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What Causes Bank Failures During the Recent Economic Recession?

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ABSTRACT

More than 400 banks failed during the recent financial crisis. Bank failures have a significant impact on the financial system and the economy as a whole. It is important to identify factors that may contribute to bank failures so that banks can take measures to reduce their default risk. This paper examines how bank specific characteristics and economic conditions affect bank failures during the recent financial crisis. We employ the logistic regression model to study this issue using data of all U. S. commercial bank insured by FDIC over the sample period 2007-2012. We find that the ratio of the loan and leases to total assets, real estate loan ratio, and non-performing loan ratio have a positive influence on the bank failures while capital adequacy ratios, return on assets, liquid ratio, and GDP growth rate have a negative impact on bank failures.

1. Introduction

Banks are financial intermediaries whose liabilities are mainly short-term deposits and whose assets are usually short-term and long-term loans to businesses and consumers. When the value of their assets falls short of the value of their liabilities, banks are insolvent (Demirguc-Kunt, Detragiache 1998). From 2000 to 2007, 32 banks were closed. Starting in 2008, when financial crisis hit the economy, 30 banks were closed. This number jumped to 148 bank failures in 2009 and 150 bank failures in 2010. In 2011, the number of failed banks dropped to 92 and there were 41 failures through the third quarter of 2012.

Insolvency of a bank can have a wide range of effects. Depositors, individuals, and organizations can lose their deposits that are in excess of the amount insured by the Federal Deposit Insurance Corporation. Moreover, an increase of bank failures can affect the overall economic health and the stability of a nation. Therefore, because of these potential effects, the banking industry is highly regulated. It is essential to identify factors that may contribute to bank failure so that banks can take measures to eliminate the risk.

Over the years, there have been several banking crises recognized by scholars. Scholars have done researches aiming at identifying factors that lead to bank failures to help regulatory agencies and organizations to take measures and prevent such tragedy. However, researchers such as Wheelock and Wilson (2000) and Estrella, Park, and Peristiani (2000) have used samples from earlier banking crises in the 1980s and 1990s. In addition, Cebula, Koch, and Fenili (2011) analyzed the impact of macro factors on bank failure and Cole and White (2011) and Samad and Glenn (2012) all analyzed data on bank failures until 2009. This paper aims to use the most current data to analyze bank-specific factors that may impact the solvency of a bank. We are also

interested in investigating the question of whether financial ratios have the same impact on bank failure in different asset groups.

Accordingly, the purpose of this research is to compare the financial characteristics between failed and survived banks and test additional factors that have an impact on the solvency of banks. The second section of this paper provides an overview of previous literature's contribution to the topic. The third section introduces the model used and variables that are included in the model. The fourth section is a discussion of results and interpretation of the results obtained. The last section of this study provides the preliminary conclusions and evaluations. This paper provides a comparison of the of different capital adequacy ratios that cause bank failure during financial crisis. In addition, the contribution of this paper is that we addressed this issue using an updated dataset from 2007 to third quarter to 2012.

2. Literature Review

The majority of studies have identified some contributing factors to bank failures for the past banking crisis during the 1980s. The consensus is that the overall economic condition contributes to the systematic risks that affect bank performance. Cebula (2010) and Demirguc-Kunt and Detragiache (1998) included the real GDP growth rate as a factor in their papers. Empirical results agreed with their hypothesis that real GDP growth is negatively correlated with the possibility of bank failures. That is, when the economic condition is good and the real GDP growth is high, banks are less likely to fail. The Standard & Poor's 500 Stock Index had also been used as an indicator of the overall economic condition. Cebula (2011) included the standard deviation of the monthly average of S&P 500 in 1970-2009 in his linear model, and he found that stock market volatility had positive impact on bank failure rate.

Apart from macroeconomic influence on banks, bank specific characteristics also contribute to failure during the recent financial crisis. Banks' liabilities, or generally, loans, are risky. Therefore, the quality of loans can have significant impact on banks' solvency. The subprime mortgage crisis of 2007/08 followed by financial crisis that started since mid 2008 has severely impacted the banking industry. Huge write-downs in mortgages erode the capital base of banks (Balasubramanyan 2010). Credit risk is a function of the quality of a bank's loans and is commonly used to evaluate bank risks. Samad (2012) used the probit model to discuss the influence of credit risk on bank survival during the 2009 financial crisis. He concluded that loan ratios, such as credit loss provision to net charge, loan loss allowance to loans, and non-current loans to total loans, are significant factors to predict bank failures. Cole and White (2011) identified the types of loans that influence banks' solvency in their paper. They found that real-estate loans play a critical role in determining the survival of banks. Other loans, such as real estate construction and development loans, commercial mortgages, and multi-family mortgages, are consistently associated with a higher likelihood of bank failure. In addition, nonperforming loans, which includes loans that are past due for 30 or more days and non-accruing loans, are also tested in models. Shaffer (2012) used the logit regression method to test three different sample groups: bank data of 1984, 1989 and 2008. He found that banks' risk of failure was more sensitive to nonperforming loans in 2008 than in the 1980s.

