volatile crisis environment. On average, banks' equity-to-asset ratio remained beyond 10% over the whole sample. Bank equity, however, did not increase as quickly as total assets especially during the period 2003-07.

**[Figure 2 around here]**

There is a clear pattern that failed banks expanded their loan portfolio at higher rates than banks that later survived. Overall, the financial crisis had a significant negative impact on bank

[17] Box 1 in the Appendix B provides a snapshot of Washington Mutual Bank's resolution.

lending as evidenced by the drop of the annual growth rate of lending from an average of 12% during 2001-07 to 6% during 2008-10 (Table 2, last column). As can be seen in Table 2, the slowdown in bank lending occurred mainly in large banks (who had lower capital and liquidity ratios than the other banks). The other banks' lending is more stable, even counter-cyclical, in the case of highly capitalized banks. The fact that large banks' higher loan growth was associated with lower capital ratios compared to small banks might be an indication for their more relaxed attitude toward risk implied by their too-big-too-fail status.

**[Table 2 around here]**

When comparing failed banks with non-failed banks in Table 2, we find that failed banks have been on average significantly smaller than non-failed banks ($800 billion of assets compared to $1,800 billion). The growth rate of lending is unsurprisingly lowest during the crisis (2% compared to 5% for banks that survived). Interestingly, the loan growth is highest for failed banks in the period 1995-2000 (17% annually), which eventually points to their aggressive lending strategy in the past. There are clear signs of financial vulnerability of failed banks prior to the intervention by the regulator. If we calculate their financial ratios for the last three years of their life, this is especially apparent in their profitability (measured by ROE), impaired loans and regulatory capital.

**[Figure 3 around here]**

Figure 3 substantiates our observations by comparing key balance sheet ratios across failed and non-failed banks over time. Equity over total assets and asset growth of failed banks start deteriorating 10-12 quarters before the intervention (upper and middle left-hand panels of Figure 3). The equity ratio drops from an average of 10% of assets to 2% in the quarter prior to the failure. Interestingly, average asset growth of failed banks is higher for failed banks before the downturn dropping from 25% to -10% at the time of failure. Again this is eventually an indication of their aggressive growth strategy. Failed banks are less profitable than non-failed banks in the 10-year window (measured by ROA, lower left-hand panel of Figure 3) dropping to -6% at the time of failure. Loan loss provisions on the other hand start increasing 10 quarters prior to the failures, a concomitant of increasing non-performing loans.

## 4 Econometric strategy and estimation results

In this section we lay out the baseline specification to estimate the probability of failure as a function of bank-specific and macroeconomic conditions.

### 4.1. The basic framework

The econometric model is estimated using the pooled Logit estimator for panel data which can be represented as follows:

$$Prob(Y_{it} = 1|X_{it-4}, Z_{it}) = \frac{1}{1 + \exp\left(-\beta X_{it-4} - \gamma Z_{it}\right)} + \varepsilon_{it} \ ,$$

where the subscripts refer to bank *i* in period *t*.[18] The dependent variable $Y_{it}$ is an indicator variable that is equal to one in the quarter a bank fails and zero otherwise. We employ two ***definitions of failure***. According to our first definition, we consider a bank as failing in the quarter it was intervened and closed by the FDIC or a similar regulatory authority. The second failure definition makes two modifications: (i) it includes as well 'undercapitalized' banks that have been acquired, defining undercapitalized banks in line with the correspondent Prompt Corrective Action category: a bank's risk-weighted capital ratio is less than 8% or its Tier 1 ratio is less than 4%;[19] and (ii) it modifies the failure date defining it as the quarter in which a failed bank became for the first time 'critically undercapitalized' in line with the correspondent Prompt Corrective Action category: the tangible equity to assets ratio falls below two percent. The reason for these modifications is that some banks that fulfill the bankruptcy conditions are purchased by other private institutions in the resolution process through a merger and

[18] We re-estimated the regressions with two other estimators including the Logit estimator for rare events data (King and Zeng (2001)) and the Logit estimator with random effects. Since the results are qualitatively the same, we do not report these robustness checks here to save space, but the results can be obtained from the authors upon request.

[19] See, Section 38 of the Federal Deposit Insurance Act.

acquisition procedure, while in other cases they are allowed to remain open even though they are technically insolvent (Mailath and Mester (1994), Wheelock and Wilson (1999)).

The set of explanatory variables includes bank-specific risk indicators taken from the call reports $X_{it-4}$ and macroeconomic variables $Z_{it}$ (as discussed below). The model is estimated by maximum likelihood with standard errors that are robust to heteroskedasticity. We estimated the model for different time intervals and decided to focus here on the period 2006-10, since it strikes a balance between pre-crisis and crisis observations. Moreover it captures the 302 commercial bank failures (of 342 cases that occurred since 1995). The bank-specific characteristics have been lagged by four quarters, while the macroeconomic variables enter the regression contemporaneously. In the following, we discuss the relations between bank failures and our explanatory variables.

### 4.2. Discussion of the explanatory variables in vectors $X_{it-4}$ and $Z_{it}$

Our choice of variables is in part based on the CAMELS framework for banking supervision which classifies bank performance (or risk) indicators into six categories: **C**apital adequacy, **A**sset quality, **M**anagement quality, **E**arnings, **L**iquidity, and **S**ensitivity to Market Risk. As discussed in Section 2, the framework is used by the OCC and other regulatory agencies to assign individual bank ratings to determine whether a bank requires a high supervisory concern or not.

***Capital adequacy*** is measured with the *total risk-based capital ratio*. This measure of capital is preferred to the traditional equity-to-asset ratio as it captures more information about core equity (such as Tier 1 and Tier 2) and puts it in relation to risk-weighted assets. The theoretical relationship between capital and bank risk is ambiguous. Higher capital might be an indication of a larger buffer stock of equity against large losses, lowering the probability of failure and improving risk-taking incentives. It also means that banks have more equity at risk which implies that expected default costs are higher which improves banks' risk-taking incentives (Hellmann et al. (2000)). On the other hand, a capital ratio might be high for regulatory reasons as stricter capital requirements are imposed on riskier banks. A high capital base also means that the

default probability is less sensitive to risky investment decisions distorting incentives to monitor risks properly. Since quickly declining capital levels mechanically precede bank defaults, we expect capital to be negatively related to the probability of failure, i.e. a higher level of capital is associated with a lower probability of default.

As measures for ***asset quality***, we use the *non-performing loan* ratio, *other real estate-owned assets* in total assets, *mortgages* in total loans, *bank size* (logarithm of total assets), *past loan growth*, the *foreign-assets ratio*, and *asset- or mortgage-backed securities* in total assets. Non-performing loans and other real estate-owned assets (which include foreclosed real-estate) are intended to capture the quality of a bank's loan book. If lending standards have been loose, it is more likely that a higher fraction of borrowers will not repay in full, or in time, and that more mortgages will have to be foreclosed. We include as well mortgages as a fraction of total loans, which is another way of accounting for a bank's exposure to the housing market, which was at the center of the subprime crisis of 2007-08 (Demyanyk and Van Hemert (2011)). We expect the variables to be positively related to the probability of failure.

The next control variable is bank size and it is an empirical question whether it is positively or negatively linked to bank default. On the one hand, large and systemic banks benefit from an implicit bailout guarantee, as governments are unlikely to let them fail in the case of distress. This would reduce failure probabilities. Moreover, large banks should be less vulnerable to idiosyncratic shocks through their global scope and diversification. Most theoretical models establish a positive link between size and the benefits of diversification (Diamond (1984), Williamson (1986)). On the other hand, implicit bailout guarantees distort bank incentives, since banks can take on risks without being penalized for it by the market or a closure. This moral hazard mechanism tends to increase risks and failure probabilities. Similarly, banks might simply get too complex to manage and to supervise (Cerasi and Daltung (2000)).[20] Finally, large banks might be more affected by systemic shocks on capital markets compared to smaller banks, as small banks tend to operate regionally, are less active in financial markets, and engage more in (stable) relationship lending.

