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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Dynamics of bank capital ratios and risk-taking: Evidence from US commercial banks

Faisal Abbas¹ and Shoaib Ali^{2*}

Abstract: This study aims to explore how different capital ratios influence the risk-taking of large commercial banks of the USA. The study collects the data from FDIC for commercial banks from 2003 to 2019. We use a two-step GMM method to manage the endogeneity, simultaneity, heteroscedasticity, and auto-correlations issue. The findings conclude that an increase in the risk-based capital ratios decreases the banks' risks. Empirical findings demonstrated a significant and positive association between non-risk-based capital ratios and bank risk-taking. The findings also demonstrate that an increase in capital buffer ratios decreases the banks' risks. The impact of capital ratios on risk-taking is heterogeneous for well and under-capitalized banks. The findings suggest that State-chartered member and non-member banks are inclined to take a higher risk than nationally chartered banks. The findings have implications for regulators to consider the State-chartered member, non-member, and nationally chartered banks while formulating the new guidelines for required capital ratios.

Subjects: Corporate Finance; Banking; Credit & Credit Institutions

Keywords: risk-based capital ratios; risk-taking; capital buffer ratios; USA

JEL Classification: G21; G28; G32

1. Introduction

In the last two decades, regulators have played a significant role in stabilizing the USA's financial system. For this purpose, the Basel-II and Basel-III has formulated in 2004 and 2010, respectively. In addition, in 2013, the regulators suggest a countercyclical capital buffer ratio for large

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PUBLIC INTEREST STATEMENT

In this study, we advocate the literature of banking and empirical findings for the extended period from 2002 to 2019. The last financial crisis 2007–08 explores the importance of bank capital and bank liquidity in banking sectors. This study also aims to highlight the relationship between bank capital ratios and bank risk-taking in the USA. This study may be valued for the decision-makers. They may seek guidance from this study for formulating policies in this area in the future. This study may also open a new horizon for researchers.

commercial banks, and Federal Reserve System (Fed) has recommended a Comprehensive Capital Review under stress testing for capital ratios to the large financial institutions. The excessive emphasis of regulatory bodies to boost up the bank capital ratios and recently published studies (Abbas et al., 2020; Abbas & Masood, 2020; Bitar et al., 2018; Deli & Hasan, 2017; DeYoung et al., 2018; Ding & Sickles, 2019) motivate us to contribute in this debate. In this regard, we are going to answer the following essential questions. How bank risk-based capital ratios influence banks' risk-taking in the current economic situations in the USA? Is the impact of non-risk based capital ratios on commercial banks' risk-taking similar to the risk-based capital ratios? Is the impact of risk-based capital and non-risk capital ratios similar for well and under-capitalized large commercial banks in the USA?

From the theoretical perspective, the relationship between risk-taking and bank capital ratios is ambiguous and unclear. Most of the literature is for non-risk based capital ratio like equity to total assets, whereas, the evidence for risk-based capital ratios are limited. As per the authors' information, there is a no study in the literature that provides evidence for the impact of risk-based capital ratios, non-risk based capital ratios and capital buffer ratios on the risk-weighted assets and allowances for loan losses of large commercial banks in the USA for the period of post-crisis.

However, the following studies align with the regulatory hypothesis that favors the positive connection between risk-taking and capital holding (Ding & Sickles, 2018; Ghosh, 2014; Iannotta et al., 2007; Jokipii & Milne, 2011). On the contrary, some studies are in line with the moral hazard hypothesis that indicates the inverse relationship between risk-taking and bank capital holding (Altunbas et al., 2007; Bitar et al., 2018; Jacques & Nigro, 1997; Lee & Hsieh, 2013). In the capital holding context, the capital buffer theory becomes critical to understand the real impact of excessive capital holding and bank risk-taking. The argument is consistent with recent studies (Abbas, Butt, et al., 2019; Berrospide & Edge, 2019; Bitar et al., 2018; Guidara et al., 2013; Jokipii & Milne, 2008).

Our contribution to the literature on bank risk is threefold. First, we investigate the impact of risk-based capital ratios and capital buffer ratios along with non-risk based capital ratios on risks of the well and undercapitalized large commercial of the USA in current economic conditions. Our study uses to investigate the impact of capital ratios to influence the risk-taking of State-chartered member banks, non-member banks, and nationally chartered large commercial banks of the USA. According to researchers understanding in literature, no study provides proof for the impact of bank capital risk-based and non-risk based capital ratios on the risk-taking of State-chartered member banks, non-member banks, and nationally chartered banks. Our study is mainly for large commercial banks instead of a mixed sample of investment, saving, and cooperative banks. This study is not similar to previous studies due to the length of the period. This study covers the unique and extended period of 2003 to 2019 for the USA's large commercial banks. The study applies a two-step GMM approach to control the issue of endogeneity, heteroscedasticity, and autocorrelations.

Our study enriches the existing literature in the following ways. Authors find no study in the literature that provides proof for the impact of risk-based capital ratios, non-based capital ratios, and capital buffer ratios on large commercial banks' risks in the post-crisis period. This is the first study that contributes to the existing literature on the impact of risk-based capital ratios, non-risk based capital ratios, and capital buffer ratios for well-capitalized and undercapitalized large commercial banks post-crisis period. This is the first study that studies the relationship between risk-based capital ratios, non-risk based capital ratios, capital buffer ratios, and risk-taking for the USA's State-chartered member banks, non-member and nationally chartered banks. The study contributes to cover the extensive period of data that has never been used earlier in the context of large commercial banks in the USA. The study contains the following parts further: The next section consists of the literature review and hypotheses development. The third part is about data and methodology. The fourth segment reports the discussion of results, and the final part contains the conclusion and policy implications of the study.