Capital ratios have also been used when evaluating factors that contribute to bank failure. Some ratios that are used in recent literature are leverage ratios, capital ratios, and capital to gross revenue ratio. Wheelock and Wilson (2000) used total equity divided by total assets and found that less well-capitalized banks are at greater risk of failure. Estrella, Park, and Peristiani (2000) examined bank failure during 1988-1992 and tested different capital ratios and bank

failure rate. Their examination of this relationship suggests that, in addition to risk-weighted ratio, leverage ratio and capital to gross revenue are significant factors in predicting bank failures during the period. Leverage ratio, or the most commonly used debt-to-equity ratio, is used to evaluate a financial institution's ability to meet debt obligations. Capital adequacy ratios, also called capital to risk weighted assets ratio, evaluates a bank's capital compared to its risk. The most commonly used capital adequacy ratio is the tier one capital ratio. Samad (2011) used ANOVA test to examine the relationship between a bank's capital adequacy and the possibility of failure. The variables he used are tier 1 capital as a percentage of average total assets, tier 1 capital as a percentage of risk-weighted assets, and total risk-based capital as a percentage of risk-weighted assets. The results strongly support the hypothesis that low capital-holding ratios contributed to the failure of banks during 2008-2009. From various studies, it is clear that adequate capital is essential to bank survival during economic downturn.

In addition to capital adequacy, bank size is also an important factor that may influence bank solvency. Cole and White (2011) tested their model of fitness for different bank asset groups. Most contributing factors hold for both small and large banks but there are a few variations in terms of bank size. Return on Assets (ROA) is a weaker negative influence on failures for large banks than for small banks. On the other hand, securities play no role in failures for large banks but have a significant influence on small banks. Balasubramanyan, Stefanou, and Stokes (2010) focused only on banks in high-risk states of Florida, Georgia, Illinois, and Ohio, found that mortgage-backed securities and bank cost efficiency are negatively correlated only in the case of large banks. Because large banks are perceived to be more stable, they tend to engage in more hedging and portfolio reconfiguration activities than small banks. Consequently, the

capitals of these banks are severely influenced by the mild housing market and people who cannot pay mortgage in economic downturn.

As the literature review shows, bank financial performance data does exhibit a predictive power in assessing potential failure of commercial banks. Although these factors have already been significantly studied over the past decades, most scholars discussed either systemic factors or bank specific factors in their papers. Our model gives an explanation that combines both macroeconomic factors and bank specific factors. Moreover, these papers employed bank financial data through 2009, while the result of this paper is based on quarterly data from 2007 to third quarter of 2012. Unlike previous literature that mostly use sample size of only hundred of banks, our data set contains all commercial banks over the 23 quarters studied.

3. Methodology and Variables

3.1 Regression Model

The literature discussed above leads to a general hypothesis that economic downturn, together with bank financial ratios, are significantly related to banks' failures. In our regression model, the dependent variable FAIL is a binary variable which equals to one if a bank fails and zero otherwise. Since the dependent variable is binary, it would be inappropriate to use Ordinary-Least-Squares models. The conceptual problem with linear regression with a dichotomous dependent variable stems from the fact that probabilities have maximum and minimum values of 1 and 0. Depending on the slope of the line and the observed values, a model can give predicted values of the dependent variable above 1 and below 0 (Pampel 2000). In this case, we choose to run the Logistic Regression Model, or Logit Model, similar to the literature (Shaffer, 2012; Cole and White, 2012). The merit of logit model is that it can be written as a linear model for the log odds, which makes it simpler to interpret than the probit model (Chen and Wong, 2004).

The dependent variable takes on two values, 1 and 0. We assign the status of failed banks as 1 and the status of survived banks as 0. By the definition of logistic model, the dependent variable can be written as the linear combination of independent variables. Unit changes of independent variables in the model will change the possibility of bank failure. Positive coefficients indicate that every one unit increase of the independent variable, the possibility of bank failure will increase by the coefficient. In the same manner, negative coefficients imply that increase in one unit of the independent variable will cause the possibility of bank failure decrease by the coefficient. Independent variables and their calculations are discussed in the next section.

3.2 Data and Variables

We collect our data from the FDIC Call Reports and the Uniform Bank Performance Reports from the FDIC website (www. fdic.gov). The time frame of this study spans from 2007 to the third quarter of 2012. Independent variables are drawn from different financial statements, such as balance sheet, income statement, and capital analysis form from the UBPR bulk data set. The number of banks included in a single quarter is around 7000. Variations in bank numbers are due to mergers and acquisitions within the banking industry that caused some financial data of acquired banks to be unavailable. The number of failed banks is identified in accordance to the failed bank list provided by FDIC. Thus, we excluded institutions that have been acquired during the surveyed period in this research. In addition, we also excluded some institutions that have missing data or extreme values. Our dataset contains 162,890 cases for the 23 quarters from 2007:Q1-2012:Q3. The variables used in this analysis are summarized in Table 1.

