

# **Is Capital Inadequacy a Factor for Bank Failure? Evidence from US Banking**

**Abdus Samad**  
**Utah Valley University**

*If capital adequacy is an important determinant for bank failure, the natural hypothesis is that there exists a significant difference in capitalization between failed banks and non-failed banks. The paper tests this hypothesis by using the ANOVA and the Kruskal-Wallis K tests t on four measures of capital adequacy: Tier 1 risk based capital to average total assets (TIRBCATA), Total risk based capital to risk weighted assets (TRBCRWA), equity capital to assets (EQCTA), and Tier 1 capital to risk weighted assets (TIRWA). The paper finds significant differences in capital adequacy between the failed and survived banks in all four measures.*

## **INTRODUCTION**

Bank capital plays an important role and serves many vital functions. The first, a bank capital is a fund that provides protection to depositor-creditors. The protection of depositors has been the primary focus of regulatory interest in bank capital accounts. Banks generate assets through their liabilities, including deposits and equity capital. These assets, loans in general, are risky. Loans may be default or depreciate in value. The depreciation of housing value in 2008-2009, for example, led to housing market crash and bank failures in the U.S. The higher the risk of assets the higher the need for capital in protecting bank depositors and creditors. Adequate capital is, therefore, a must. The second reason for the need of capital is that it provides funds to finance the operation of banks including the acquisition of fixed assets. A single most important questions relating to bank failures is: (i) did the failed banks have adequate capital? If capital is an important determinant of bank failures, the natural hypothesis is that there exists a significant difference in capitalization between failed and successful banks. In other words, there should be significant difference in the relative levels of capitalization between failed banks and survived banks. This study is motivated to test this hypothesis.

The study is important for two important reasons: (i) Determining capital ratio that significantly distinguishes failed banks from a group of non-failed peer banks can be used in providing an early warning signal for bank management and bank regulators. By providing early warning signal, the detection of significant capitalization ratios can save billions of tax-payers 'dollars. 2009 is the worst in the history of United States bank failures since the Great Depression of the 1930s. There are more than 140 FDIC banks failed in 2009 alone with a minimum loss of millions of dollar for the taxpayers.

## **SURVEY OF LITERATURE**

The banking literature of bank capital, capital adequacy and bank failure is expanding with bank failures. Sinkey (1975) provided several characteristics of problem banks and compared them with a

control group banks using the data for the period 1969-1971. The characteristics of problem banks were expressed in terms various financial ratios. ANOVA test was performed in four measures of capital adequacy and found significant differences. Apilado and Gies (1972) examined and performed capital adequacy hypothesis testing using several measures of capital adequacy for the period 1935-1969. Their test found significant difference. Cotter (1966) compared mean test of the failed banks with the non-failed banks during 1921-1933. Three hypotheses of interest were tested for each of the period (1914-1921) utilizing several measures of capital adequacy and found a significant differences between the two groups of bank. The hypotheses were: (i) that the mean ratio of the group of bank that failed is equal to the mean ratio of the group of non-failed banks, (ii) that the mean ratio of the individual bank within the failed banks is equal to each other, and (iii) that the mean ratio of the individual banks within the non-failed bank is equal to each other. Test results showed 'significant variation among individual banks within groups' than between groups. Estrella, Park, and Persistiani (2000) examined bank failure during 1988-1992 within the current regulatory framework of Basel Accord. Their examination of relationship between different capital ratios and bank failure suggest that, in addition of risk-weighted ratio, leverage ratio and gross revenue ratio are significant factors in predicting bank failure. Bevaer, W. 1966 studied financial firm failures in relation with financial ratios. Shrieves, Roland E. 1992 investigated the relationship between changes in risk and capital and a found positive relationship between them. Demyanyk, Hassan ( 2009) examined financial and economic circumstances and found that the association of the U.S. subprime mortgage crisis and the global financial turmoil led to severe crises to other countries.

The short review of existing literature provided in the next section shows that no work relates to the great bank failures during 2008-2009. The number of bank failures is phenomenon in 2009. There were more than 120 banks failures in 2009 (as of October 31). The review of the literature also suggests that all previous studies concentrated on problem banks vis-à-vis non-problem banks whereas this paper focuses on, instead of problem banks, failed banks. This paper provides a major contribution, at least, in these two fields.

## DATA AND METHODOLOGY

Data for all failed and survived banks during 2009 are obtained from the call reports of FDIC from the Web site: [WWW.FDIC.GOV](http://WWW.FDIC.GOV). The number of failed banks of each state is matched by the number of success banks from the same state in order to make the comparison meaningful.