2. Literature review and hypothesis development

The literature provides conflicting views on the relationship of risk-based and non-risk based capital ratios, capital buffer ratios, and risk-taking of commercial banks. Some studies conclude a positive relationship between bank capital ratios and bank risk-taking (Ding & Sickles, 2018; Jokipii & Milne, 2011; Mahdi & Abbas, 2018; Shim, 2010; Tan & Floros, 2013), and some studies support the negative relationship (Bitar et al., 2018; Coffinet et al., 2012; Laeven et al., 2016).

Anginer and Demircug-Kunt (2014) conduct a study and conclude that higher capital buffers make bank shareholders more prudent and pragmatic in making their investment choices. This argument is line with the theory of “more skin in the game” approach, thus strengthens the management and evaluation of bank threats, provided that higher capital requirements mitigate bank risk and public bailout demands (Demircug-Kunt et al., 2013). In the earlier studies, Jacques and Nigro (1997) Conduct a study on US commercial banks and conclude that an increase in bank capital decreases bank risk. Using a simultaneous equation model, Aggarwal and Jacques (1998) argue that holding higher risk-based capital ratios decreases US commercial banks’ riskiness. Findings of Tan and Floros (2013) also favors the negative relationship between risk-taking and capital holding.

Heid et al. (2003) argue that banks hold a higher amount of capital than their regulatory capital ratio faces lower problems of normal banking activities in crisis conditions. Alfon et al. (2004) conclude a negative relationship between capital and risk in the U.K Banks. Van Roy (2005) reports an inverse relationship between bank capital ratios and risk-taking, and the finding is in line with (Lee & Hsieh, 2013). Bitar et al. (2018) conduct a study and conclude that risk-based capital requirements had little impact on bank costs. Flannery and Rangan (2008) explain the bank capital build-up of US banks to mitigate risk.

On the contrary, Shrieves and Dahl (1992) use the simultaneous equation technique on US commercial banks and conclude that an increase in risk-based capital increases commercial banks’ risk-taking. Rime (2001) provides proof in favor of a positive relationship between capital and risk. Besides, Jokipii and Milne (2011) and Ghosh (2014) argues that banks increase their capital with an increase in risk. Altunbas et al. (2007) demonstrate a positive relationship between bank capital and risk-taking in European commercial banks. The following studies favor a positive connection between risk-taking and capital ratios (Avery & Berger, 1991; Blum, 1999; Kim & Santomero, 1988; Koehn & Santomero, 1980). Based on the above discussion, we develop the following hypotheses in the context of capital ratios and risk-taking:

Hypothesis 1: There is a positive relationship between the non-risk based capital ratios and risk-taking of the USA large commercial banks.

Hypothesis 2: There is a negative relationship between the risk-based capital ratios and risk-taking of the USA large commercial banks.

Hypothesis 3: There is a negative relationship between the capital buffer ratios and risk-taking of the USA large commercial banks.

Hypothesis 4: The impact of capital ratios on risk-taking is more significant for well-capitalized banks than undercapitalized banks.

Hypothesis 5: The impact of capital ratios on risk-taking is more significant for nationally chartered banks than state-chartered member and non-member banks.

3. Data and econometric technique

3.1. Data descriptions

This study's population is the large commercial banks, according to the information of FDIC on 31 December 2019. The study includes only 937 active banks whose continuous data is available is ranging from 2003 to 2019. Moreover, we drop the banks with a common equity ratio of less than 4.5% of risk-weighted assets on 31 December 2019. The regulators impose a restriction on the activities (for example, restrictions on lending, level of liquidity, and dividend payments) of those facing difficulties in meeting the regulatory requirements. Due to such stringent restrictions and tight monitoring of regulators on banking activities, critically under capital banks are significantly affected. The study divides the sample into well-capitalized banks (banks having a risk-based capital ratio higher than 8%) and undercapitalized banks (banks have a risk-based capital ratio of less than 8%, but the common equity ratio must be equal to 4.5% or above). The study also excludes the banks that have missing data for endogenous variables for two or more years. The study uses financial statements to collect the bank's specific variables, and the data for macro-economic variables obtain from the world development indicators (WDI) database.

3.2. Dependent and independent variables details

The study uses risk-weighted assets to total assets and loan loss allowances to gross loans as dependent variables. The measurement of risk-taking is consistent with the following studies (Bitar et al., 2018; Jacques & Nigro, 1997). The independent variables are non-risk based capital ratios (equity to total assets, tier-I to total assets) consistent with (Abbas et al., 2020; Abbas & Masood, 2020; Lee & Hsieh, 2013); risk-based capital ratios (tier-I plus tier-II to risk-weighted assets, tier-I to risk-weighted assets) in line with the studies of (Abbas, Butt, et al., 2019; Bitar et al., 2018; Ding & Sickles, 2019); and capital buffer ratios in line with (Abbas, Butt, et al., 2019; Jokipii & Milne, 2008, 2011). The control variables used in the study include profitability, bank size, loan ratio, income diversification, bank efficiency, liquidity, real gross domestic product, and inflation rate. The following studies support the relevance of control variables (Abbas, Iqbal, et al., 2019; Ali et al., 2019; Bitar et al., 2018; Ding & Sickles, 2019). The detail for dependent, independent, and control variables are available in Table 1.