Loan Loss Reserve (LLR) is calculated by dividing allowance for loans and leases by total assets. The allowance for loans and leases is an estimation of the amount of loans that might be ultimately uncollectible. As Bella and Rose (2011) pointed out, an adequate LLR is a safety

and soundness issue because a deficit in LLR implies that the bank's capital ratios overstate its ability to absorb unexpected losses. Higher loan loss reserve ratio means banks are more prepared to loan default risks. We expected this variable to negatively affect the failure of banks.

Table 1 Summary of Variables, Formulas, and Expected Sign

Variable	Formula/Description	Expected Sign
GDP growth(GDP)	Quarterly growth rate of GDP	-
Loan Loss Reserve (LLR)	Loan and leases allowance/Total Assets	-
Loan and Leases to Assets Ratio (LLTA)	Total Loan and Leases/Total Assets	+
Real Estate Loan Ratio (RE)	Real estate loan/Total Loans	+
Liquid Ratio	Total Cash and due from banks/Total Assets	-
Tier 1 Capital Ratio (T1CR)	Tier 1 Capital/Total Risk-Weighted Assets	-
Total Risk-Weighted Capital Ratio (TCR)	Total Risk Based Capital/Risk –Weighted Assets	-
Leverage Ratio (Leverage)	Tier 1 Capital/Total tangible Assets	-
Non-Performing Loan Ratio (NPLR)	Non-performing loans and leases/Total Assets	+
Gross Revenue (GrossRev)	Tier 1 Capital/(Total interest and non-interest income)	-
Return on Assets (ROA)	Net income/Total Assets	-
Size of Banks (Size)	Ln(Total Assets)	?
FAIL	Dummy Variable(Filed=1, Non-failed=0)	Dependent

Loan and Leases to Total Assets (LLTA) is calculated by dividing total loan and leases to total assets. Unlike cash and due from banks that are liquid assets available immediately, loans and leases are not liquidated until the signed term expires. Therefore, loans and leases are risky. Failure was more likely for banks with larger ratios of loans to assets (Wheelock et al., 2000). This ratio is designed to capture the portion of banks' total assets that are at risk. Shaffer's (2012) logit regression result also indicated a significant correlation between loan to asset ratio and bank failure in the 2008 bank sample. Therefore, we expect high LLTA to have a positive impact on possibility of bank failure. That is, the more loans and leases a bank holds, the higher possibility of failure in the future.

Gross Domestic Product growth rate (GDP) is a commonly used macroeconomic indicator of an economy (Cebula et al., 2011; Shim, 2012). The higher the growth rate of real GDP, the lower the bank failure rate, presumably because of the stronger economy implied by a higher GDP and the resulting better loan performance on bank balance sheets (Cebula et al., 2011). Shim (2012) found that GDP growth rate is positively associated with bank default risk, which implies that the probability of bank insolvency is increasing during recessions. We predict GDP to have a negative correlation with the possibility of bank failure.

Real Estate Loan Ratio (RE) is calculated by dividing total real estate loan to total loans. The subprime mortgage crisis of 2007/08, followed by financial crisis that started in mid-2008, have severely impacted the banking industry. Cole et al. (2011) argued that real estate loans play a critical role in determining survival of banks during the financial crisis. We expect this ratio to have a positive impact on the failure of banks, meaning that the more real estate loans a bank holds the more likely the bank will fail.

Liquid ratio is calculated by dividing non-interest generating cash and due from banks to total assets. This variable captures the availability of liquid assets to mediate potential losses. Banks with a higher level of liquid assets that can readily be turned into cash when needed indicates that they have a greater ability to meet short-term financial obligations without having to result to untimely sale of investment or fixed assets (Shim 2013). We expect this variable to have a negative impact on bank failure, which means that the higher the liquid ratio of a bank, the less likely that the bank will fail.

Tier 1 Capital Ratio (T1CR) is tier 1 capital to total risk-weighted assets. Tier 1 capital is a bank's core capital and an essential indicator of a bank's financial strength. Samad (2011) proved that there are significant difference between failed banks and survived banks with respect

to tier 1 capital ratio. In addition, Samad et al. (2012) found that tier 1 risk-based capital to average assets are significant factors in explaining bank failures. We expect this variable to have a negative impact on possibility of failure of commercial banks. That is, banks with the higher the tier 1 capital ratio are less likely to fail.

Total Risk-based Capital Ratio (TCR) is a capital adequacy indicator in addition to the Tier 1 Capital Ratio. By running ANOVA tests between failed and non-failed banks on Total Risk-based Capital Ratio, Samad (2011) concluded that there is a significant difference in capital holdings between failed and non-failed banks. In particular, the capital holding ratios of all non-failed banks were significantly higher than those of failed banks. Thus, banks with higher capital adequacy ratios, T1CR and TCR, might be less likely to fail. Therefore, we expect this variable to have negative impact on the failure of banks. That is, banks with higher total risk-based capital ratio are less likely to fail.