It has been a common practice to measure the adequacy of a bank's capital by means of some ratios. These ratios, generally, describe bank's capital in relation to bank's assets or deposits. Capital funds are necessary for a commercial bank for three important reasons—to obtain a charter, to provide funds to begin operation, and to provide protection to creditors in case of failures. Once bank capitals are in place, these capitals are used in various purposes including the investment in income generating assets. Since the determination of capital adequacy is one of the goals for this paper uses four, bank examiners most comely used, measures of adequacy. They are as follows:

EQCTA= Total equity capital as a percent of total assets.

T1RBCATA= Tier 1 capital as a percentage of average total assets minus intangible assets

T1RWA= Tier 1 capital as a percentage of risk weighted assets as defined by the appropriate Federal regulator for prompt corrective measure.

TRBCRWA = Total risk based capital as a percentage of risk weighted assets as defined by the Appropriate federal regulator for prompt corrective measure.

Table 1 presents summary statistics of four measures of capital adequacy for two groups of banks (Failed banks and peer group banks).

**TABLE 1**  
**SUMMARY STATISTICS FOR FOUR MEASURES OF CAPITAL ADEQUACY**  
**FOR FAILED BANKS AND PEER GROUP BANKS<sup>A</sup>**

	T1RBCATA <sub>f</sub>	T1RBCATA <sub>s</sub>	T1RWA <sub>f</sub>	T1RWA <sub>s</sub>	TRBCRW A <sub>f</sub>	TRBCRWA <sub>s</sub>	EQCTA <sub>f</sub>	EQCTA <sub>s</sub>
Mean	6.004514	11.13601	7.617086	16.64747	8.978321	17.76252	6.152505	11.41166
Median	5.926867	9.840206	7.563107	12.47028	8.939178	13.62316	6.068985	10.42965
Maximum	14.24345	64.00821	18.61454	255.1160	19.92062	256.3907	13.41245	63.78937
Minimum	1.211337	3.110854	1.413247	4.814076	2.826493	6.064432	-2.018988	3.205896
Std. Dev.	2.178252	6.013089	2.606391	21.76355	2.604451	21.74321	2.457378	5.936350
Skewness	0.524512	5.586031	0.819566	9.625923	0.795069	9.667020	0.063946	5.527345
Kurtosis	3.846426	45.89719	5.598575	104.7438	5.553380	105.4025	3.420206	46.14307
Jarque-Bera	10.59850	11462.41	55.06287	62547.59	52.78169	63350.41	1.125421	11570.59
Probability	0.004995	0.000000	0.000000	0.000000	0.000000	0.000000	0.569663	0.000000

<sup>f</sup> and <sup>s</sup>=failed and success bank respectively.

The examination of Table 1 shows that mean of all four measures of capital adequacy for the failed banks are lower than that of non-failed banks.

Since there is low p-value associated with Jarque-Bera tests, this leads to the rejection of null hypothesis of a normal distribution and warrants non-parametric Kruskal-Wallis tests.

Failed banks will be compared with their non failed peer group banks with respect to banks financial and operating characteristics expressed in various ratios. This paper uses two statistical methods—ANOVA and Kruskal-Wallis *K*—for determining whether there exist a statically significant difference in capitalization ratios between the groups of failed and survived banks. The ANOVA technique which yields a test statistics, called F-statistics, is used in determining whether the differences among the means of two sample groups are statistically significant. However, both ANOVA and *t* tests produce strong results due to the non-normal distribution of ratios. This problem is overcome by the non-parametric, Kruskal-Wallis *K* test.

The Kruskal-Wallis *K* tests do not restrict to normality assumption. Kruskal-Wallis test is a rank based non parametric test of hypothesis that the subgroups have the same general distribution against the alternative that at least one subgroup has the distribution. The *K* statistics  $\approx$  follows X<sup>2</sup> distribution with *G*– 1 degrees of freedom where *G* = number of groups. Since both failed and non-failed banks have analogous characteristics (ratios), any statistical differences in the banking behavior between them would be due to the difference in their performance behavior.

The hypothesis of interest is statistically tested for each of measures of capital holding ratios:

*Null hypothesis, H<sub>0</sub>:  $\mu_{fbk} = \mu_{sbk}$ : There is no difference between the mean of the ratios for the failed banks equal to the mean ratios of the survived banks.*

*Alternative hypothesis, H<sub>a</sub>:  $\mu_{fbk} \neq \mu_{sbk}$ : There is a difference between foreign and domestic banks; in particular, they have different means.*

Where  $\mu_{fbk}$  = Mean of the ratios for the failed banks,  $\mu_{dbk}$  = mean of the ratios for the survived banks.

## EMPIRICAL RESULTS

Results of ANVA test between two groups of banks are provided Table 2 - Table 5.