3.3. Econometric model

The study uses the following econometric model to test the impact of non-risk based capital ratios, risk-based capital ratios, and capital buffer ratios on risk-taking. The basic econometric expressions:

$$Risk_{i,t} = \beta_1 Risk_{i,t-1} + \beta_2 Capital_{i,t} + \beta_3 Control\ variables_{i,t} + i, t \quad (1)$$

In equation (1) risk is the dependent variable (RWATA, LLAGL¹) and. $Risk_{i,t-1}$ is lagged value for the dependent variable. Whereas capital represents (TCAPR, TITA, RBCR, TIRBR, BTRBCR, and BTIRBCR²). The sign of "t" reports the time and the sign of "i" represents the cross-sections. Control variables include (ROA, BE, Bank Size, LR, LIQ INDIV, RGDP, Inflation rate).³ The availability of lagged dependent variables the use of simple panel OLS is not a good choice. Because the OLS does not control the problem of endogeneity, autocorrelations and heteroscedasticity. In equation-1, which contains the unobserved cross-sectional effects, ν_i and the observation-specific errors $e_{i,t}$. In simple terms the equation-2 would be:

$$i, t = \nu_i + e_{i,t} \quad (2)$$

The next issue is the presence of the $Risk_{i,t-1}$ which gives rise to the first-order autocorrelation. The fourth problem is a shorter time and a greater number of cross-sections. We should normally use the estimation of instrumental variables (two-stage least squares, or 2SLS) to address Problem 1 (and issue 2), which is what we applied first. We tried loan ratio, gross domestic product and bank efficiency as exogenous instruments. However, the first-stage results of the 2SLS regressions

Table 1. Descriptive statistics

Panel-A: Summary Statistics

Variable	Measurements	Mean	Std.Dev.	p ⁵	p ²⁵	p ⁷⁵
RWATA	Risk-weighted assets/total assets	.733	.12	0.487	0.640	0.814
LLAGL	Loan loss allowances/gross loans	.024	.003	0.018	0.012	0.016
TCAPR	Total equity/total assets	.112	.019	0.071	0.083	0.114
TITA	Tier I/total assets	.094	.014	0.072	0.082	0.103
TRBCR	Tier I plus Tier II/risk-weighted assets	.142	.026	0.106	0.117	0.158
TIRBR	Tier I/risk-weighted assets	.126	.03	0.103	0.107	0.147
BTRBCR	TRBCR less 8%	.049	.022	0.032	0.038	0.078
BTIRBCR	TIRBCR less 6%	.065	.018	0.042	0.046	0.086
ROA	Net income/total assets	.02	.004	-0.002	0.005	0.012
LR	Net loans/total assets	.656	.112	0.453	0.576	0.757
BE	Cost/income ratio	3.037	1.761	0.915	1.728	3.922
INDIV	Non-interest income/total assets	.453	.097	0.262	0.406	0.530
SIZE	Log of total assets	13.544	.94	12.258	12.855	14.130
LIQ	Liquid assets/total assets	.25	.124	0.088	0.166	0.324
RGDPR	Real growth rate of gross domestic product	2.083	1.039	-0.292	1.671	2.861
INFRATE	Consumer price index (CPI)	1.91	.664	0.758	1.534	2.064

Panel-B: Dummy variables codes

Before-crisis interactive dummy 1 for 2003–2006 otherwise zero

Post-crisis interactive dummy 1 for 2010–2019 otherwise zero

Well capitalized banks interactive dummy 1 for well-capitalized otherwise zero

Undercapitalized interactive dummy 1 for undercapitalized otherwise zero

Nationally chartered member banks interactive dummy 1 for nationally chartered banks otherwise zero

State-chartered member banks interactive dummy 1 for state-chartered member bank otherwise zero

State-chartered non-member banks interactive dummy 1 for state chartered non-member banks otherwise zero

reveal that my instruments were weak. The fixed-effects estimator's IV is likely to bias in the OLS estimators' context with poor instruments. Due to these reasons, the study uses GMM estimators, as suggested by (Arellano & Bond, 1991). The capital endogenous regressors are also included, rather than using just the exogenous instruments mentioned above. This predetermines the endogenous variables and thus does not correspond with the error term in equations (1). To deal with the problem of fixed effects, the difference GMM uses first-differences to transform equation (1) into:

$$\Delta Risk_{i,t} = \beta_1 \Delta Risk_{i,t-1} + \beta_2 \Delta Capital_{i,t} + \beta_3 \Delta Control\ variables_{i,t} + \Delta i, t \quad (3)$$

The transformation form would be:

$$\Delta risk_{i,t} = \alpha \Delta risk_{i,t-1} + \beta \Delta capital'_{i,t} + \Delta i, t \quad (4)$$

After transforming the regressors using first differencing, the fixed effect is removed, because it does not vary with time. From equations two we get

$$\Delta i, t = \Delta \nu_i + \Delta e_{i,t} \quad (5)$$

Or

$$i, t - i, t - 1 = (\nu_{it} - \nu_{it-1}) + (e_{it} - e_{it-1}) = (e_{it} - e_{it-1}) \quad (6)$$

The first-differenced lagged dependent variable problem has also become an instrument with its past values. Therefore, the study applies GMM methods to estimate consistent, efficient and unbiased estimators.

4. Results and discussion

4.1. Descriptive statistics and correlations

Table 1 (panel A, panel B) provides summary statistics for bank-specific proxies and macroeconomic variables. The dependent variables include risk-weighted assets and loan loss allowance. The average value of risk-weighted assets is 73.3%, and the annual standard deviation is 12%. The average value of loan loss allowances is 2.4%, and the annual standard deviation is 0.03%. The average value of non-risk based capital ratios measure as equity to total assets is 11.2%, and the annual standard deviation is 0.19%. The mean value of risk-based capital ratio measures as tier-I plus tier-II to risk-weighted assets is 14.2%, and the annual standard deviation is 2.8%. Table 2 contains the findings for the correlations matrix of explanatory variables. The results show that the correlation between explanatory variables is not high; that suggests there is no multicollinearity problem.