Leverage Ratio (Leverage) is calculated by dividing tier 1 capital to total tangible assets. Leverage ratio assumes implicitly that capital needs of a bank are directly proportional to its level of assets (Estrella et al, 2000). Lower leverage ratio implies less risk based capital cushion compared to the size of the organization. Less capital cushion may increase the possibility of bank failure in financially difficult times. Estrella et al. showed that leverage ratio is a good predictor of bank failure, in addition to other complex capital ratios. We expect this ratio to have negative effect on bank failure. That is, the higher the leverage ratio of a bank, the lower the possibility of future failure.

Non-Performing Loans Ratio (NPLR) is calculated by dividing non-performing loans by total loans. In our model, we calculated non-performing loans as the sum of loans and leases that are 30-89 days past due and still accruing interest, loans and leases that are 90 or more days

past due and still accruing interest, and nonaccrual loans and leases. We used this calculation because past literature (Cole et al. 2012) has included all these past due loans in their non-performing assets variable. These loans and leases have already past due and are risky because the debt might be uncollectible, especially for nonaccrual loans and leases. This variable reflects the size of non-performing loans within total bank assets. If the ratio is relatively high, then losses on underwriting bad debts might be huge and potentially impact the solvency of the bank. Thus, we expect this variable has a positive effect of the failure of banks. That is, banks with more non-performing loans on account are more likely to fail.

Gross Revenue ratio (GrossRev) is calculated by dividing tier one capital to total interest and non-interest income. Estrella et al. (2000) denoted that gross revenue includes components associated with off-balance-sheet activities. Thus, gross revenue may reflect the riskiness of bank assets better than total assets. Their study result implied that gross revenue ratio is a simple and good predictor of bank failure. We expect this ratio to have a negative correlation with bank failure, which suggests that banks with higher gross revenue ratio will be less likely to fail.

Return on Assets (ROA) is calculated by dividing net income by total assets. This ratio is frequently used as an indicator that reflects the efficiency of banks' management on using their assets to generate profit (Cole and White, 2011; Shim, 2013; Samad and Glenn, 2012). Clearly, higher ROA means greater efficiency in converting assets into net income. Low ROA indicates less efficiency and that the organization is more likely to experience financial difficulty. We expect this variable to have negative impact on the failure of banks.

Size is calculated by taking the natural logarithm of individual banks' total assets. Small banks are more vulnerable compared to large banks during financial recession. Large banks tend

to be more diversified when managing capital assets and have easier access to the capital markets than smaller banks (Shim, 2013). As Cole and White noted, smaller banks, especially younger ones, are generally more prone to failure than are larger banks. However, large banks might be more prone to risky lending activities, which have potentially huge losses. Large banks have more opportunity to receive government assistance and funding during financially difficult times because the impact of a large bank's failure could be substantial. Shim (2013) pointed out that there are possible moral hazard issues among large banks due to a government safety net through implicit "too big to fail" policies. Thus, we expect this variable to have a significant impact on bank failure, but we are unsure about the expected signed.

4. Results

4.1 Descriptive statistics

Table 2 presents the summary of descriptive statistics for all variables used in three models. The summary includes data of an unbalanced panel of 165,255 quarterly observations divided into two groups, survived banks and failed banks. Comparing the descriptive statistics of banks in the two groups, we observe that the Loan and Leases to Total Assets (LLTA), Real Estate loans ratio (RE), and Non-performing Loans Ratio (NPLR) are significantly higher for failed banks compared to survived banks. In addition, capital adequacy ratios of failed banks, such as Tier 1 Capital Ratio (T1CR), Total Risk-based Capital Ratios (TCR), and Leverage Ratios (Leverage), are significantly lower than that of survived banks. The differences indicate that failed banks have less risk-based capital cushion towards potential risks while bearing more risky assets at the same time.

Table 2 Descriptive Statistics

	Failed Banks		Survived Banks	
	Mean	Std. Deviation	Mean	Std. Deviation
LLTA	.7397	.1167	.6402	.1550
LLR	.0234	.0177	.0164	.0102
NPLR	.0890	.0885	.0357	.0364
ROA	-.0078	.0215	.0033	.0112
RealELoan	.8006	.1501	.6961	.1881
Liquid	.0554	.0553	.0720	.0741
T1CR	.1036	.0654	.1608	.0829
TCR	.1158	.0648	.1723	.0825
Leverage	.0813	.0472	.1051	.0419
GrossRev	2.8073	2.5652	3.9881	3.5627
Size	12.3763	1.1827	12.0070	1.3220

LLR is the loan loss reserve measured by loan allowance to total assets; LLTA is the total loan and leases to total assets; RealELoan is the real estate ratio measured by total real estate loans to total loans; Liquid is bank liquidity measured by cash and due from banks to total assets; NPLR is the non-performing loans ratio measured by non-performing loans to total assets; ROA is return on assets calculated by net income to total assets as an indicator of bank management efficiency; Size is the indicator that measure firm size by taking the natural logarithm of total assets. T1CR is the tier one risk-based capital ratio measured by tier one capital to total risk-weighted assets. TCR is the total risk-based capital ratio measured by total risk-based capital to total risk-weighted assets, while leverage ratio is tier one capital to total tangible assets.