[20] For instance, the bank holding company *JP Morgan Chase & Co* controlled at-end 2011 close to 3400 subsidiaries (of which 451 are foreign entities), see Avraham et al (2012).

Another variable that captures information about asset quality is a bank's past loan growth, because high growth rates can be an indication of an aggressive growth strategy associated with looser lending standards (Keeton (1999), Salas and Saurina (2003), Dell'Ariccia and Marquez (2006)). Typically, a failing bank will not have a high loan growth in the run up to its closure, as the regulator will impose more and more restrictions on bank activities when capital levels decline. Rather, failing banks might be characterized by an excessive loan growth well-ahead of the failure (as evidenced in Figure 3). We have experimented with different lags and calculate past loan growth as the average of the annual loan growth lagged by 10 to 17 quarters (as suggested in Figure 3) and expect it to be positively related with the probability of failure.

Asset- and mortgage-backed securities (ABS and MBS, respectively) have been at the center of the recent financial crisis and a source of toxic assets. We include two measures, the sum of ABS and MBS held-to-maturity (HTM) over total assets, and the sum of ABS and MBS that are available-for-sale (AFS). Higher investments in ABS and MBS might be seen as an indication of the degree to which a bank engaged in the securitization of loans (when some tranches are kept on the balance sheet). In this case, the relation of our ABS and MBS measures and bank failure is ambiguous (Altunbaş et al. (2011)). Securitization allows banks to pass on credit risk to other investors, and as such it would tend to reduce the probability of failure. It has been argued however that securitization distorts banks' incentives to monitor borrowers properly (Demyanyk and Hasan (2010)). The creation of liquidity might in turn lead the bank to grant riskier loans in the search-for-yield. This would imply a positive relation between risk and ABS and MBS investments. Finally, we include foreign assets relative to total assets to capture international diversification. Since the financial crisis was homemade and did not originate abroad, we expect it to be negatively related to bank failures, although foreign exposures might also be an indication of higher risk as banks could suffer from informational disadvantages in foreign markets (Ahearne et al. (2004)).

Although ***management quality*** is indirectly measured by the other measures on capital and asset quality, we include *bank age* as a measure for experience and expertise and a measure for *managerial efficiency* calculated as non-interest expense over the sum of net interest income and non-interested income (Oshinsky and Olin (2006)). By directly reducing profitability and

therewith the capacity to absorb losses, non-interest expense (mainly salaries, benefits and expenses on premises and fixed assets) should be kept on reasonable levels. We experimented with different measures and included a dummy variable that distinguishes less efficient from highly efficient banks.[21] We expect that more efficient banks have lower default probabilities. Similar, we expect that longer established banks have lower default probabilities as they could have more developed risk management techniques and a higher experience in the banking business.

***Earnings*** of a bank are essential to absorb loan losses, provide finance for the internal growth of capital, and to attract investors to supply capital. The retention of earnings can be used to develop and maintain a prudential capital base. Typically some quarters before the failure of a bank, bank losses and asset write downs increase substantially and we expect that bank failures are explained to a large part by bank profits (or better losses). We have experimented with aggregate measures of profitability such as return on assets and return on equity and with more disaggregated ones. [22] In our baseline specification, we decided to include the net interest margin (net interest income divided by total assets) and the net non-interest margin (net non-interest income over assets). While the former gives an indication of how well an institution manages its traditional business of financial intermediation, the latter reflects how well a bank manages its unconventional, fee-based banking service activities. We expect the variables to be negatively related to failures, although high profits might as well be an indication of a riskier portfolio.

***Liquidity*** risks are at the core of the traditional banking business, as banks receive deposits that can be withdrawn on demand and grant private and corporate loans with higher maturities. Managing this risk is an important complement to the other prudential management practices

[21] We do not directly use the efficiency ratio (non-interest expense over the sum of net interest income and non-interested income), because both the lowest and the highest values are associated with bad management situations. Indeed, the lowest values of the efficiency ratio are associated with banks showing a negative sum of net interest income and non-interested income while the highest values are associated with banks for which the sum of net interest income and non-interested income are close to zero. As a result, we define our dummy variable as being equal to one if the efficiency ratio (in t-4) is positive and less than the average ratio and zero otherwise.

[22] We annualize income flows by adding up the quarterly flow of income over 4 quarters.

such as capital adequacy and operational efficiency. We experimented with different indicators of liquidity risk combing information on the asset and liability side. In our final specification, we include the *loan-to-deposit ratio* and *other borrowed money* as a fraction of total assets and expect them to be positively related to the probability of failure. A higher loan-to-deposit ratio means that a bank finances a higher fraction of its (illiquid) loan portfolio with other types of non-deposit funding. If these funds are borrowed on money markets, it makes banks more vulnerable to liquidity problems, since deposits have proven to be a relatively stable source of funds during the recent crisis. Rather, it was the dry up in wholesale funding markets that affected banks the most (Demirgüç-Kunt and Huizinga (2010) and Huang and Ratnovski (2011)). In addition to the loan-to-deposit ratio, we measure banks' exposure to money market funding directly by the item other borrowed money.

It is important to take into account the ***local economic conditions*** prevailing in particular states, since the boom-and-bust cycle in housing prices varied across the country (Arizona, California, Florida and Nevada accounted for close to 60% of US residential foreclosures). As such, bank failures might be more frequent in particular regions than in others (as evidenced in Figure 4). We control therefore, state-by-state, for housing prices and private income and expect them to be negatively related to the probability of failure.

**[Figure 4 around here]**

Finally, we control for the **stance of monetary policy** and include the average effective federal funds rate in our baseline specification. By reducing refinancing costs, the monetary policy rate would be positively related to the probability of failure in normal times, although it might be that banks take on higher risks when interested rates are low implied by the search-for-yield argument (Borio and Zhu (2008)). Since policy rates were cut in the midst of the crisis when bank closures mounted, we expect it to be negatively correlated with failure probabilities (lower rates are associated with more failures).

### 4.3. Results - baseline specification

We report the estimation results of the baseline specification starting with a parsimonious model (specification 1) which does not include all of the outlined bank-specific and macroeconomic control variables (see Table 4, column 1).[23] We then successively include more variables. More precisely, specification 2 includes the macroeconomic regressors (Table 4, column 2) and specification 3 includes the average past loan growth (Table 4, column 3). In the final specification, we report the estimation results based on specification 3 using our second failure definition including in addition undercapitalized banks that have been acquired and modifying the date of failure if appropriate (as discussed in Section 4.1).

**[Table 3 around here]**

Note that the sample of banks differs across the four specifications, which is due to the fact that the different sets of regressors are not available for all banks. For instance, 24 FDIC-insured banks among which 3 entities failed (of 8,322 banks and 302 failures in total) are dropped when the macroeconomic control variables are included (specification 2), because these banks are located in jurisdictions that are not part of the US but associated as a commonwealth (such as Puerto Rico). Moreover, we lose an additional 640 banks of which 38 entities failed, when including the average past loan growth defined by a moving average of loan growth from t-10 to t-17 quarters (specification 3). This subset of institutions represents banks that have only been created in Q3/2001 or later (given our estimation period from Q1/2006 to Q4/2010). Finally, with the modified failure definition, the number of failures increases by 27 cases representing acquisitions of undercapitalized banks.

**[Table 4 around here]**

The results of specification (1) confirm largely our intuition and are in line with the related literature (see, amongst others, Wheelock and Wilson (1999) and King et al. (2006)). Banks that

[23] Descriptive statistics for the explanatory variables, computed over this sample, are reported in Table 3. We verified that there is no multi-collinearity problem by analyzing the variance inflation factors and the correlation matrix. The variable definitions using the call report variable abbreviations are provided in Appendix C.

have lower capital ratios, one year ahead of failure, have significantly higher default probabilities. This is a purely mechanical relation, since banks are closed based on the level of capital, which can quickly diminish when a bank is not sufficiently capitalized and asset write-downs and losses rise. By the same token, failure was more likely for banks with higher fractions of non-performing loans and other real estate-owned (foreclosed) assets reflecting banks poor lending standards prior to the crisis. It is also not surprising that banks with higher fractions of mortgage lending had higher failure probabilities since the financial crisis originated to a large part in the mortgage market.

