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How do large commercial banks adjust capital ratios: empirical evidence from the US?

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ABSTRACT

This research explores the balanced panel data to examine the level of capital adjustment for major insured commercial banks over the 2002-2018 period using a two-step GMM estimator. The findings show that the speed of adjustment of the large insured commercial banks is faster than that of non-financial companies. The results contribute to a slower average adjustment pace of a total capital ratio than the total risk-based capital and capital buffer ratios. The adjustment of capital is faster in the post-crisis period than during and before-crises era. The adequately capitalized banks adjust capital ratio faster than well-capitalized banks. In contrast, the under-capitalized banks adjust the total risk-based capital ratio and capital buffer ratio more quickly than that of others. The low liquid banks needed a higher time to restore equilibrium than high liquid banks. The results of this study have economic significance for policy implications and future regulations.

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1. Introduction

In the wake of the 2007-2009 financial crisis, regulators proposed significant revisions to the rules for financial institutions, in particular by reshaping the current capital criteria. The regulators tighten the re-designing frameworks for the required capital for financial intuitions Bakkar et al. (2019). In the previous decade, the researchers have been investigating the numerous aspects of the bank capital (De Jonghe & Öztekin, 2015; Demirguc-Kunt et al., 2013; Dermine, 2015; DeYoung et al., 2018), particularly for the assessment of capital on the performance (Abbas et al., 2019b; Ayaydin & Karakaya, 2014; Berger & Bouwman, 2013), and on banks risk-taking (Allahrakha et al., 2018; Balla & Rose, 2019; Bitar et al., 2016; Bougatef & Mgadmi, 2016).

This study aims to fill the gaps in the previous literature by addressing some questions. Are there variations in the average rate of capital adjustment, the total risk-based capital ratio, and the capital buffer ratio? Are there differences in the pace of change of the total capital ratio, total risk-based capital ratios, and capital buffer

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ratios during before and after the crisis? The speed of adjustment for the various categories of cross-sections is further distinguished.

The reason for this speed of adjustment is the most recent developments in Basel III concerning the need for a higher capital sum for the resilience of the financial system to meet unforeseen economic shocks. The emphasis of this study is on the capital ratio calculated as equity to overall assets; the total risk-based capital ratio measured as Tier 1 and Tier II equity to total risk-weighted assets Bakkar et al. (2019) and capital buffer ratio Jokipii and Milne (2011). The adjustment process is similar to previous studies (Bakkar et al., 2019; De Jonghe & Öztekin, 2015; Lepetit et al., 2015).

The study uses a standard approach for partial adjustment to estimate the average speed of adjustment Berger et al. (2008). This adjustment model undertakes that every institution has a particular desired and required capital ratios. However, there is very difficult to maintain desired ratios in a round number, and these ratios remain different in friction because of the holding cost of capital. Therefore, randomly bank's actual capital ratios and target capital ratios always remain different Bakkar et al. (2019). The actual and risk-based capital ratio considered as the weighted average of a lagged number of respective capital ratios. In this situation, one can think and expect the faster adjustment of the bank's risk-based capital ratios than total capital ratio. There may be a set of factors to use for the frictions of these capital ratios De Jonghe and Öztekin (2015). As we use the annual data for this analysis, there is possible to manipulate the different factors to reach the required results to avoid the regulatory violations. The study used annual financial data of large commercial banks as reported to FDIC[1]. Due to this reason, our analysis provides an average speed of adjustment yearly. To investigate the differences in the rate of adjustment in capital ratios is like Bakkar et al. (2019) and De Jonghe and Öztekin (2015).

This study enriches the existing literature in several aspects. The analysis is critical in providing different metrics that are responsible for influencing the adjustment of varying capital ratios under current conditions. This study provides details for well, adequately under-capitalized, high, and low liquid banks. The study is unique due to the data period, advancement in regulations, technological transformations, and financial integrations. This study contributes to the existing literature of banking for the adjustment of total capital ratio, total risk-based capital ratio, and capital buffer ratios. The significant contributions include a comparison of the speed of adjustment for well, adequately, under, significantly undercapitalized, high liquid, and low liquid large commercial banks. The next contribution of this work is to highlight the differences in the adjustment of total capital ratio, total risk-based capital ratio, and capital buffer ratio due to crisis and regulations. The study provides insight for before-crisis, during-crisis, and the post-crisis period of commercial banks. This study contributes to compare the speed of adjustments for financial and non-financial.