4.2. Full sample results for capital ratios and bank risk-taking

Table 3, column 1, consists of the findings for the impact of bank capital ratios on large commercial bank risk-taking from 2003 to 2019. The findings indicate that impact of non-risk based capital ratio (equity/total assets ratio) on bank risk-taking (RWATA) is positive and statistically significant. The positive relationship between non-risk based capital ratio and bank risk-taking of large insured commercial banks is in line with hypothesis 1(H₁) and consistent with regulatory hypothesis theory. The findings are also in line with the subsequent empirical studies (Ding & Sickles, 2018; Mahdi & Abbas, 2018; Shrieves & Dahl, 1992). Table 3, column 2, contains the result of tier-I to total assets (TITA) ratio on risk-taking and concludes a similar relationship. On the contrary, (Table 3 columns 3, 4, 5, 6), the impact of risk-based capital ratios and capital buffer ratios is negative on large commercial banks' risk-taking. The negative relationship indicates that increased risk-based capital and excessive capital holding than regulatory capital ratios decrease banks' risks. The negative relationship between risk-based capital ratios and large commercial banks' risk-taking in the USA is consistent with (H₂). The negative relationship between the capital buffer and the risk-taking of

Table 2. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RWATA	1									
TCAPR	0.035	1								
ROA	0.043	0.078	1							
LR	0.059	-0.065	0.026	1						
BE	-0.033	-0.042	-0.418	-0.016	1					
INDIV	-0.005	0.012	0.083	-0.014	-0.019	1				
SIZE	0.019	0.021	-0.006	-0.024	-0.036	0.021	1			
LIQ	-0.038	0.004	0.015	-0.020	-0.021	0.015	0.016	1		
RGDPR	-0.021	0.022	0.064	-0.015	-0.083	0.023	-0.012	0.026	1	
INFRATE	0.021	-0.106	0.067	0.036	-0.015	-0.031	-0.042	-0.052	0.061	1

Source (author's calculation Stata output)

Table 3. Risk and Capital ratios model (Full sample results): The dependent variable is risk-weighted assets to total assets ratios. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA	RWATA
L. RWATA	0.854** (0.072)	−0.523*** (0.087)	0.566*** (0.034)	0.788*** (0.032)	0.675*** (0.034)	0.769*** (0.035)
Non-risk based capital	0.338*** (0.0374)					
Profitability	−0.0084 (0.172)	0.072 (0.342)	0.432*** (0.162)	0.336*** (0.156)	0.527*** (0.142)	0.356*** (0.142)
Loan ratio	0.364* (0.136)	0.581*** (0.046)	0.204*** (0.024)	0.388*** (0.021)	0.405*** (0.022)	0.203*** (0.025)
Bank efficiency	0.001 (0.001)	−0.013* (0.001)	0.001 (0.001)	0.002 (0.003)	0.003 (0.003)	0.002 (0.001)
Income diversification	0.031*** (0.011)	0.033 (0.020)	0.0353*** (0.009)	0.036*** (0.009)	0.038*** (0.008)	0.039*** (0.008)
Bank size	−0.003 (0.005)	0.018*** (0.003)	0.004* (0.001)	0.002 (0.001)	0.003* (0.001)	0.001 (0.001)
Liquidity	0.088 (0.145)	−0.325*** (0.052)	−0.008 (0.018)	−0.004 (0.017)	−0.008 (0.018)	−0.005 (0.018)
Economic growth	0.005 (0.002)	−0.003*** (0.001)	0.005*** (0.004)	0.004*** (0.004)	0.003*** (0.004)	0.002*** (0.001)
Inflation rate	0.005** (0.002)	−0.002 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Tier-I/TA		0.757*** (0.119)				
Risk-based capital			−0.357*** (0.038)			
Tier-I/RWA				−0.483*** (0.049)		
Capital buffer					−0.446*** (0.045)	
Tier-I buffer						−0.461*** (0.047)
Constant	−0.220 (0.232)	0.366*** (0.015)	0.058** (0.023)	0.0673*** (0.0236)	0.0243 (0.0218)	0.0225 (0.0218)
Observations	14,976	14,976	14,992	14,976	14,992	14,992
Number of id	936	936	937	936	937	937
AR (2)	0.428	0.177	0.261	0.314	0.459	0.345
Hansen value	0.781	0.719	0.872	0.276	0.325	0.467

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

large commercial banks is in line with (H₃). The negative association between capital ratios and risk-taking is in line with the following studies (Altunbas et al., 2007; Bitar et al., 2018; Jacques & Nigro, 1997; Lee & Hsieh, 2013).