Table 3 represents the correlation matrix of variables. The regression results are presented in Table 4. Other variables being the same, Model I includes tier 1 risk-based capital ratio (T1CR) as capital adequacy indicator, while Model II includes total risk-based capital ratio and Model III includes leverage ratio (Leverage) as capital adequacy measurement. Loan and leases to total assets (LLTA), real estate ratio (RE), non-performing loans ratio (NPLR), and size are statistically significant and have positive influence on bank failure. Conversely, return on assets (ROA), liquid ratio (Liquid), GDP growth rate, loan loss reserve (LLR), and capital adequacy ratios are statistically significant and have negative influence on bank failure. At the same time, gross revenue is only a significant factor that increases insolvency risks of banks in model III.

Table 3 Correlation matrix of variables

	GDP	LLTA	LLR	NPLR	ROA	Liquid	Gross Rev	Size	RealE Loan	TCR	T1CR
LLTA	.078										
LLR	-.102	-.196									
NPLR	.028	.208	-.481								
ROA	-.075	-.092	.334	.128							
Liquid	-.126	.153	-.148	-.073	.042						
GrossRev	.076	.078	-.028	-.048	-.072	-.067					
Size	-.004	.122	-.030	.071	-.098	.136	-.018				
RealELoan	.000	-.071	.006	.013	.005	.028	-.006	.097			
TCR	.002	-.067	-.158	-.018	-.009	-.012	.004	-.212	.010		
T1CR	-.009	.212	.156	.039	-.019	-.010	-.005	.238	-.032	-.964	
Leverage	.017	-.545	.006	-.010	.041	.120	-.161	-.070	.108	.053	-.294

The significant and positive sign of total loan and leases to total assets indicates that banks with higher loan and leases are more likely to fail. Loans are typically the least liquid and most risky of bank assets (Wheelock et al., 2000). If a bank expands its lending activities without increasing capital, it is exposed to more risks and cannot fully liquidate these assets until the loan contracts are over. The coefficients of loan loss reserve ratio suggest that it is only a significant factor in model I but it is not significant in model II and model III. The negative correlation implies that if banks can increase one unit of loan loss reserve, holding all other variable unchanged, the bank's possibility of failure will decrease by the coefficient.

The regression result suggests size is significant at 10% level in model I but it is not significant in model II and III as we expected. The negative coefficient in model I implies that larger banks are less likely to fail.

The positive and significant sign of real estate ratio suggests that increase in real estate loans will increase the possibility of bank failure. Increases in real estate lending activity are risky because of its long-time commitment of funds. If banks expand lending business to less qualified borrowers, they are exposed to higher loan default risks. This result is expected and is

consistent with previous literatures (Cole et al., 2011; Shaffer, 2012). The coefficients of non-performing loans ratio (NPLR) are positive and significant in three models, indicating that a positive association between NPLR and the possibility of bank failure. Large coefficients suggest that one unit change in NPLR has great influence on bank failure compared to the effect of other variables. This result is consistent with previous literatures (Shaffer, 2012; Shim, 2013) and will encourage banks to take additional measures to assess borrowers' credit risk and eliminate possibility of loan default.

Table 4 Regression Result

	Model I	**Model II**	**Model III**
Constant	-5.284***	-5.240***	-7.234***
	(.000)	(.000)	(.000)
GDPGrowth	-4.960***	-4.952***	-5.206***
	(.000)	(.000)	(.000)
LLTA	3.027***	3.035***	4.533***
	(.000)	(.000)	(.000)
LLR	-3.990*	-2.922	-1.680
	(.063)	(.173)	(.425)
NPLR	11.067***	11.062***	11.607***
	(.000)	(.000)	(.000)
ROA	-13.897***	-13.779***	-16.716***
	(.000)	(.000)	(.000)
Liquid	-4.766***	-4.751***	-4.923***
	(.000)	(.000)	(.000)
GrossRev	-.025***	-.024***	-.051***
	(.001)	(.001)	(.000)
Size	-.022*	-.012	.017
	(.088)	(.376)	(.186)
RealELoan	2.165***	2.157***	1.942***
	(.000)	(.000)	(.000)
T1CR	-13.756***		
	(.000)		
TCR		-13.948***	
		(.000)	
Leverage			-11.973***
			(.000)
Pseudo-R^2	.059	.059	.056

LLR is the loan loss reserve, measured by loan allowance to total assets; LLTA is the total loan and leases to total assets; RealELoan is the real estate ratio measured by total real estate loans to total assets; Liquid is bank liquidity measured by cash and due from banks to total assets; NPLR is the non-performing loans ratio measured by non-performing loans to total assets; ROA is return on assets calculated by net income to total assets as an indicator of bank management efficiency; Size is the indicator that measure firm size by taking the natural logarithm of total assets; GDPGrowth is the quarterly real Gross Domestic Product growth rate in 2005 dollar. T1CR is the tier one risk-based capital ratio measured by tier one capital to total risk-weighted assets. TCR is the total risk-based capital ratio measured by total risk-based capital to total risk-weighted assets, while leverage ratio is tier one capital to total tangible assets. Significance of each variable is presented in parentheses.
* Statistical significant at 10% level.
** Statistical significant at 5% level.
*** Statistical significance at 1% level

The negative and significant signs of return on assets (ROA) show that more profitable banks are less likely to fail. This result would encourage banks to increase management efficiency in order to survive. In addition, ROA has a more significant influence on possibility of bank failure in model III, in which one unit increase of ROA will cause possibility of bank failure to decrease more than in other two models. Gross revenue ratio (GrossRev) is significant and negatively correlated with bank failure in all three models. This shows that there is an inverse relationship between banks' gross revenue ratio and possibility of bank failure. As banks increase one unit of gross revenue, their possibility of becoming insolvent will decrease.