After the first introductory section, the rest of the paper is structured in the following parts and sections. The second part reviews the literature on adjustment of capital. The third section provides the partial adjustment model, data collection sources, sample selection and definitions, and measurement of variables used in the analysis. The fourth part of this paper describes the discussion of empirical findings. The fifth section of this research contains the conclusions.

2. Review of literature and hypothesis for capital adjustment ratios

This part provides the literature about the adjustment of capital. The early studies explore two types of analysis to adjust their capital ratios. The first analysis investigates the adjustment of the size of the asset and the portfolio risk required to achieve the RWA[2] target. The second analysis examines the behavior of banks to adjust the level of regulatory capital and RWA to meet the target capital ratio Shimizu (2015). Previous studies evidence that Shrieves and Dahl (1992) use the partial adjustment model to reveal the effect of regulations on banks' capital for commercial banks and Baranoff and Sager (2002) for insurance firms. Hancock and Wilcox (1994) apply a two-component pattern for adjustment purposes. Leary and Roberts (2005), empirically investigate and conclude that organizations actively rebalance their capital ratio in the presence of adjustment costs.

Flannery and Rangan (2006) provide that, on average, firms remain one-third of the deviation between target capital ratio and actual capital ratio in a year. They favor that firms have their target capital ratio and try to achieve that possibly at a lower cost. Drobetz and Wanzenried (2006) argue that firm-specific factors and macroeconomic factors are influential for the adjustment of a firm's debt and capital ratios. They conclude that during a reasonable margin of profit and under well going economic situations, firms adjust their capital quickly. Huang and Ritter (2009), deliver that firms use external financing to improve their capital ratio when the cost of the new issue remains low. They find that a moderate pace with a half-life of 3.7 years for the capital ratios to achieve their targeted equilibrium ratios. Memmel and Raupach (2010), concluded the significant differences across financial entities. They argue that the use of the liability side for the adjustment of capital is more appropriate, whereas the tendency of capital adjustment is higher from the assets side. They also argued that the banks adjust their capital ratio faster than other origination. Öztekin and Flannery (2012) argue that financial traditions and legal laws significantly influence the adjustment of capital. They say that larger organizations have lower transaction costs to adjust leverage. Francis and Osborne (2012) employed a partial adjustment model to investigate the capitalization process of firms.

De Jonghe and Öztekin (2015) argue that banks primarily use equity to adjust their capital instead of assets liquidation. They conclude that banks use earnings to extend their assets. They find that banks make quick adjustments in their capital ratios, where the regulations are stringent. Lepetit et al. (2015) show that in the absence of excess control rights, most of the European banks boost their capital ratio by equity without reducing lending. Cohen and Scatigna (2016), explore the adjustment channel for capital ratios and find that the availability of a higher amount of capital makes banks phase out the crises and earn higher profits by lending. The banks adjust their capital more rapidly in a crisis period. Bakkar et al. (2019) conclude that banks adjust their capital ratio faster than the regulatory capital ratio. They classify the sample according to size and conclude that larger banks manage their capital ratio slower. In contrast, they provide that riskier banks adjust their regulatory capital ratio faster

than their leverage ratio. The hypotheses of the study can be described as follows, taking into consideration the literature review:

Hhypothesis (H_1): Large commercial banks adjust their risk-based capital ratios more quickly than traditional capital ratios

Hypothesis (H_2): Well-capitalized banks adjust their capital ratios more rapidly than adequate and undercapitalized banks

Hypothesis (H_3): High liquid banks adjust their capital ratios faster than low liquid banks

Hypothesis (H_4): The pace of capital ratio adjustment is higher in the post-crisis era than before and during the crisis phase.