**TABLE 2**  
**TEST OF EQUALITY OF MEANS FOR T1RWA BETWEEN THE FAILED AND NON-FAILED BANKS**

Method	Degrees of freedom	Value	Probability
t-tes	278	4.874704	0.0000
Anova F-statistics	(1,278)	23.76274	0.0000
<b>Analysis of Variance</b>			
Sources of Variation	Degrees of freedom	Sum of Square	Mean Square
Between	1	5708.346	5708.346
Within	278	66781.88	240.2226
Total	279	72490.23	259.8216

**TABLE 3**  
**TEST OF EQUALITY OF MEANS FOR EQCTA BETWEEN THE FAILED AND NON-FAILED BANKS**

Method	Degrees of freedom	Value	Probability
t-tes	278	9.685358	0.0000
Anova F-statistics	(1,278)	93.80616	0.0000
<b>Analysis of Variance</b>			
Sources of Variation	Degrees of freedom	Sum of Square	Mean Square
Between	1	1936.110	1936.110
Within	278	5737.776	20.63948
Total	279	7673.886	27.50497

**TABLE 4**  
**TEST OF EQUALITY OF MEANS FOR T1RBCATA BETWEEN THE FAILED AND NON-FAILED BANKS**

Method	Degrees of freedom	Value	Probability
t-tes	278	9.493710	0.0000
Anova F-statistics	(1,278)	90.13053	0.0000
<b>Analysis of Variance</b>			
Sources of Variation	Degrees of freedom	Sum of Square	Mean Square
Between	1	1843.261	1843.261
Within	278	5685.381	20.40101
Total	279	7528.642	26.98438

**TABLE 5**  
**TEST OF EQUALITY OF MEANS FOR TRBCRWA BETWEEN THE FAILED AND NON-FAILED BANKS**

Method	Degrees of freedom	Value	Probability
t-tes	278	4.746233	0.0000
Anova F-statistics	(1,278)	22.52673	0.0000
<b>Analysis of Variance</b>			
Sources of Variation	Degrees of freedom	Sum of Square	Mean Square
Between	1	5401.351	5401.351
Within	278	66657.52	239.7753
Total	279	72058.88	258.2755

An examination of t-test and ANOVA of all four measures of capital adequacy, reported in Table 2, Table 3, Table 4, and Table 5, shows that there are significant difference in capital holding ratios between the two group of banks—failed and non-failed. The capital holding ratios of all non-failed banks, whether it is equity capital to asset (EQCTA), or Tier 1 capital average total assets (T1RBCATA) or total risk based capital to risk weighted assets (TRBCRWA) or Tier 1 capital to risk weighted assets (T1RWA), were significantly higher than those of failed banks. The high significance is supported by a very low *P-value*, reported in all four Tables.

The significant (statistically) difference in capital holding ratios in all four variables supported by *t*-test and ANOVA rejects the null hypothesis that there is no difference between the two groups of banks. The rejection of  $H_0$  provides strong evidences that there are significant differences in capitalization between the failed and non-failed banks.

Results for Kruskal-Wallis tests in all four measures of capital adequacy are provided in Table 6.

**TABLE 6**  
**KRUSKAL-WALLIS TEST FOR EQUALITY OF MEDIA FOR THE**  
**FAILED AND NON-FAILED BANKS**

Measure of capital adequacy	Failed banks Median	Non-failed banks Median	Kruskal-Wallis statistics	Probability
T1CRWA	7.53	12.47	145.36	0.0000
TRBCRWA	8.93	13.62	138.19	0.0000
T1RBCATA	5.92	9.84	138.01	0.0000
EQCTA	6.06	10.42	128.14	0.0000

The analysis of Table 6 shows that all measures of capital adequacy, there are differences between two groups of banks—failed and non-failed. The low p-value associated with T1CRWA, TRBCRWA, T1RBCATA, and EQCTA suggests that the differences are statistically significant. The significance in difference provides strong evidences in rejecting the null-hypothesis of equality of capital adequacy between two groups of banks.

## CONCLUSIONS

The paper tests the capital adequacy hypothesis between the two groups of banks—failed and non-failed banks with respect of four measures of capital holding ratios. They are total equity capital as a percent of total assets (EQCTA), Tier 1 capital as a percentage of average total assets (T1RBCATA), Tier 1 capital as a percentage of risk weighted assets (T1RWA), and total risk based capital as a percentage of risk weighted assets (TRBCRWA). Both ANOVA and non-parametric, Kruskal-Wallis, tests strongly supports the hypothesis that there are significant differences between the two groups of banks with respect to their capital holding ratios.

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