The coefficients of capital adequacy ratios, Tier 1 risk-based capital ratio (T1CR), Leverage ratio, and total risk-based capital ratio (TCR), are negative and statistically significant at 1% level. The result indicates that these capital ratios are significant factors that influence bank solvency. Nevertheless, model III with leverage ratio has less predicting power than other two models with risk-weighted capital ratios. This supports the result of Estrella et al. (2000) that risk-weighted ratio is the most effective predictor of failure over long time horizons. In particular, risk-weighted ratios do not consistently outperform leverage ratios in short horizons of less than two years. Since our study lasts more than five years, T1CR and TCR clearly have more predicting power.

4.2 Result based on different Total Assets

Table 5 is a comparison of regression results for banks in different asset groups. Small banks are more vulnerable compared to large banks. Several scholars have addressed the correlation of bank size and bank survival during financial crisis. Wheelock and Wilson (2000) concluded that smaller banks are more likely to fail and be acquired than larger banks.

We divide all banks into four groups according to their total asset: (1) banks with total assets less than 100 million dollars, (2) banks with total assets between 100 million dollars and 1 billion dollars, (3) banks with total assets between 1 billion dollars and 10 billion dollars, and (4) banks with total assets more than 10 billion dollars. According to data provided by FDIC, the average tier 1 risk based capital ratio for banks in group (1) is 18.39%, and this ratio is 10.94% for banks in group (4). The average real estate loans to total asset ratio is 17.9% for banks in group (1), 29.9% for banks in group (2), and 8.9% for banks in group (4). The large difference attracts our attention. Small banks and large banks may have different banking characteristics such that financial ratios will also have different impact on the possibility of failure.

In the previous section, model II with total risk-based capital ratio as a capital indicator has the best predicting power, and we are thus using this model in this section. An overview of table 5 shows that these results are consistent with the regression results in the previous section. The table indicates that loan and leases to total assets (LLTA), real estate ratio (RE), and liquid ratio are significant in all three groups at 1% level. Other variables have mixed results on bank failure for different bank groups.

Table 5 Regression result according to banks' total assets

	(1)	(2)	(3)	(4)
	Asset<100M	**100M<Asset<1B**	**1B<Asset<10B**	**Asset>10B**
Constant	-5.022***	-3.421***	-4.404***	7.115
	(.000)	(.000)	(.004)	(.115)
GDPGrowth	-7.840***	-3.919***	.367	-15.164***
	(.000)	(.000)	(.808)	(.001)
LLTA	2.681***	3.282***	4.268***	-6.350***
	(.000)	(.000)	(.000)	(.000)
LLR	13.013***	-10.541***	-19.383**	73.435***
	(.001)	(.000)	(.021)	(.002)
NPLR	8.774***	10.843***	11.889***	4.774
	(.000)	(.000)	(.000)	(.307)
ROA	-21.615***	-8.823***	10.600**	17.839
	(.000)	(.000)	(.020)	(.205)
RealELoan	1.147***	3.041***	1.578***	5.138***
	(.000)	(.000)	(.000)	(.001)
Liquid	-5.147***	-4.973***	-2.962**	-22.457***
	(.000)	(.000)	(.044)	(.007)
TCR	-2.058***	-24.623***	-45.703***	-61.025***
	(.000)	(.000)	(.000)	(.000)
GrossRev	-.021*	-.023**	-.010	.038
	(.071)	(.023)	(.751)	(.679)
Size	-.112*	-.116***	.160*	-.188
	(.093)	(.000)	(.084)	(.349)
Pseudo-R^2	.026	.081	.097	.062
Failed banks	98	300	53	19
Number of Observations	59,742	90,597	10,643	1,908

LLR is the loan loss reserve, measured by loan allowance to total assets; LLTA is the total loan and leases to total assets; RealELoan is the real estate ratio measured by total real estate loans to total assets; Liquid is bank liquidity measured by cash and due from banks to total assets; NPLR is the non-performing loans ratio measured by non-performing loans to total assets; ROA is return on assets calculated by net income to total assets as an indicator of bank management efficiency; Size is the indicator that measure firm size by taking the natural logarithm of total assets; GDPGrowth is the quarterly real Gross Domestic Product growth rate in 2005 dollar. T1CR is the tier one risk-based capital ratio measured by tier one capital to total risk-weighted assets. TCR is the total risk-based capital ratio measured by total risk-based capital to total risk-weighted assets, while leverage ratio (Leverage) is tier one capital to total tangible assets. Significance of each variable is presented in parentheses.
* Statistical significant at 10% level.
** Statistical significant at 5% level.
*** Statistical significance at 1% level