3. Data and partial adjustment model

3.1. Data

The population of this study is the large United States insured commercial banks. As these banks comprise nearly half of the bank's assets. Nonetheless, we have large banks in our study, because the shareholders are the real owners, so capital control is usually carried out at the centralized level. The bank-specific data were collected from the consolidated financial statement like balance sheets, and income statements reported to FDIC quarterly. The information for economic indicators compiled from the World Bank, and data for economic freedom is obtained from the heritage foundation established in 1996. In the data structure of the present study, Federal Deposit Insurance Corporation (FDIC)[3] institutional directory has used for the extraction of detailed information about the financial system necessary to analyze the data in the long run period according to the reports of FFIEC[4] call/TFR and is updated quarterly by FDIC. The annual dataset is consisted of financial institutions involved in the dataset and retrieved that covers the long-term period ranging from 2002 to 2018. The sample of the study is balanced to a comparable panel data containing insured commercial banks of the US as described in the reports of FRSR[5] and further, the assets based on a consolidated form. In the reported number dated 31 December 2018, which was published by FDIC, there were several banks in approximately 1806. Nevertheless, the requirements for inclusion of the research sample units for sufficient and reliable data collection based on the following parameters: the active status of the banks mentioned on the published date must be current. There must be no missed observations in the long-run duration for any specific variables of analysis of at least two years. Banks 'total assets must be higher than $300 million, as of December 31, 2018. Following filtration of correctly followed parameters, 899 banks were chosen for the sample size of the analysis. For a deeper understanding and richness of observations, the sample is classified as well, adequately under, significantly undercapitalized banks on the basis given by regulators (see sample table for details). In comparison, there was a problem of normality in knowledge for all variables to be tiny at 1% and 99%. However, the list of variables and their definitions provided in Table 9.

Sample details table

Overall sample	899
Well-capitalized Banks	139 (Risk-based capital ratio > 10%)
Adequately-capitalized banks	103 (Risk-based capital ratio < 10% and = 8%)
Undercapitalized Banks	241 (Risk-based capital ratio < 8% and =6%)
Significantly undercapitalized banks	416 (Risk-based capital ratio < 6%)
High liquid banks	477 (Based on Liquid Ratio)
Low liquid banks	452 (Based on Liquid Ratio)

3.2 Partial adjustment model

In the present situation of stringent regulations, banks usually maintain their desire capital ratio. The financial institutions are bound to follow the regulator's recommendations. In case of violation, banks have to bear the cost as imposed by regulators. The banks can function by maintaining the higher capital ratio as recommended by or below a regulator. The circumstances where the cost of the capital improvement is higher than the cost to bear while working at a lower than needed equity level. Such a process is based on the trade-off between the cost of adjustment of capital and costs to bear at a lower capital ratio Bakkar et al. (2019) and Flannery and Hankins (2013). It has developed in practice in the previous studies to model capital ratio using a partial adjustment process Flannery and Hankins (2013), Bakkar et al. (2019) and Lemmon et al. (2008). In a capital adjustment model, a bank's current capital is X_{it}, it is a weighted average of required capital ratio X^*_{it}, and the last period's capital ratio, X_{it-1}, as well as a random shock, ε_{it} similar to Bakkar et al. (2019) and De Jonghe and Öztekin (2015). The equation of the partial model is as under:

$$X_{it} = \gamma X^{*}\mathrm{it} + (1-\gamma)X\mathrm{it} - 1 + \varepsilon\mathrm{it} \tag{1}$$

Here "it" represents cross-section (i), which is a bank in this case and period (t), which is the year in this study. In general, each period, every bank closes a proportion γ of the difference between require and actual capital level. The lower the value of Gamma (γ), the more critical the capital ratio is, and the bank required a longer time to achieve its required capital ratio after a shock occurred in an economy. Therefore, the sign of γ used as a gauge of capital adjustment, which is also called the speed of adjustment for a bank and its complement (1- γ) as the part of the capital that is inertial.

Bank's target capital (capital ratio, risk-based capital ratio, and capital buffer ratio), X^*_{it}, is unknown, and it is not a constant value, and it has varied concerning time and working. This target capital ratio based on a linear trend of the lagged ratio of capital, characteristics of bank, and time fixed factors like De Jonghe and Öztekin (2015) and Bakkar et al. (2019). The equation would be like this:

$$X*_{\mathrm{it}} = \beta Z_{\mathrm{it}-1} + V_{\mathrm{t}} + u_{\mathrm{i}} \tag{2}$$

To incorporate the bank characteristics, we follow the model of Bakkar et al. (2019) they recently used the data of banks and found out the speed of adjustment of

bank capital ratio and an earlier study of Gropp and Heider (2010) show the adjustment of capital by using the data of non-financial firms. We use factors like Gropp and Heider (2010), Bakkar et al. (2019), and Berger et al. (2008).