The coefficient on the size variable is counter to our expectations as larger banks had a higher probability of failure. This might be an indication that larger banks took on higher risks prior to the crisis implied by incentive distortions associated with their too-big-to-fail status. It could also be caused by an omitted variable bias which we will address in more detail below. It appears that banks with foreign operations and with higher fractions of ABS and MBS securities on their balance sheets did neither have higher nor lower failure probabilities than the other banks. We also find that more experienced banks and those with a more efficient management have a lower default probability in line with our expectations.

Not surprisingly, the failure probability is negatively related to earnings. Both a higher net interest margin and a higher net non-interest margin, one year ahead of failure, are associated with significantly lower failure probabilities. With regards to our two measures for liquidity (or the funding structure), we find evidence that banks with higher fractions of loans to deposits and those financed with more short-term funds had significantly higher probabilities of default than the other banks (though the result for short-term borrowing are a bit weaker with a p-value of 12%).

Most of the qualitative results appear robust across our four specifications. The inclusion of the macroeconomic control variables shows that they are highly significant determinants of failures and they should thus be included (see, specification 2). Drops in property prices and personal income increase the failure probability of banks by affecting adversely borrowers' collateral and repayment capacity. Lower monetary policy rates are associated with higher default probabilities which might point to the existence of a risk-taking channel of monetary policy.

However, as discussed before this result might also be driven by the fact that the Fed reduced interest rates in the midst of the crisis. Once our measure for past loan growth is included, it turns out to be highly significant and positively related to bank failures (specification 3). This is an important finding as it highlights that past loan growth is an important leading indicator of bank failures, possibly reflecting banks' loose lending standards and aggressive growth strategies. The fact that the other coefficients remain stable indicates that our results are not driven by banks that were created more recently. Finally, the main results are robust to the modification of failure definition (specification 4).

In conclusion, we find that most coefficients are robust across our specifications in terms of magnitude and significance. Important short-term determinants the capital ratio, the non-performing loan ratio, the mortgage ratio, and the two measures of earnings (net interest and net non-interest margins). This is a purely mechanical relation, since banks are closed based on the level of capital, which can quickly diminish when a bank is not sufficiently capitalized and asset write-downs and/or losses rise. The funding structure of banks appears as well to be an important short-term determinant of bank failure, though the significance of the coefficients of our two risk indicators sometimes falls slightly below 10%. This confirms our intuition that banks become more vulnerable, when they finance larger parts of their loan book with non-deposit and/or money market funding, but also that liquidity problems are not easy to identify with standard indicators. The major long-term determinants of bank failures are bank age and our measure of the average past loan growth. The latter finding indicates that loan growth represents an important leading indicator of bank failures (see also Figure 4). Finally, local economic conditions have played a major role in affecting bank failures, although there still is bank-specific variation (as evidenced before).

### 4.4. Have bank holding companies been a source of strength?

An important part of the US banking system is controlled by bank holding companies (BHC), a legal and organizational form unique to the US banking regulation. Traditionally, the fields of

activities in which BHCs could engage in have been strongly regulated, however, many of the restrictions were removed with the Gramm-Leach-Bliley Act in 1999 (Omarova and Tahyar (2011)). As such, bank holding companies operate nowadays through a network of subsidiaries in a variety of market segments, and they combine the traditional banking business with investment banking, insurance and other activities.[24] Bank holding companies are supervised and regulated by the Federal Reserve and are required, similar to their banking subsidiaries, to maintain minimum capital ratios. In addition, banking regulation requires bank holdings to ensure that they are a 'source of strength', that is, providing financial assistance to banking subsidiaries in distress (Avraham et al. (2012)).

Against these backdrops, we investigate in this subsection whether the determinants of bank failures have been different for the sample of BHC-controlled commercial banks and whether there are BHC-specific factors that help explain commercial bank failures. With 5,607 banking institutions that have been controlled by bank holdings in 2010 (77% of all banks) and 242 failures during 2008-10 (80% of the total), the sample of BHC-controlled commercial banks is important and deserves a proper investigation.

***Data source and description***

Large bank holding companies are required to fill in consolidated and unconsolidated (or parent-only) reports on a quarterly basis, while smaller holdings report only on an unconsolidated basis and semi-annually.[25] In general, the reports are less detailed than the call reports of commercial banks, but they allow for a comprehensive disaggregation of balance sheets and income, with a breakdown by the industry in which the subsidiaries operate (bank,

[24] The most common industries in which BHCs operate are asset management (trusts, funds and other financial vehicles), credit intermediation, securities trading, management and accounting, health, and insurance (Avraham et al. (2012)).

[25] Prior to 2006, the threshold of large bank holdings was $150 million of consolidated assets increasing to $500 million thereafter. For estimation, we interpolate the semi-annual reports of small bank holdings to quarterly frequency.

non-bank and bank holdings).[26] An interesting feature of the bank holding reports is that they allow identifying rescued institutions which received state support in the form of (Troubled Asset Relief Program) TARP funds. This is an important piece of information for our analysis of bank failures, since a bank that has been classified before as non-failed could have actually been failing without the assistance of the Treasury.

As of end-2010, 77% of the FDIC-insured commercial banks (5,607 institutions) or 85% of the banking system's assets ($13 trillion) have been controlled by 4,820 bank holding companies. Taken on their own, bank holdings owned $3 trillion of unconsolidated assets and controlled, on average, two FDIC-insured banking subsidiaries and an unknown number of non-bank and bank holding subsidiaries. The median of the relative size of bank holdings (measured by the BHC's unconsolidated assets over the subsidiary's assets) is 11%, being highest when a large bank holding owns a small FDIC-insured trust company.[27] During the crisis period of 2008-10, 242 BHC-controlled banks failed and have been placed into receivership by the FDIC or a similar regulatory agency. Moreover, 531 bank holding companies that controlled 826 banks have been rescued and received $257 billion of TARP funds.[28]

***Econometric strategy***

To control for bank holding characteristics, we augment our baseline specification by including a vector of BHC-specific control variables $B_{it-4}$:

[26] A caveat is that non-bank subsidiaries are treated in the consolidation as if they operated on a stand-alone basis (Avraham et al. (2012)). This gives rise for problems associated with double-counting, since for example a loan granted to another holding's subsidiary will be treated as if it was part of the non-bank subsidiary's balance sheet (even though the positions would net out on a consolidated basis). Moreover, some major non-bank subsidiaries (mainly those that are active in securities trading and insurance) do not file in the FDIC forms and report to other functional regulators (Avraham et al. (2012)).

[27] Such as Bank of America Corp. with $456 billion of unconsolidated assets in 2010 and its National Trust Delaware with $3 million of assets.

[28] On average, rescued bank holdings received state support of 24% of unconsolidated assets or 2.5% of consolidated assets.

$$Prob(Y_{it} = 1|X_{it-4}, Z_{it-4}, B_{it-4}) = \frac{1}{1 + \exp\left(-\beta X_{it-4} - \gamma Z_{it-4} - \delta B_{it-4}\right)} + \varepsilon_{it} \ ,$$

where $Y_{it}$ denotes our indicator variable of bank failures (according to the second definition, section 4.1), $X_{it-4}$ the vector of bank-specific variables and $Z_{it}$ the vector of macroeconomic controls. We estimate the regression with the same set of bank-specific and macroeconomic variables used in specification 4. Before turning to the discussion of the estimation results, we discuss the relations between bank failures and BHC-specific regressors.

***Discussion of the BHC-specific explanatory variables in $B_{it-4}$***

***Capital adequacy*** at the group level is measured by the ratio of the BHC consolidated *equity capital* over consolidated assets. A higher capital buffer at the group level allows the holding company to distribute capital internally and transfer it to a particular subsidiary in distress. If the bank holding controls only one banking subsidiary and no other subsidiary (one-bank BHC), then the capital buffer is more likely to act as a source of strength to the distressed banking subsidiary. If however the bank holding controls several bank and non-bank subsidiaries (multi-bank BHC), it depends on the financial situation of the other subsidiaries.[29]

To control for the ***asset structure*** of the BHC we use its *stand-alone size* (measured by the logarithm of unconsolidated assets) and the proportion of *equity investment in non-bank subsidiaries* relative to unconsolidated assets. BHC size is intended to capture that larger bank holdings should be in a better position to support a bank subsidiary in distress. This depends, however, on the quality of its assets, since many asset values dropped during the crisis. With regards to equity investment in non-bank subsidiaries, a higher ratio might be an indication of diversification and it could make the holding company less vulnerable to shocks in the banking sector. On the other hand, it might also indicate increased vulnerability, if holding companies operate in other crisis-prone industries and sectors (such as securities trading or insurance), or they could simply have less expertise in banking.