Loan loss reserve ratio (LLR) is a significant factor in all groups except group (3). The positive coefficients in group (1) and (4) indicate positive relationships for largest and smallest banks with possibility of failure, meaning that more loan allowance will increase banks'

insolvency risks. However, for banks in group (2) and (3), the negative sign implies that banks with more loan allowance will be less likely to fail. This result may imply that smallest and largest banks have enough loan allowance prepared for default risks that setting more asset aside will impact the organization's financial solvency due to high cost of capital. Loan and leases to total assets ratio (LLTA) is significant in all four groups. The positive coefficients of group (1), (2), and (3) indicate that writing more loans and leases will increase possibility of bank failure. However, the negative coefficient for group (4) implies that increased writing of loans and leases will help banks to survive financial difficulties. This result may imply that small or medium size banks are bearing too much loans and leases on account, while the largest banks are well diversified with their asset.

The positive and significant sign of non-performing loans ratio (NPLR) in groups (1) through (3) implies that NPLR has a positive correlation with possibility of bank failure on banks in these groups. This result suggests that banks that bearing more bad debt are more likely to fail. The coefficients in each group increase as banks become larger implies that one unit increase of bad debt will cause higher possibility of bank failure in larger banks than smaller ones. The positive and significant signs of real estate ratio (RealELoan) imply that increase in real estate loans will increase banks' possibility of failure. It is also observed that groups with larger banks have greater coefficients, which suggests that increase in one unit of real estate loans will have greater impact on the solvency of larger banks. Therefore, large banks should be more cautious when writing additional real estate loan contracts

The negative and significant sign of total risk-based capital ratio for banks in all four groups implies that the higher total risk based capital as financial cushion, the less likely the banks will fail. As banks' total assets increase the coefficients of the variable decreases further,

indicating that total risk-based capital ratio has greater negative influence on bank failure as banks' total asset increase. Therefore, banks should adjust capital buffer according to bank size. Size is only a significant factor at 1% level for banks in group (2) while it is significant at 10% level for bank failure in group (1) and (3). The negative and significant coefficients in groups (1) and (2) indicates a negative influence on banks with total assets less than 1 Billion dollars while the positive coefficient for group (3) implies that banks in this group are more likely to fail when they become larger. The negative and significant sign of liquid ratio for banks in all groups implies that it is negatively correlated with possibility of bank failure. In addition, the coefficient decreases dramatically in group (4). This implies that more liquid assets for banks in group (3) will have a greater effect on bank solvency than smaller banks.

The coefficient of return on asset (ROA) is negative and significant for banks in group (1) and (2), indicating a negative correlation between ROA and possibility of bank failure. For small banks, increase in bank efficiency will help banks remain solvent. Gross Revenue ratio only has significant impact on banks in group (1) and (2) with negative sign. This implies that efforts to increase banks' gross revenue will decrease banks' possibility of failure for small banks.

5. Conclusion

In this paper, we use commercial bank data for the period 2007:Q1 – 2012:Q3 to provide empirical evidence of relationships between bank financial ratios and bank failures during the recent financial crisis. The regression results support our hypothesis that bank specific characteristics, together with macroeconomic indicator, play an important role in determining bank failures during the recent financial crisis. Regression results suggest that the ratio of the loan and leases to total assets, real estate loan ratio, non-performing loans ratio, and bank size

have a positive influence on bank failure. In contrast, return on assets, liquid ratio, gross revenue ratio, leverage ratio, and GDP growth rate have a negative impact on bank failure as expected.

Our results suggest that financial ratios have different influences on bank failures when we repeat regressions using the sub-grouped data. The increase in the ratio of the loan and leases to total assets has a negative impact on the bank failure for banks with assets more than 10 billion dollars, while it has a positive impact on bank failure for banks with assets less than 10 billion dollars. Interestingly, return on asset is negatively related to failures of smaller banks, but it is positively associated with larger banks' failures.

Consistent with previous literatures, we find that capital adequacy ratios such as tier 1 capital ratio, total risk-based capital ratio, and leverage ratios are all significant predictors of a bank failure. Further studies may need to consider the impact of new Basel III regulation on the bank failure.