In this partial model of adjustment for capital ratios, we incorporated two factors of unobserved heterogeneity called time (V_t) and panel fixed effect u_i. The panel fixed effects unobserved heterogeneity includes the efficiency of management, risk behavior, economic conditions, as well as of the country in which the financial intuition is in operation, which is the USA in this case. The inclusion of fixed effects in the capital adjustment model is supported by Bakkar et al. (2019), Gropp and Heider (2010), and Huang and Ritter (2009). Putting the equation of required capital, equation (2), in equation (1) and the specification would become like:

$$X^*_{it} = \gamma \left(\beta Z_{it-1} + V_t + J_I\right) + (1 - \gamma) X_{it-1} + \varepsilon_{it} \quad (3)$$

In the existence of a lagged value of the dependent variable, the use of ordinary least square and fixed effects would provide biased estimators. Due to the biasedness of OLS and fixed effects model we would estimate the coefficient of equation (3) by applying a generalized method of moments (GMM) as suggested by Blundell and Bond (1998) and used by Bakkar et al. (2019), and Flannery and Hankins (2013). In a dynamic environment, GMM regulates the endogeneity of the lagged dependent variable. GMM controls the problem of measurement error, reduces omitted bias issues, and controls unobserved heterogeneity problems in panels. For this study, we use the GMM two-stage system. The two-step GMM method is more effective than the one-step GMM program, and the two-step GMM approach is capable of capturing the highest estimator values. This model is to apply separately for capital ratio, risk-based capital ratio, and capital buffer ratio.

4. Results and discussion

4.1. Descriptive statistics

Table 1A contains descriptive statistics, which provide information on the minimum, maximum, average, standard deviations, and no observation of the proxies used in the analysis. Capital ratios are the key emphasis and vector of concern. The overall amount of the total capital ratio is 13.6%, the average value is 10.2%, and the minimum capital ratio is 7.8%. The maximum value of the average risk-based capital ratio is 19.2%, with an average of 14.1% and a standard deviation of 1.8%. The capital buffer ratio averages 5.9%, the median amount is 9.2%, and the standard deviation is 2.1%.

4.2. Correlation matrix

Table 2 displays the matrix of correlations, which provides the sign of the relation and connectivity between variables. The results show that the values are within the appropriate range. The result shows that there is no issue with the high correlation

Table 1A. Panel descriptive statistics.

Variable	Obs	Mean	S.D	P^5	P^{25}	P^{75}
Capital Ratio (TCAPR)	14396	.102	.018	.078	.087	.115
Risk-based capital ratio (TRBCR)	14396	.141	.027	.108	.119	.159
Buffer capital ratio (BTRBCR)	14396	.059	.021	.033	.039	.079
Tier-I Capital ratio (TITA)	14396	0.09	.020	.072	.081	.104
Tier-I Risk-based ratio (TIRBCR)	14396	0.13	.020	.104	.108	.148
Tier-I Buffer ratio (BTIRBCR)	14396	0.07	.019	.043	.047	.087
Profitability (ROA)	14396	.01	.005	−.001	.006	.013
Credit Risk (ALLGL)	14396	.014	.004	.008	.011	.017
Liquidity (LTOD)	14396	.822	.16	.501	.713	.938
Bank Efficiency (BE)	14396	3.048	1.756	.905	1.72	3.94
Income diversification (INDIV)	14396	.463	.098	.261	.407	.540
Market Power (MP)	14396	.139	.271	.022	0.027	.109
Asset diversification (AD)	14396	.58	.031	.518	.557	.606
Industrial development (INDD)	14396	.073	.075	.023	.028	.109
Bank SIZE	14396	13.554	.95	12.2	12.8	14.1
Financial freedom (FFINDX)	14396	78.235	8.565	70	70	90
Investment freedom (INVFINDX)	14396	73.824	5.009	70	70	80
Inflation rate	14396	1.92	.665	.759	1.54	2.06
Economic cycle (RGDPR)	14396	2.084	1.038	−.291	1.67	2.81

Table 1B. A Yearly distribution of total capital ratio, risk-based capital ratio and buffer ratio.