[29] Ashcraft (2008) finds that a bank affiliated with a multi-bank holding company is significantly safer than either a stand-alone bank or a bank affiliated with a one-bank holding company.

We measure ***profitability*** on the group-level by *return on assets* calculated by the annualized flow of unconsolidated income over unconsolidated assets and expect it to be negatively related to failures, as more profitable BHCs are more likely to be in a position to support bank subsidiaries in distress.

To capture the ***funding structure*** of bank holdings, we include unconsolidated *short-term borrowing* and *balances due to other subsidiaries* (non-bank and other bank holdings), both as a ratio over unconsolidated assets. Bank holdings that rely more heavily on funds from the money market are more likely to be a source of vulnerability to bank subsidiaries, since money markets collapsed in the midst of the crisis (Demirgüç-Kunt and Huizinga (2010) and Huang and Ratnovski (2011)). If balances due to other subsidiaries reflect funding from subsidiaries that are engaged in asset management, securities trading, or insurance, a higher reliance on this type of funding might be an indication of higher risks, since these sectors have been as well been heavily affected by the financial collapse. On the other hand it might be an indication of lower risks, if these balances originate from less-crisis prone industries or sectors.

Finally, we include information on individual ***bank rescues*** associated with the TARP program and expect that bank subsidiaries of rescued bank holdings are less likely to fail. We experimented with different ratios using the amount of injected TARP funds and decided to work with a *rescue dummy* variable that is equal to one if a bank holding is subject to a rescue program and zero otherwise. One might argue that it was not the injected amount that mattered to help them to survive, rather, it was the signal that the Treasury is willing to support a particular bank is what mattered (by calming down investor and depositor uncertainty).

***Estimation results***

As mentioned before, BHC-controlled banks represent a subsample of the whole spectrum of commercial banks in the United States representing 77% of all banks, or 85% of the banking system's assets, among which 80% of the crisis-related bank failures occurred. It is therefore important to re-estimate our previous specification (see, specification 4 in Table 4) without bank

holding-specific characteristics to gauge whether the results are different for the sample of BHC-controlled banks. The estimation results are shown in specification 5 (see, column 1 of Table 5).

While most coefficients are qualitatively similar in terms of signs and magnitudes, we note that the significance of some variables decreased, particularly in the case of the indicators on earnings (net interest and non-interest margin) and managerial efficiency. This suggests that these factors have been main drivers of bank failures in the case of stand-alone banks, while they were less important in the case of BHC-controlled banks. These findings seem intuitive, since a banking subsidiary's management quality and its earning strength only reflect one part of the picture. What really matters for banking subsidiaries of bank holding companies are profits and managerial efficiency on the group-level.

**[Table 5 around here]**

The BHC-specific variables are successively introduced in specifications 6 and 7 (see, columns 2 and 3 of Table 5). The discussion focuses on the final specification as it includes the whole set of bank-specific, holding-specific, and macroeconomic variables. Most of the BHC-specific characteristics turn out to be significant determinants of bank failures and the results appear intuitive. Higher capital on the group-level is associated with lower failure probabilities on the subsidiary-level confirming that well-capitalized bank holdings tend to be source of strength.

While the earning measures have been insignificant on the subsidiary-level, return on assets on the group-level turns significant indicating that higher profits decrease failure probabilities. On the funding side of bank holding companies, it appears that borrowing on money markets and from non-bank subsidiaries is a source of vulnerability for banking subsidiaries, as failure probabilities increase significantly with our two measures for a BHC's funding structure. Especially the latter finding is interesting as it shows that the reliance on funds from non-banking subsidiaries and money markets is a dangerous cocktail. Finally, we find evidence that the TARP rescue program has been effective in circumventing bank collapses as the failure probability decreases significantly when a bank received TARP funds. Overall, our results indicate that bank holdings can be both a source of strength and a source of instability to their

bank subsidiaries, which ultimately depends on the group's level of capital, profitability and funding structure.

## 5 Conclusion

This paper examined the determinants of bank failures in the US banking system during the recent financial crisis. The analysis employs a dataset on the financial statements reported by FDIC-insured commercial banks and bank holding companies headquartered in the United States, along with information on bank failures, mergers, acquisitions and individual bank rescues.

Using limited-dependent variable regression techniques, we find that failed banks were characterized by significantly higher loan growth rates, well ahead of the financial crisis (3-5 years), than banks that later survived. Failed banks have also been characterized by lower levels of capital, higher fractions of non-performing loans, and by higher exposures to the mortgage market. We also find evidence that banks were more likely to fail when they were owned by low capitalized bank holdings that relied more on funding from money markets and their non-bank subsidiaries. Along we find that individual rescues of bank holding companies have been effective in preventing bank failures.

Regarding the appropriate regulation of banks, we provide evidence that capital requirements should be forward-looking and linked to banks' past loan growth. Moreover, we find some tentative evidence that bank exposures to non-bank activities have been a source of bank fragility. More research would have to be devoted to identifying the particular market segments that affected banks the most.

## 6 Literature


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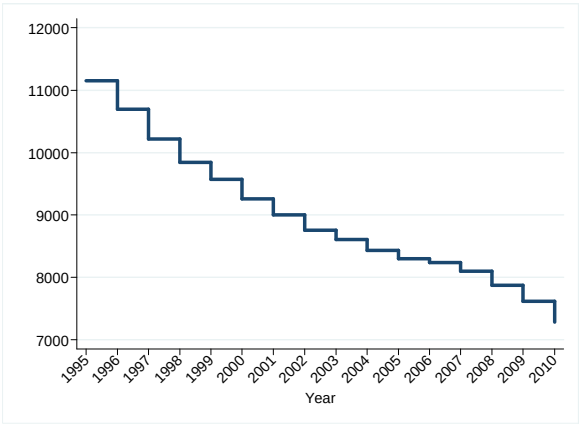
# Appendix A