Table 4. Risk and Capital ratios model (overall sample): The dependent variable is loan loss allowances to gross loans ratio. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
L.LLAGL	0.836*** (0.013)	0.833*** (0.013)	0.922*** (0.024)	0.838*** (0.024)	0.739*** (0.013)	0.846*** (0.015)
Non-risk based capital	−0.003** (0.001)					
Profitability	−0.026*** (0.008)	−0.027*** (0.007)	−0.027*** (0.007)	−0.027*** (0.007)	−0.027*** (0.007)	−0.027*** (0.008)
Loan ratio	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)
Bank efficiency	−0.001*** (0.002)	−0.001*** (0.002)	−0.001*** (0.002)	−0.001*** (0.002)	−0.001*** (0.002)	−0.001*** (0.002)
Income diversification	−0.004*** (0.001)	−0.004*** (0.001)	−0.004*** (0.001)	−0.004*** (0.001)	−0.004*** (0.001)	−0.004*** (0.001)
Bank size	−0.003 (0.002)	−0.004* (0.002)	−0.003 (0.002)	−0.005** (0.002)	−0.003 (0.002)	−0.004** (0.002)
Liquidity	−0.002** (0.006)	−0.001** (0.006)	−0.002** (0.006)	−0.001** (0.006)	−0.002** (0.006)	−0.001** (0.006)
Economic growth	−0.004*** (0.002)	−0.003*** (0.002)	−0.002*** (0.002)	−0.004*** (0.002)	−0.004*** (0.002)	−0.004*** (0.002)
Inflation rate	−0.005*** (0.004)	−0.003*** (0.004)	−0.003*** (0.004)	−0.005*** (0.004)	−0.003*** (0.004)	−0.005*** (0.004)
Tier-I/TA		−0.005 (0.006)				
Risk-based capital			0.002 (0.001)			
Tier-I/RWA				−0.003*** (0.001)		
Capital buffer					−0.004*** (0.001)	
Tier-I buffer						−0.004*** (0.001)
Constant	0.008*** (0.008)	0.007*** (0.008)	0.008*** (0.008)	0.007*** (0.008)	0.008*** (0.008)	0.007*** (0.008)
Observations	14,928	14,928	14,928	14,928	14,928	14,928
Number of id	933	933	933	933	933	933
AR (2)	0.234	0.231	0.212	0.322	0.235	0.225
Hansen value	0.432	0.321	0.234	0.411	0.433	0.237

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

The study also uses the allowances for loan losses proxy for commercial banks' risk-taking. In this second stream of the study (Table 4 columns 1, 2, 3, 4, 5, and 6), the results indicate that non-risk based capital ratio and tier-I risk-based capital ratio influences the allowances for loan losses of large commercial banks. Table-4, column 1 concludes that an increase in non-risk based

capital ratios decreases the allowance for loan losses in the USA's large commercial. The negative relationship is also consistent with tier-I risk-based capital ratio and allowances for loan losses of the large commercial banks in the USA. However, the allowances for loan losses depend on the quality of capital. The findings suggest that high-quality capital like tier-I against risk-weighted assets decreases the allowances for loan losses higher than the non-risk based capital ratio. The negative relationship between capital ratios and allowances for loan losses explains that in commercial banks, the higher level of capital motivates bank managers to maintain lower level allowances for loan losses. The findings are in line with (Jacques & Nigro, 1997; Laeven et al., 2016; Raz, 2018).

The findings are in line with the theoretical rationale and regulatory recommendations. The risk-based capital ratios are more significant to influence the risks of large commercial banks of the USA. The empirical results indicate that large commercial banks decrease their allowance for loan losses with increased quality capital ratios. For justification, an increase in capital buffer ratio decreases the allowances for loan losses higher than the impact of the tier-I buffer ratio. Similarly, an increase in tier-I risk-based capital ratio decreases the allowances for loan losses higher than non-risk based capital ratio. In line with (Bitar et al., 2018; Ding & Sickles, 2019), we find that when the managers of large commercial banks increase the risk-based capital level, consequently, that correspondingly decreases the ratio of allowances for loan losses of large commercial banks; other things held constant. The study applies a two-step GMM approach to test the role of non-risk based, risk-based capital, and capital buffer ratios on the risk-taking of large commercial banks of the USA. The study uses diagnostic tests to validate the methodological findings that confirm that there is no problem with instruments over-identification and second-order autocorrelations. The study shows the Hansen statistics for over-identification of instruments and AR (2) for autocorrelation at each table's end.

4.3. Findings of pre and post-crisis period

The study uses dummies to explore the impact of non-risk based capital, risk-based capital, and capital buffer on the risk-taking in pre, pro, and post-crisis periods. Tables 5 and 6 (columns 1, 2, 3, 4, 5, and 6) contain the findings for pre, pro, and post-crisis periods. In table 5, the risk proxy is risk-weighted assets to total assets. The results indicate that the relationship between non-risk based capital and risk-taking is positive and significant for pre, pro, and post-crisis periods. However, the ratio of risk-taking against an increase in non-risk based capital ratios is higher during the crisis and lower in the post-crisis period. These conclusions are in favor of regulators' recommendations. The lower increase in risk-taking of commercial banks in the post-crisis era compared with an increase in non-risk based capital in pre-crisis is due to the stringent regulations and monitoring of larger banks. The positive connection between non-risk based capital ratios and bank risk-taking is supported by (Mahdi & Abbes, 2018; Shim, 2010; Shrieves & Dahl, 1992). Table 5, columns 3, 4, 5, and 6 contain the findings for risk-based capital ratios and capital buffer ratios. The sign of the coefficient is consistent with baseline findings. The results provide proof that increases in risk-based capital ratios decrease the level of risks. The outcomes confirm that the impact of risk-based capital ratios and capital buffer ratios on risk-taking are similar during and post-crisis periods. However, the quality of capital is important to influence the risk-taking of large commercial banks. The impact of capital buffer ratio is higher than the risk-based capital ratio to influence the banks' risk in pre, pro, and post-crisis periods. Similarly, the impact of the tier-I buffer ratio is more significant than the capital buffer ratio to influence risk-taking in pre, pro, and post-crisis periods. The findings are in line with the subsequent empirical studies (Altunbas et al., 2007; Bitar et al., 2018; Ding & Sickles, 2019; Jacques & Nigro, 1997). Table 6 (columns 1, 2, 3, 4, 5, and 6) contains the findings for the impact of capital ratios on banks' allowances loan losses in pre, pro, and post-crisis periods. The relationship between allowances for loan losses and risk-taking in crisis is positive and significant, which contradicts the baseline findings. The simple reason for this relationship is the turmoil period in which banks cannot boost their capital ratios at a lower cost; banks create allowances to keep their risk lower in the crisis period. On the contrary, findings show that