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Appendix I Number of failed banks in each state by quarter

	08 1	08 2	08 3	08 4	09 1	09 2	09 3	09 4	10 1	10 2	10 3	10 4	11 1	11 2	11 3	11 4	12 1	12 2	12 3	Tota l
AL							2	1	1					2				1		7
AR		1										1								2
AZ							3	2	1	1		2	1		1	1				12
CA			2	3	3	3	3	8	2	4	4	2	3		1			1		39
CO					1	1		1					2		3	1				9
FL			1	1	2	1	3	8	6	8	10	5	2	4	5	2	2	2	1	63
GA			1	4	4	5	10	6	7	2	5	7	6	8	5	4	4	1	4	84
IA							1									1				2
ID						1														1
IL				1	3	3	10	5	3	9	3	1	3	1	3	2	3	1	3	54
IN							1								1		1			3
KS			1		1	1		1			1	2			1				1	9
KY							1													1
LA									1							1				2
MA										1										1
MD					1		1		1		2	1						2		8
MI				1		1		3		3	1	1	1	1			1			13
MN		1				1	2	3	4	2	1	1		1		1	2	1	1	21
MO	2					1	1	1	1	3		2				1			2	14
MS										1				1						2
NC						2							1			1		1		5
NE					1					1						1				3
NJ						1	1				1					1		1		5
NM									1	1			1							3
NV			3		1	1	1		1	2	1			1						11
NY							1		2		1									4
OH							1	1	1		1									5
OK							1				1		2					1		5
OR					2		1		1		2									6
PA							1					2			1		1			6
PR										3										3
SC										1	3		1	1	1			2		9
SD							1													1
TN																	2	1		3
TX				2			2	3	1						1					9
UT					1	1			3							1				6
VA								1			1				2					4
WA					1	1	1		4	3	2	2		2	1					17
WI								1			1	1	3							6
WV			1																	1
WY							1													1
Total	**2**	**2**	**9**	**12**	**21**	**24**	**50**	**45**	**41**	**45**	**41**	**30**	**26**	**22**	**26**	**18**	**16**	**15**	**12**	**460**

Appendix II Number of banks in year 2011 by State (Status: 0=survived banks, 1=failed banks)

	201101		201101	201102		201102	201103		201103	201104		201104
	0	1	Total	0	1	Total	0	1	Total	0	1	Total
AK	6		6	6		6	6		6	6		6
AL	132	3	135	130	3	133	132	3	135	131	3	134
AR	120	4	124	120	4	124	121	3	124	122	2	124
AZ	36		36	35		35	32		32	30		30
CA	246	6	252	246	4	250	243	2	245	240	2	242
CO	103		103	103		103	100		100	100		100
CT	44		44	43		43	43		43	43		43
DC	5		5	4		4	4		4	4		4
DE	33		33	33		33	31		31	31		31
FL	214	6	220	213	4	217	213	2	215	213	1	214
GA	239	6	245	234	3	237	231	2	233	228	2	230
GU	2		2	2		2	2		2	2		2
HI	7		7	7		7	7		7	7		7
IA	340	1	341	341	1	342	337	1	338	335	1	336
ID	16		16	17		17	17		17	17		17
IL	542	10	552	541	9	550	537	6	543	534	3	537
IN	107	1	108	108		108	109		109	111		111
KS	305	5	310	305	4	309	303	2	305	304	2	306
KY	176	4	180	177	3	180	177	3	180	178	1	179
LA	136	1	137	134	1	135	132	1	133	129	1	130
MA	148		148	147		147	145		145	146		146
MD	51		51	50		50	50		50	51		51
ME	23		23	23		23	23		23	23		23
MI	124	1	125	122	1	123	122		122	122		122
MN	377	4	381	374	4	378	375	1	376	371	1	372
MO	304	4	308	303	4	307	305	4	309	305	3	308
MS	85	1	86	84	1	85	85		85	84		84
MT	70		70	70		70	70		70	70		70
NC	86	1	87	85	1	86	84	1	85	83	1	84
ND	90		90	90		90	90		90	88		88
NE	210	2	212	209	2	211	209	2	211	206	2	208
NH	18		18	17		17	17		17	17		17
NJ	86	1	87	87	1	88	87	1	88	83	1	84
NM	46		46	46		46	45		45	47		47
NV	26		26	25		25	23		23	23		23
NY	151	3	154	149	2	151	146	2	148	149	1	150
OH	165	7	172	166	6	172	168	4	172	170	3	173
OK	237	4	241	237	3	240	238	2	240	237	1	238
OR	31	1	32	31	1	32	31	1	32	32	1	33

PA	181	4	185	180	4	184	179	3	182	181	3	184
PR	7		7	7		7	7		7	7		7
RI	10		10	10		10	10		10	10		10
SC	60	3	63	62	3	65	60	2	62	58	2	60
SD	80		80	80		80	80		80	79		79
TN	173	3	176	174	2	176	172	2	174	174	1	175
TX	585	8	593	583	6	589	582	5	587	585	1	586
UT	54		54	54		54	54		54	52		52
VA	105	1	106	104	1	105	103		103	103		103
VI	2		2	2		2	2		2	2		2
VT	13		13	13		13	13		13	13		13
WA	70	2	72	66	2	68	64	2	66	66	1	67
WI	248	5	253	249	4	253	251	2	253	252	1	253
WV	59	2	61	58	1	59	58	1	59	58	1	59
WY	34		34	34		34	34		34	34		34
Total	**6819**	**104**	**6923**	**6791**	**85**	**6876**	**6760**	**60**	**6820**	**6747**	**42**	**6789**

*Note: number of banks in each quarter may also due to mergers and acquisitions.