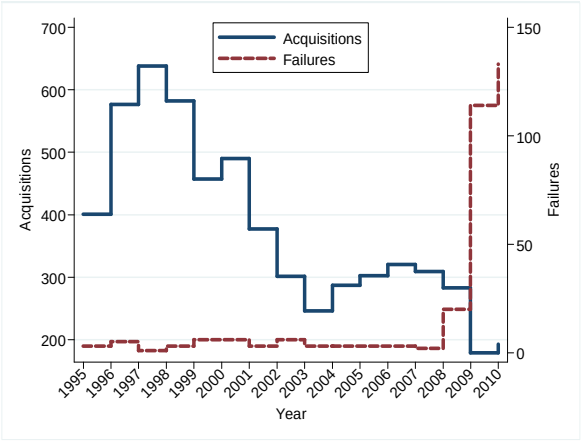
## A.1. Figures

**Figure 1: Number of banks, failures and M&As in the US, 1995-2010**

Number of banks

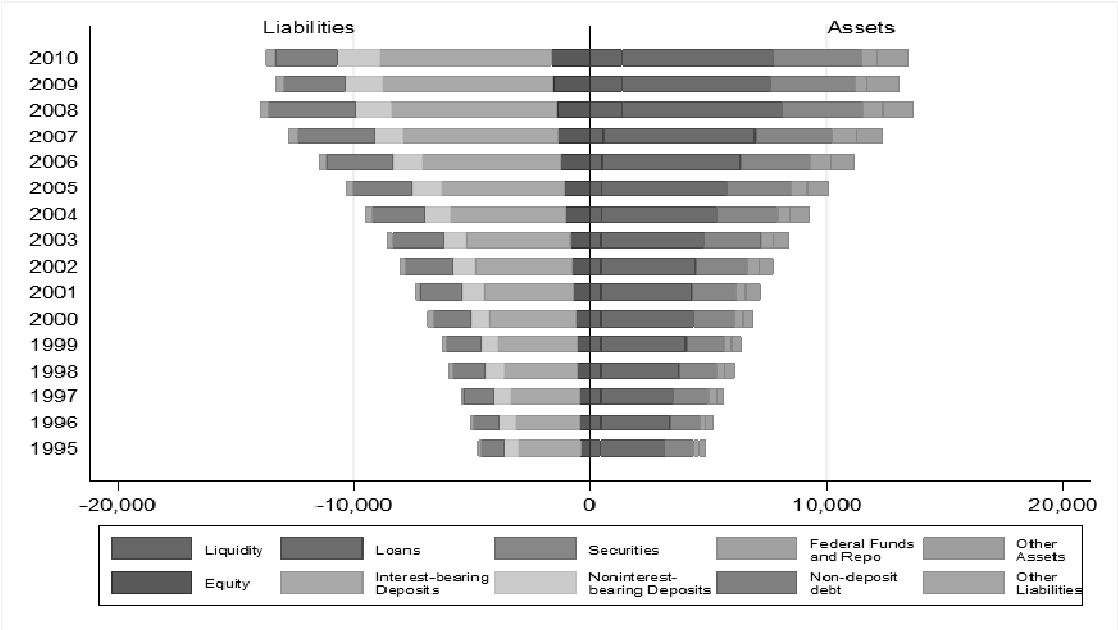



Number of failed and acquired banks[30]




Source: Federal Reserve Bank of Chicago

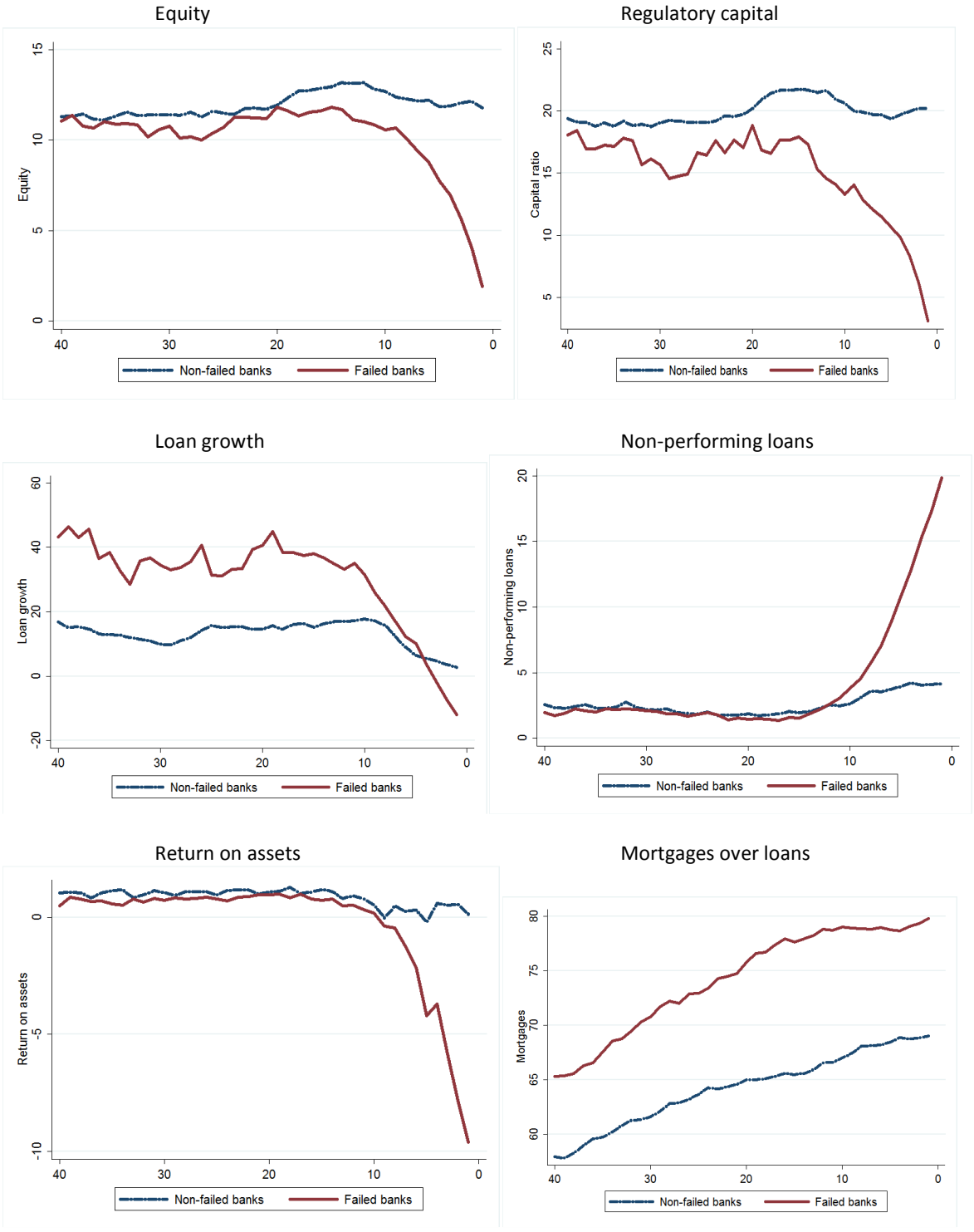
**Figure 2: Commercial bank balance sheets, 1995-2010, in billion USD**




Source: Federal Reserve Bank of Chicago; authors own calculations.

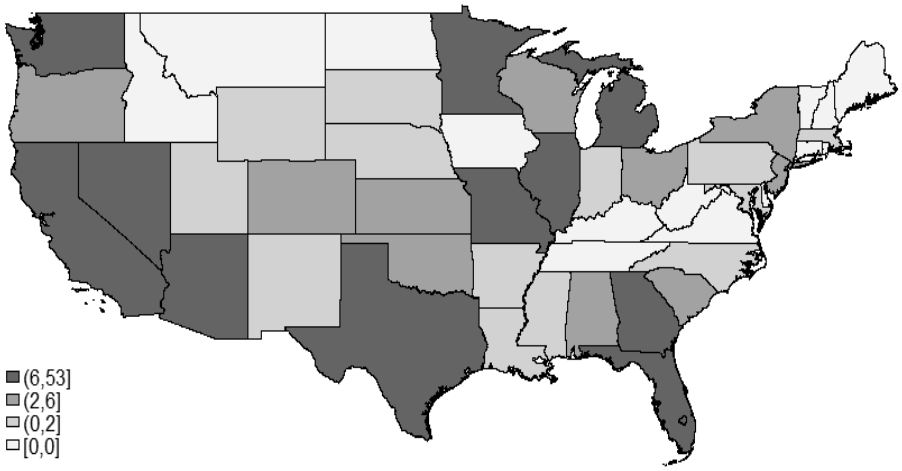
[30]We take into account only the banks that exist in the call reports.

**Figure 3: Trends at failed banks and survivors**[1]




[1] Unweighted averages by bank group (failed versus survivor), per quarter. Values on the horizontal axis indicate the number of quarters prior to failure in the case of failed banks, and the number of quarters prior to Q4/2010 in the case of non-failed banks (survivors).

**Figure 4: Bank failures by state, 2007-2010[1]**




[1] The different colors are related to the number of bank failures within a state. There are 4 categories: 0 failures occurred during 2007-10, 1 or 2 failures, 3 to 6 failures, and 7 to 53 failures. The highest number of bank failures has been observed in Georgia (53), followed by Florida and Illinois (both 40).