Table 5. Risk and Capital ratios model (post-crisis and before-crisis results): The dependent variable is risk-weighted assets to total assets. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis): Note Post-crisis (AC) and Before-crisis (BC)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA	RWATA
L. RWATA	0.511*** (0.033)	0.455*** (0.046)	0.624*** (0.035)	0.663*** (0.033)	0.612*** (0.038)	0.752*** (0.037)
Non-risk based capital	0.355*** (0.041)					
Non-risk based capital*AC	−0.084*** (0.013)					
Non-risk based capital*BC	−0.038** (0.012)					
Tier-I/TA		0.576*** (0.056)				
Tier-I/TA *AC		−0.122*** (0.017)				
Tier-I/TA *BC		−0.058*** (0.011)				
Risk-based capital			−0.341*** (0.040)			
Risk-based capital *AC			−0.006 (0.015)			
Risk-based capital *BC			−0.024* (0.016)			
Tier-I/RWA				−0.553*** (0.057)		
Tier-I/RWA *AC				−0.005 (0.012)		
Tier-I/RWA *BC				−0.038** (0.018)		
Capital buffer					−0.525*** (0.068)	
Capital buffer *AC					0.009 (0.030)	
Capital buffer *BC					−0.027 (0.036)	
Tier-I buffer						−0.456***

(Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA	RWATA
						(0.052)
Tier-I buffer *AC						0.001
						(0.025)
Tier-I buffer *BC						−0.031
						(0.026)
Constant	−0.029**	−0.032*	0.081**	0.023***	0.019	0.066
	(0.027)	(0.022)	(0.024)	(0.025)	(0.023)	(0.026)
Observations	14,976	14,976	14,992	14,976	14,992	14,992
Number of id	936	936	937	936	937	937
AR (2)	0.431	0.324	0.431	0.377	0.345	0.214
Hansen value	0.149	0.169	0.891	0.553	0.344	0.411

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

Table 6. Risk and Capital ratios model (post-crisis and before-crisis period results): The dependent variable is loan loss allowances to gross loans ratio. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis): Note Post-crisis (AC) and Before-crisis (BC)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
L. LLAGL	0.511***	0.741***	0.952***	0.744***	0.822***	0.835***
	(0.022)	(0.014)	(0.010)	(0.015)	(0.015)	(0.014)
Non-risk based capital	0.001					
	(0.002)					
Non-risk based capital*AC	0.0036***					
	(0.001)					
Non-risk based capital*BC	0.005***					
	(0.008)					
Tier-I/TA		0.007***				
		(0.002)				
Tier-I/TA *AC		−0.009***				
		(0.001)				
Tier-I/TA *BC		0.006***				
		(0.009)				
Risk-based capital			0.058***			
			(0.003)			

(Continued)

Table 6. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
Risk-based capital *AC			−0.005***			
			(0.007)			
Risk-based capital *BC			0.003***			
			(0.006)			
Tier-I /RWA				0.029*		
				(0.016)		
Tier-I /RWA *AC				−0.005***		
				(0.007)		
Tier-I /RWA *BC				0.026***		
				(0.007)		
Capital buffer					0.069***	
					(0.019)	
Capital buffer *AC					−0.041***	
					(0.015)	
Capital buffer *BC					0.062***	
					(0.014)	
Tier-I buffer						0.035*
						(0.019)
Tier-I buffer *AC						−0.006**
						(0.014)
Tier-I buffer *BC						0.005***
						(0.002)
Constant	0.014***	0.003***	0.066***	0.030***	0.007***	0.007***
	(0.014)	(0.009)	(0.008)	(0.009)	(0.008)	(0.008)
Observations	14,968	14,968	14,968	14,968	14,628	14,968
Number of id	935	935	935	935	935	935
AR (2)	0.291	0.334	0.419	0.426	0.452	0.422
Hansen value	0.911	0.412	0.295	0.191	0.522	0.911

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

banks keep lower allowances for loan losses in the post-crisis period. The findings are in line with the findings of (Bitar et al., 2018). One possible reason for such behavior is stringent regulations for quality capital due to that banks increase their capital instead of loan loss allowances

4.4. Findings of well & undercapitalized commercial banks

We use interactive terms, dummies, for well-capitalized banks and undercapitalized banks.⁴ The study uses dummies to explore the impact of non-risk based capital ratios, risk-based capital ratios, and capital buffer ratios on the risks of well and undercapitalized large

commercial of the USA. The study applies interactive terms with the nations of W for well-capitalized and U for undercapitalized banks. Table 7 (columns 1, 2, 3, 4, 5, and 6) reports well and undercapitalized banks' results for the impact of capital ratios on risk-taking (RWATA). The findings show that the impact of non-risk based capital ratio on risk-taking of well and undercapitalized banks is positive and statistically significant. The impact of non-risk based capital ratios on the risk-taking of undercapitalized banks is higher than the well-capitalized banks. The findings are not in line with hypothesis 4(H₄), suggesting the higher impact of capital ratios for well-capitalized banks than undercapitalized banks. The findings remain robust to the proxy of tier-I total assets ratio of non-risk based capital ratio. The outcomes confirm that the impact of risk-based capital ratios and capital buffer ratios on risk-taking is negative and significant for well and undercapitalized banks. The impact is more significant for undercapitalized banks than well-capitalized banks. The undercapitalized banks increase their risk with an increase in non-risk based capital ratio higher than well-capitalized banks.