## A.2. Tables

**Table 1: Bank failures, acquisitions and recapitalizations, 1995-2010**

| | ***Failures*** | | ***Acquisitions*** | | ***Recapitalizations*** | | |
|---|---|---|---|---|---|---|---|
| | *Number of banks* | *Involved assets (bil. $)* | *Number of banks* | *Involved assets (bil. $)* | *Number of banks* | *Rescue amount (bil. $)* | *Involved assets (bil. $)* |
| *2008-10* | 342 | 668.75 | 732 | 1,394.50 | 625 | 187.19 | 6,869.46 |
| *2000-07* | 23 | 3.63 | 2634 | 3,460.16 | 0 | 0 | 0 |
| *1995-99* | 18 | 1.16 | 2655 | 2,145.60 | 0 | 0 | 0 |
| *Total* | 383 | 673.54 | 6021 | 7,000.26 | 625 | 187.19 | 6,869.46 |

Note: *Failures* refer to bank closures that were resolved by a regulator (FDIC, RTC, NCUA, or another regulatory agency), *acquisitions* to bank mergers or acquisitions (including acquisitions of 40-100% of assets and splits), and *recapitalizations* to individual bank rescues within the TARP program. *Number of banks* denotes the number of events in a particular period, *involved assets* indicates the sum of total assets of the involved banks (measured at the date of the event), and *rescue*. Some cases have been in the M&A database but not in the database on the financial statements: 4 failures during 2000-07 and 7 during 1995-99; 158 acquisitions during 2008-10, 736 during 2000-07, and 804 during 1995-1999 (many of which involve intra-group acquisitions (involve the same ultimate owner of the non-survivor and survivor). 84 out of 709 banks that received a recapitalization have not been identified.

Source: Call reports of commercial banks and bank holding companies(Federal Reserve Bank of Chicago); thrift reports only for 2007 (FDIC); M&A database (Federal Reserve Bank of Chicago); CNN money list on TARP recipients; authors' own calculations.

## Table 2: Overview of commercial bank financial statements (1995-2010)

| | *Large* | *Small* | *High liquid* | *Low liquid* | *High capitalized* | *Low capitalized* | *Failed* | *Acquired (2006-2010)* | *Other* | *Total* |
|---|---|---|---|---|---|---|---|---|---|---|
| *Number of banks* | 3529 | 3530 | 3522 | 3522 | 3374 | 3375 | 302 | 1268 | 7293 | 14130 |
| *Mean annual growth rate of lending (2008-2010)* | 5.95 | 7.22 | 9.55 | 5.19 | 15.53 | 4.01 | 2.22 | 6.72 | 7.75 | 5.99 |
| *Mean annual growth rate of lending(2001-2007)* | 14.35 | 6.76 | 7.33 | 13.34 | 15.71 | 10.17 | 27.81 | 14.05 | 11.74 | 11.80 |
| *Mean annual growth rate of lending(1995-2000)* | 16.41 | 9.02 | 9.21 | 14.45 | 11.37 | 15.38 | 22.54 | 15.00 | 12.11 | 13.64 |
| | | | | | *Bank specific characteristics (end-2007)* | | | | | |
| *Number of banks* | 1967 | 1869 | 2045 | 1961 | 2237 | 1415 | 298 | 709 | 7090 | 8097 |
| *Mean assets (mil. USD)* | 7138.83 | 35.35 | 768.82 | 2013.66 | 881.43 | 3276.06 | 799.03 | 2070.36 | 1839.65 | 1821.56 |
| *Percentage of all assets* | 95.21 | 0.448 | 10.66 | 26.77 | 13.37 | 31.43 | 1.61 | 9.95 | 88.43 | 100.00 |
| *Mean deposits (mil. USD)* | 4029.32 | 29.20 | 381.56 | 994.06 | 321.70 | 2113.38 | 583.49 | 1459.77 | 963.99 | 994.35 |
| *Percentage of all deposits* | 92.69 | 0.689 | 9.57 | 23.78 | 9.20 | 38.35 | 2.23 | 13.27 | 84.50 | 100.00 |
| *Mean Loans (mil. USD)* | 3629.17 | 21.48 | 257.57 | 1143.36 | 397.44 | 1712.68 | 586.25 | 1284.80 | 921.50 | 940.99 |
| *Percentage of all lending* | 93.67 | 0.526 | 6.92 | 29.37 | 11.65 | 31.81 | 2.29 | 11.96 | 85.74 | 100.00 |
| *Mean Net Income (mil. USD)* | 63.74 | 0.389 | 5.02 | 23.29 | 15.68 | 19.22 | 4.35 | 11.97 | 16.23 | 15.39 |
| *Percentage of all net income* | 94.76 | 0.594 | 8.13 | 36.11 | 29.03 | 22.51 | 1.07 | 7.02 | 91.93 | 100.00 |
| | | | | | *Ratios (averages 1995-2010)*[31] | | | | | |
| *Liquidity/total assets* | 24.90 | 30.27 | 44.44 | 13.32 | 30.82 | 25.84 | 18.00 | 25.51 | 28.06 | 27.75 |
| *Loans/total assets* | 61.94 | 55.32 | 44.64 | 69.29 | 53.33 | 64.67 | 75.38 | 64.21 | 60.28 | 60.44 |
| *Deposits/total assets* | 78.12 | 82.54 | 80.62 | 80.58 | 74.54 | 84.07 | 81.40 | 79.19 | 82.12 | 81.96 |
| *Loans/deposits* | 80.68 | 67.02 | 56.41 | 86.04 | 68.67 | 77.22 | 91.50 | 80.10 | 74.20 | 74.23 |
| *Equity/total assets* | 10.63 | 13.98 | 13.77 | 11.77 | 19.45 | 7.82 | 9.90 | 12.59 | 11.90 | 11.75 |
| *Regulatory capital ratio* | 13.80 | 19.95 | 21.54 | 15.02 | 26.32 | 11.60 | 9.31 | 14.67 | 17.17 | 16.67 |
| *Total securities/total assets* | 21.13 | 25.89 | 34.80 | 15.34 | 25.72 | 22.46 | 11.00 | 18.82 | 23.89 | 23.51 |
| *Impaired loans/total lending* | 1.53 | 1.71 | 1.73 | 1.43 | 1.84 | 1.36 | 2.43 | 1.54 | 1.51 | 1.53 |
| *Return on equity* | 6.90 | 5.26 | 5.80 | 6.31 | 3.62 | 7.73 | 0.572 | 4.71 | 5.92 | 6.01 |
| *Return on asset* | 0.62 | 0.56 | 0.62 | 0.60 | 0.51 | 0.60 | -0.21 | 0.44 | 0.59 | 0.58 |

Note: The sample period goes from 1995 to 2010 covering 14130 banks and 578185 observations. A "small" bank has a size that is equal or less than the first quartile of bank size (assets), while a "large" bank has a size that is in the fourth quartile of bank size. The same distinction applies to "low liquid" and "high liquid" banks (measured by average liquidity ratio, i.e. liquid assets over total assets), as well as to "low capitalized" and "high capitalized" banks (measured by capital over total asset ratio). "Failed banks" refers to bank failures where the resolution involved a regulator (such as the FDIC), "acquired banks" to banks that have been acquired by another bank, and "other banks" are the remaining banks that have never been acquired. The columns on failure and acquisition are calculated for 2006-2010 sub-samples.

Source: Federal Reserve Bank of Chicago and authors' calculations

[31] The "failed banks" and "acquired banks" parts are calculated for the last three years before the events.