Table 7. Risk and Capital ratios model (Well (W) & Undercapitalized (U) banks results): The dependent variable is risk-weighted assets to total assets. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA	RWATA
L. RWATA	0.424*** (0.040)	0.631*** (0.033)	0.632*** (0.034)	0.681*** (0.036)	0.752*** (0.035)	0.611*** (0.037)
Non-risk based capital	0.483*** (0.053)					
Non-risk based capital*W	-0.236*** (0.037)					
Non-risk based capital*U	-0.084*** (0.023)					
Tier-I/TA		0.557*** (0.059)				
Tier-I/TA *W		-0.153*** (0.032)				
Tier-I/TA *U		-0.077*** (0.084)				
Risk-based capital			-0.413*** (0.044)			
Risk-based capital *W			0.054*** (0.013)			
Risk-based capital *U			0.002 (0.012)			
Tier-I/RWA				-0.522*** (0.010)		
Tier-I/RWA *W				0.067*** (0.086)		
Tier-I/RWA *U				0.012 (0.012)		
Capital buffer					-0.469***	

(Continued)

Table 7. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA	RWATA
					(0.072)	
Capital buffer *W					0.101***	
					(0.036)	
Capital buffer *U					0.023	
					(0.028)	
Tier-I buffer						−0.588***
						(0.048)
Tier-I buffer *W						0.081**
						(0.039)
Tier-I buffer *U						0.019
						(0.024)
Constant	0.061**	−0.031	0.039**	0.051**	0.010	0.018
	(0.031)	(0.023)	(0.027)	(0.022)	(0.025)	(0.025)
Observations	14,976	14,976	14,992	14,976	14,992	14,992
Number of id	936	936	937	936	937	937
AR (2)	0.721	0.528	0.321	0.487	0.419	0.414
Hansen value	0.511	0.311	0.223	0.446	0.439	0.212

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

On the contrary, the risks of undercapitalized banks decrease with an increase in risk-based capital ratios higher than well-capitalized banks. The positive correlation between risk-taking and capital ratios are consistent with the following studies (Ghosh, 2014; Iannotta et al., 2007; Shrieves & Dahl, 1992), and negative connections are in line with the following studies among others (Altunbas et al., 2007; Ding & Sickles, 2019; Jacques & Nigro, 1997; Lee & Hsieh, 2013). Table 8 (columns 1, 2, 3, 4, 5, and 6) reports well and undercapitalized banks' results for the impact of capital ratios on risk-taking (ALLGL) of large commercial banks. The findings are in line with the full sample results. The coefficient of the non-risk based capital ratio is significant and negative, which indicates that banks use capital and loan loss allowances alternatively. The findings provide that the relationship between risk-based capital ratio and loan loss allowances is negative similar to (Bitar et al., 2018).

4.5. Robustness checks

The study uses different techniques to reach consistent and unbiased results. The study first uses risk-weighted assets to total assets ratio for the full sample of banks. The study then divide the sample into well and undercapitalized banks to test the consistency of sign and significance. The findings remain robust concerning sign and significance. Then study uses the allowances for loan losses to explore the consistency of signs and significance to divide the sample into well-capitalized and undercapitalized banks. The findings again remain consistent with the baseline results of allowance for loan losses and capital ratios. The next threshold is for the banks' division as per their charter that has not been used in previous studies. Tables 9 and 10 contain the outcomes for the impact of capital ratios on risk-taking by dividing the sample into state-chartered member banks, non-member banks, and nationally chartered banks. The study uses interactive dummies for NAT, SMB, and SNM for nationally chartered banks, state-chartered banks, and non-member banks. Table-9 (columns 1, 2, 3, 4, 5, and 6) explores that the relationship between risk-taking (RWATA) and capital ratios remain robust

Table 8. Risk and Capital ratios model (Well (W) & Undercapitalized (U) banks results): The dependent variable is loan loss allowances to gross loans ratio. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
L. LLAGL	0.946*** (0.014)	0.912*** (0.030)	0.835*** (0.027)	0.837*** (0.016)	0.926*** (0.016)	0.925*** (0.014)
Non-risk based capital	−0.035** (0.016)					
Non-risk based capital*W	0.001 (0.006)					
Non-risk based capital*U	0.005 (0.004)					
Tier-I/TA		−0.025 (0.003)				
Tier-I/TA *W		−0.004 (0.007)				
Tier-I/TA *U		0.003 (0.004)				
Risk-based capital			0.022 (0.014)			
Risk-based capital *W			−0.009** (0.004)			
Risk-based capital *U			−0.0001 (0.003)			
Tier-I/RWA				−0.024 (0.016)		
Tier-I/RWA *W				−0.003 (0.005)		
Tier-I/RWA *U				0.002 (0.003)		
Capital buffer					0.009* (0.016)	
Capital buffer *W					−0.017* (0.008)	
Capital buffer *U					−0.005 (0.007)	
Tier-I buffer						−0.008 (0.017)

(Continued)

Table 8. (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
Tier-I buffer *W						−0.005
						(0.008)
Tier-I buffer *U						−0.002
						(0.005)
Constant	0.007***	0.004***	0.009***	0.006***	0.006***	0.002***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
Observations	14,938	14,938	14,938	14,938	14,938	14,938
Number of id	934	934	934	934	934	934
AR (2)	0.316	0.244	0.234	0.242	0.254	0.235
Hansen value	0.424	0.816	0.221	0.422	0.322	0.282