## Table 3: Descriptive statistics for the regression variables

Baseline estimation (Table 4, column 1)

| *Variable* | *Obs.* | *Mean* | *Std. Dev.* | *Min* | *Max* |
|---|---|---|---|---|---|
| *Risk-weighted capital ratio* $_{t-4}$ | 145676 | 17,713 | 13,547 | 0 | 480,328 |
| *Non-performing loans* $_{t-4}$ | 145676 | 2,379 | 3,029 | 0 | 100 |
| *Other real estate owned* $_{t-4}$ | 145676 | 0,256 | 0,660 | 0 | 26,334 |
| *Mortgages* $_{t-4}$ | 145676 | 68,232 | 19,588 | 0 | 100 |
| *Size* $_{t-4}$ | 145676 | 11,890 | 1,327 | 7,714 | 21,293 |
| *ABS & MBS, hold to maturity* $_{t-4}$ | 145676 | 0,605 | 3,189 | 0 | 67,337 |
| *ABS&MBS avail. for sale* $_{t-4}$ | 145676 | 5,748 | 8,104 | 0 | 82,159 |
| *Foreign assets* $_{t-4}$ | 145676 | 0,158 | 2,253 | 0 | 84,175 |
| *Efficiency dummy* $_{t-4}$ | 145676 | 0,556 | 0,497 | 0 | 1 |
| *Age* $_{t}$ | 145676 | 69,255 | 43,439 | 1 | 226,75 |
| *Net interest margin* $_{t-4}$ | 145676 | 3,694 | 1,174 | -145,592 | 67,697 |
| *Noninterest income* $_{t-4}$ | 145676 | 0,918 | 4,416 | -253,415 | 371,599 |
| *Other borrowed money* $_{t-4}$ | 145676 | 4,587 | 6,071 | 0 | 76,275 |
| *Loans over deposits* $_{t-4}$ | 145676 | 82,779 | 43,377 | 0,001 | 1944,597 |

## Table 4: Baseline estimations

| | *Specification 1* | | *Specification 2* | | *Specification 3* | | *Specification 4* | |
|---|---|---|---|---|---|---|---|---|
| | *Failure definition 1* | | *Failure definition 1* | | *Failure definition 1* | | *Failure definition 2* | |
| | *Coeff.* | *Std.error* | *Coeff.* | *Std.error* | *Coeff.* | *Std.error* | *Coeff.* | *Std.error* |
| | | | *C: capital adequacy* | | | | | |
| *Capital* $_{t-4}$ | -0.444*** | 0.036 | -0.460*** | 0.038 | -0.438*** | 0.038 | -0.411*** | 0.035 |
| | | | *A: asset quality* | | | | | |
| *Non-performing loans* $_{t-4}$ | 0.119*** | 0.013 | 0.112*** | 0.014 | 0.157*** | 0.017 | 0.160*** | 0.017 |
| *Other real estate owned* $_{t-4}$ | 0.086** | 0.039 | 0.085** | 0.041 | 0.073* | 0.044 | 0.069 | 0.045 |
| *Mortgages* $_{t-4}$ | 0.046*** | 0.008 | 0.037*** | 0.008 | 0.016** | 0.008 | 0.019** | 0.007 |
| *Size* $_{t-4}$ | 0.146** | 0.062 | 0.064 | 0.064 | 0.105* | 0.064 | 0.119* | 0.061 |
| *Loan growth* $_{t-10/t-17}$ | | | | | 0.006*** | 0.002 | 0.007*** | 0.002 |
| *ABS & MBS, hold to maturity* $_{t-4}$ | -0.011 | 0.026 | -0.023 | 0.029 | -0.036 | 0.032 | -0.035 | 0.033 |
| *ABS & MBS, avail. for sale* $_{t-4}$ | -0.013 | 0.013 | -0.016 | 0.014 | 0.003 | 0.014 | -0.004 | 0.013 |
| *Foreign assets* $_{t-4}$ | 0.016 | 0.035 | 0.018 | 0.028 | -0.016 | 0.038 | -0.027 | 0.042 |
| | | | *M: management* | | | | | |
| *Managerial efficiency* $_{t-4}$ | -0.873*** | 0.166 | -0.519*** | 0.171 | -0.280 | 0.179 | -0.347** | 0.166 |
| *Age* $_{t}$ | -0.007*** | 0.002 | -0.005*** | 0.002 | -0.005** | 0.002 | -0.004** | 0.002 |
| | | | *E: earning* | | | | | |
| *Net interest margin* $_{t-4}$ | -0.059*** | 0.009 | -0.054*** | 0.009 | -0.039** | 0.015 | -0.035* | 0.019 |
| *Net non-interest income* $_{t-4}$ | -0.020*** | 0.005 | -0.025*** | 0.005 | -0.018* | 0.010 | -0.016* | 0.009 |
| | | | *L: liquidity* | | | | | |
| *Other borrowed money* $_{t-4}$ | 0.016 | 0.010 | 0.013 | 0.011 | 0.028** | 0.013 | 0.024* | 0.013 |
| *Loans over deposits* $_{t-4}$ | 0.004*** | 0.001 | 0.003*** | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 |
| | | | *S: sensitivity to markets and the economy* | | | | | |
| *House prices growth* $_{t}$ | | | -0.052*** | 0.010 | -0.050*** | 0.012 | -0.050*** | 0.010 |
| *Federal funds rate* $_{t}$ | | | -0.450*** | 0.085 | -0.429*** | 0.095 | -0.245*** | 0.070 |
| *Income growth* $_{t}$ | | | -0.054*** | 0.018 | -0.059*** | 0.020 | -0.088*** | 0.018 |
| *Constant* | -6.007*** | 1.038 | -4.005*** | 1.068 | -3.718*** | 1.045 | -4.329*** | 0.982 |
| *Observations* | 145676 | | 145355 | | 133880 | | 133781 | |
| *Pseudo* $R^2$ | 0.32 | | 0.36 | | 0.37 | | 0.35 | |
| *Banks* | 8322 | | 8298 | | 7658 | | 7655 | |
| *Failed banks* | 302 | | 299 | | 261 | | 283 | |
| *Correctly predicted* | 66 | | 75 | | 68 | | 81 | |
| *False alarms* | 107 | | 100 | | 90 | | 90 | |
| *- among which rescued banks* | 8 | | 7 | | 6 | | 6 | |

Notes: Sample period 2006-2010. Failure definition 1: dummy=1 for failed banks at its last call report date. Failure definition 2: dummy=1 when the tangible equity ratio of a failed bank or an acquired bank falls below 2% for the first time.

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

**Table 5: Estimation results with information on bank holdings**

| | *Specification 5* | | *Specification 6* | | *Specification 7* | |
|---|---|---|---|---|---|---|
| | *Coeff.* | *Std. error* | *Coeff.* | *Std. error* | *Coeff.* | *Std. error* |
| | | | *Banking subsidiary characteristics* | | | |
| *Capital* $_{t-4}$ | -0.427*** | 0.040 | -0.331*** | 0.039 | -0.321*** | 0.038 |
| *Non-performing loans* $_{t-4}$ | 0.177*** | 0.019 | 0.167*** | 0.016 | 0.168*** | 0.016 |
| *Other real estate owned* $_{t-4}$ | 0.031 | 0.054 | 0.020 | 0.053 | 0.011 | 0.052 |
| *Mortgages* $_{t-4}$ | 0.014* | 0.008 | 0.014* | 0.008 | 0.014* | 0.008 |
| *Size* $_{t-4}$ | 0.162** | 0.067 | 0.229** | 0.114 | 0.248** | 0.118 |
| *Loan growth* $_{t-10/t-17}$ | 0.007*** | 0.002 | 0.008*** | 0.002 | 0.009*** | 0.002 |
| *ABS&MBS hold to maturity* $_{t-4}$ | -0.039 | 0.044 | -0.058 | 0.047 | -0.054 | 0.046 |
| *ABS&MBS avail. for sale* $_{t-4}$ | -0.002 | 0.014 | -0.008 | 0.014 | -0.009 | 0.014 |
| *Foreign assets* $_{t-4}$ | -0.023 | 0.034 | -0.025 | 0.033 | -0.016 | 0.031 |
| *Managerial efficiency* $_{t-4}$ | -0.277 | 0.174 | -0.194 | 0.177 | -0.156 | 0.178 |
| *Age* $_{t}$ | -0.006*** | 0.002 | -0.005** | 0.002 | -0.004** | 0.002 |
| *Net interest margin* $_{t-4}$ | -0.020 | 0.068 | -0.026 | 0.041 | -0.030 | 0.027 |
| *Net non-interest income* $_{t-4}$ | -0.034 | 0.053 | -0.021 | 0.058 | -0.022 | 0.059 |
| *Other borrowed money* $_{t-4}$ | 0.026* | 0.015 | 0.024 | 0.015 | 0.016 | 0.015 |
| *Loans over deposits* $_{t-4}$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 |
| | | | *Bank holding characteristics* | | | |
| *Size* $_{t-4}$ | | | 0.048 | 0.092 | -0.018 | 0.100 |
| *Capital* $_{t-4}$ | | | -0.063** | 0.028 | -0.049** | 0.022 |
| *Return on assets* $_{t-4}$ | | | -0.008** | 0.003 | -0.006* | 0.003 |
| *Short-term borrowing* $_{t-4}$ | | | 0.022*** | 0.007 | 0.021*** | 0.007 |
| *Dummy rescue* $_{t}$ | | | -2.446*** | 0.602 | -2.384*** | 0.600 |
| *Equity invested in non-banks* $_{t-4}$ | | | | | 0.013 | 0.013 |
| *Money borrowed from non-banks* $_{t-4}$ | | | | | 0.014*** | 0.004 |
| | | | *Macroeconomic conditions* | | | |
| *House prices growth* $_{t}$ | -0.052*** | 0.011 | -0.055*** | 0.011 | -0.054*** | 0.011 |
| *Federal funds rate* $_{t}$ | -0.287*** | 0.087 | -0.318*** | 0.088 | -0.303*** | 0.089 |
| *Income growth* $_{t}$ | -0.088*** | 0.020 | -0.090*** | 0.020 | -0.097*** | 0.020 |
| *Constant* | -4.319*** | 1.189 | -6.213*** | 1.212 | -6.308*** | 1.214 |
| *Observations* | 100637 | | 100637 | | 100637 | |
| *Pseudo* $R^2$ | 0.36 | | 0.38 | | 0.39 | |
| *Banks* | 6189 | | 6189 | | 6189 | |
| *Failed banks* | 242 | | 242 | | 242 | |
| *Correctly predicted* | 72 | | 86 | | 87 | |
| *False alarms* | 78 | | 79 | | 80 | |
| *- among which rescued banks* | 6 | | 4 | | 3 | |