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

Table 9. Risk and Capital ratios model (Nationally chartered member banks (NAT), State-chartered member banks (SMB), State-chartered non-member banks (SNM) results): The dependent variable is risk-weighted assets to total assets. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA
L.RWATA	−0.362***	−0.428***	0.567***	0.798***	0.757***
	(0.080)	(0.090)	(0.030)	(0.034)	(0.033)
Non-risk based capital	0.395***				
	(0.001)				
NAT* Non-risk based capital	−0.115*				
	(0.058)				
SMB* Non-risk based capital	−0.032				
	(0.052)				
Tier-I/TA		0.701***			
		(0.121)			
NAT* Tier-I/TA		−0.132**			
		(0.066)			
SMB* Tier-I/TA		−0.041			
		(0.060)			
Risk-based capital			−0.344***		
			(0.032)		
NAT* Risk-based capital			−0.002		
			(0.014)		
SMB* Risk-based capital			−0.004		
			(0.011)		
Tier-I/RWA				−0.486***	
				(0.096)	
NAT* Tier-I/RWA				0.045	

(Continued)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	RWATA	RWATA	RWATA	RWATA	RWATA
				(0.013)	
SMB* Tier-I/RWA				0.007	
				(0.012)	
Capital buffer					−0.420***
					(0.047)
NAT* Capital buffer					−0.0111
					(0.033)
SMBB* Capital buffer					−0.009
					(0.027)
Constant	0.324***	0.352***	0.047**	0.066***	0.025
	(0.016)	(0.041)	(0.028)	(0.026)	(0.028)
Observations	14,966	14,966	14,962	14,976	14,972
Number of id	935	935	936	937	936
AR (2)	0.610	0.310	0.621	0.382	0.593
Hansen value	0.242	0.352	0.821	0.154	0.326

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

and consistent for NAT, SNM, and SMB banks. Table 10 (columns 1, 2, 3, 4, 5, and 6) provides proof in favor of baseline findings. The impact of capital ratios to influence the risk-taking of SNM and SMB is higher than NAT commercial banks. The findings are not in line with the hypothesis 5(H₅) that states that the impact of capital ratios to risk-taking is higher for NAT banks than SNM and SMB.

Table 10. Risk and Capital ratios model (Nationally chartered member banks (NAT), State-chartered member banks (SMB), State-chartered non-member banks (SNM) results): The dependent variable is loan loss allowances to gross loans ratio. Our predictions are the two-step GMM approach. (Robust standard errors are reported in parenthesis)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
L.LLAGL	0.837***	0.639***	0.634***	0.835***	0.634***
	(0.014)	(0.027)	(0.031)	(0.014)	(0.030)
Non-risk based capital	−0.003**				
	(0.001)				
NAT* Non-risk based capital	0.001*				
	(0.004)				
SMB* Non-risk based capital	0.007				
	(0.004)				
Tier-I/TA		0.013***			
		(0.009)			
NAT* Tier-I/TA		0.004			
		(0.001)			

(Continued)

Table 10. (Continued)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	LLAGL	LLAGL	LLAGL	LLAGL	LLAGL
SNM* Tier-I/TA		0.001 (0.001)			
Risk-based capital			0.015*** (0.001)		
NAT* Risk-based capital			0.003 (0.009)		
SMB* Risk-based capital			0.004 (0.008)		
Tier-I/RWA				−0.003** (0.003)	
NAT* Tier-I/RWA				0.007** (0.003)	
SMB* Tier-I/RWA				0.002 (0.003)	
Capital buffer					0.014*** (0.003)
NAT* Capital buffer					0.004 (0.002)
SMB* Capital buffer					0.008 (0.009)
Constant	0.007*** (0.008)	0.013*** (0.001)	0.015*** (0.002)	0.006*** (0.008)	0.012*** (0.012)
Observations	14,938	14,938	14,938	14,938	14,938
Number of id	934	934	934	934	934
AR (2)	0.312	0.432	0.145	0.231	0.322
Hansen value	0.242	0.171	0.172	0.238	0.161

Robust Standard errors in parentheses*** p < 0.01, ** p < 0.05, * p < 0.1

5. Conclusion

This study aims to explore how different capital ratios influence the risk-taking of large commercial banks of the USA. The study collects the data from FDIC for large commercial banks from 2003 to 2019. We use a two-step GMM method to control the endogeneity, simultaneity, heteroscedasticity, and auto-correlations issue. The findings conclude that the impact of risk-based capital is higher and more significant to decrease risks of large commercial banks. The outcomes confirm that the impact of non-risk based capital ratios on risk-taking is positive and in line with the regulatory hypothesis that is in line with regulators' recommendations. On the contrary, the relationship between risk-based capital ratios, capital buffer ratios, and banks' risk-taking is negative. The findings justify the regulators' efforts because when banks increase their capital against their risky assets, their risk goes down. The findings remain robust throughout the analysis. The study reveals that capital ratios' impact on influencing risk-taking is more significant for under-capitalized banks than well-capitalized commercial banks. The findings are heterogeneous for pre, pro, and post-crisis periods. The results show that the influence of risk-based and non-risk based capital ratios on risk is higher for SNM and SMB than NAT. The findings have implications for regulators to formulate the guidelines for risk-based capital ratio in present conditions. The heterogeneous results for NAT, SNM, and SMB, are also more important to consider for suggesting the new regulations in the USA. We

have only investigated the large commercial banks, whereas the scholars may explore the smaller banks, cooperative, saving, and investment banks for better understanding in the future.

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Notes

1. RWATA = risk-weighted assets to total assets, LLAGL = loan loss allowances to gross loans.
2. TCAPR = total equity to total assets, TITA = Tier one equity to total assets, BTRBCR = TRBCR-8%, BTIRBCR = TIRBCR-6%
3. For detail see table- one.
4. Well-capitalized = If the risk-based capital ratio is higher than 8%, if the risk-based capital ratio is less than 8% than Undercapitalized banks.

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