Notes: Sample period 2006-2010. Dependent variable, dummy=1 when the tangible equity ratio of a failed bank or an acquired bank falls below 2% for the first time.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

# Appendix B

### The resolution of WaMu (FDIC-insured Thrift Company)

**Box 1 - Case Study**: Washington Mutual Bank's resolution

Washington Mutual Bank (WaMu) was a federally-chartered savings association (thrift) regulated by the Office of Thrift Supervision (OTS) and FDIC-insured since January 1, 1934. WaMu was wholly owned by Washington Mutual Inc. (WMI), a savings and loan holding company. On September 25, 2008 the primary regulator, the OTS decided to seize Washington Mutual Bank from Washington Mutual Inc. and placed it into receivership of the FDIC after a 9-day bank run causing a withdrawal of 16.7 billion dollars in deposits.

In the resolution process, the FDIC facilitated a sale of WaMu to JP Morgan Chase. The latter acquired all the banking operations, including all assets, deposits, covered bonds and other secured debt. On the other hand, equity claims, subordinated and senior unsecured debt were not assumed by JP Morgan Chase. There was no publicly-owned stock in WaMu. Shareholders' shares were in WMI, the holding company, which filed the Chapter 11 of the United States' Bankruptcy Code the next day. The purchase and assumption transaction resulted in no loss to the deposit insurance fund.

According to the FDIC, the failure of WaMu can be attributed to both the failure of internal management and of regulatory supervision. WaMu grew rapidly through acquisitions starting in 1991 becoming the country's third-largest mortgage lender in 2001. However, it appears that WaMu increasingly shifted its businesses away from originating traditional fixed-rate and single family residential loans, towards riskier non-traditional loan products and subprime loans. When the housing market collapsed in 2007, the situation of the bank deteriorated rapidly with loan losses, borrowing capacity limitations, and a falling stock price.

As the primary federal regulator, OTS had identified concerns with WaMu's high-risk lending strategy. However, OTS's supervision did not adequately ensure that WaMu corrected those problems early enough. The OTS did not lower WaMu's composite CAMELS rating in time. As a result, the FDIC did not reflect WaMu's risk in its deposit insurance premium.

As WaMu was sold to JP Morgan Chase at a low price of 1.9 billion dollars, shareholders suffered large losses and claimed that the bank had not get fair value during the seizure. The holding company as well as shareholders filed several lawsuits against the FDIC and JP Morgan Chase, contesting the ownership of over 20 billion dollars in assets. There case is still under a legal review process as of May 2012.

Reference:
FDIC OIG report: Evaluation of Federal Regulatory Oversight of Washington Mutual Bank
FDIC website, http://www.fdic.gov/bank/individual/failed/

# Appendix C

# Variable definitions

### C.1. Baseline estimations

**Dependent variable**

Definition 1: The failure dummy is equal to 1 in the quarter of a bank's failure and zero otherwise.

Definition 2: This version changes the date at which a bank failed, if necessary, to the date at which a bank's tangible equity ratio falls below 2% for the first time.[32] Moreover, it includes acquisitions of undercapitalized banks during 2008-10 (with a risk-based capital ratio below 8% or a Tier 1 ratio below 4%).

**Independent variables**

*Capital adequacy*

- Total risk-weighted capital ratio = 100 × total risk-based capital (rcfd3792) / total risk-weighted assets (rcfda223)

*Asset quality*

- Non-performing loan ratio = 100×past due and nonaccrual loans[33] / total loans (rcfd2122)
- Allowances for loan and lease losses (ALLL) ratio, = 100×rcfd3123 / total loans
- Mortgage loan ratio =100×loans secured by real estate (rcfd1410)/ total loans
- Size = logarithm of total assets (rcfd2170)
- Loan growth rate, annual growth rate of total loans = 100×(rcfd2122 - $rcfd2122_{t-4}$) / $rcfd2122_{t-4}$
- Other real estate owned ratio =OREO (rcfd2150) / total assets (rcfd2170)

*Management quality*

- Efficiency ratio, = 100×non-interest expense flow[34](riad4093) / (net interest income flow (riad4074) + non-interested income flow (riad4079))

[32] Tangible equity ratio= Tier 1 capital(rcfd8274) / total assets (rcfd2170)

[33] Past due and nonaccrual loans are equal to the sum of items 1-9 from schedule RC-N of the call reports with a modification in 2007.

[34] The item riad4093 in income statement records accumulated non-interest expense from the beginning of the fiscal year. The non-interest expense flow in one quarter = riad4093 – $riad4093_{t-1}$. This calculation applies to all income statement items.

Managerial efficiency dummy = 1 when efficiency ratio between 0 and 70%

- Age = 2010 – year of establishment (rssd9950)

*Earnings*

- Net interest margin = net interest income flow (riad4074) / total assets
- Net non-interest income =non-interested income flow / total assets

*Liquidity*

- Loan to deposit ratio, =total loans / total deposits (rcfd2200)
- Other borrowed money ratio = 100×other borrowed money (rcfd3190) / total assets

*Sensitivity to markets and the economy*

- House price growth rate = 100 (average house price by state - average house price by state$_{t-4}$) / average house price by state$_{t-4}$
- Effective federal funds rate = average of monthly effective federal funds rate in a quarter
- Income growth rate = 100 × (income by state – income by state $_{t-4}$) / income by state $_{t-4}$

**C.2. Estimation with information on bank holding companies**

**BHC variables**

- Size = logarithm of total unconsolidated assets (bhcp2170 for large BHCs and bhsp2170 for small BHCs)
- Capital ratio = 100× consolidated equity (bhck3210 for large BHC and bhsp8519 for small BHC) / total consolidated assets
- Return on assets (ROA) = 100 ×net income flow (bhcp4340 for large BHC and bhsp4340 for small BHC) / total unconsolidated assets
- Short-term borrowing ratio = sum of commercial papers (bhcp2309 and bhsp2309) and other short-term borrowing (bhcp2332 and bhsp2724) over total unconsolidated assets
- Equity invested in non-banks = investment in nonbank subsidiaries (common and preferred stocks bhcp1273 and bhsp0088) over total unconsolidated assets
- Money borrowed from non-bank = balance due to nonbank subsidiaries and related institutions (bhcp3606+bhcp3607 for large BHC and bhsp3621 for small BHC) over total unconsolidated assets