Year	TCAPR	TRBCR	BTRBCR
2002	0.0962	0.1358	0.0547
2003	0.0965	0.1371	0.0557
2004	0.0966	0.1354	0.0542
2005	0.0975	0.1345	0.0536
2006	0.0980	0.1332	0.0525
2007	0.0983	0.1309	0.0507
2008	0.0987	0.1307	0.0504
2009	0.0992	0.1367	0.0555
2010	0.1013	0.1440	0.0618
2011	0.1053	0.1495	0.0764
2012	0.1032	0.1507	0.0674
2013	0.1011	0.1509	0.0661
2014	0.0975	0.1509	0.0631
2015	0.0974	0.1449	0.0625
2016	0.9064	0.1439	0.0615
2017	0.0932	0.1461	0.0613
2018	0.0919	0.1446	0.0601

Source: Author's Calculations by using Stata.

between variables. The lower relationship between variables suggests that there is no problem with high multicollinearity among the explanatory variables. The symbol of factors indicates economic value and importance. For example, the results suggest that profitability and the overall capital ratio are positively correlated, which implies that an improvement in productivity contributes to an increase in the capital ratio. Likewise, the strong link between credit risk and capital underpinned by the legislative theory that an increase in risk implies an increase in capital.

4.3. Overall sample findings

Table 3 provides data on the overall sample and the outcomes of well-capitalized banks. Testing the misspecification that might result from the absence of crucial

Table 2. Pairwise correlations matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
TCAPR	1.00															
TRBCR	0.50*	1.00														
BTRBCR	0.48*	0.98*	1.00													
ROA	0.08*	0.07*	0.06*	1.00												
ALLGL	0.09*	0.18*	0.19*	−0.06*	1.00											
LTOD	0.01	−0.40*	−0.40*	0.03*	−0.18*	1.00										
BE	−0.06*	−0.08	0.01	−0.48*	0.02*	−0.02*	1.00									
INDIV	0.11*	0.08*	0.08*	0.58*	−0.09*	−0.09*	−0.21*	1.00								
MP	0.010	−0.02*	−0.02*	0.03*	0.04*	−0.03*	−0.02*	0.11*	1.00							
AD	−0.05*	0.27*	0.28*	0.05*	0.04*	−0.59*	−0.02*	0.12*	−0.03*	1.00						
INDD	−0.01	−0.11*	−0.11*	0.011	−0.06*	0.05*	−0.02*	0.11*	−0.05*	0.03*	1.00					
Bank SIZE	0.12*	−0.10*	−0.10*	−0.03	0.05*	0.08*	−0.03*	0.31*	0.10*	0.02*	0.45*	1.00				
FFINDX	−0.21*	−0.20*	−0.21*	0.11*	−0.17*	0.08*	−0.10*	−0.12*	−0.09	0.05*	0.07*	−0.26*	1.00			
INVFINDX	0.04*	−0.04*	−0.04*	−0.22*	−0.04*	0.11*	0.01	−0.11*	0.03	−0.08*	−0.05*	0.11*	−0.11*	1.00		
INFRATE	−0.10*	−0.11*	−0.12*	0.16*	−0.17*	0.07*	−0.10*	−0.03*	−0.06	0.02*	0.02*	−0.14*	0.52*	−0.11*	1.00	
RGDPR	0.02*	0.04*	0.04*	0.16*	−0.11*	−0.03*	−0.09*	0.21*	0.01	0.03*	0.04*	−0.02*	0.19*	−0.38*	0.46*	1.00

Source: Author's Calculations by using Stata. * shows significance at the .01 level.

Table 3. A two-step system GMM results: Dependent variables: total capital ratio (TCAPR), total risk-based capital ratio (TRBCR) and buffer capital ratio (BTRBCR).

	Overall Sample Banks			Well-capitalized Banks		
VARIABLES	(1) TCAPR	(2) TRBCR	(3) BTRBCR	(4) TCAPR	(5) TRBCR	(6) BTRBCR
Lagged. Dependent	0.798***	0.733***	0.710***	0.739***	0.696***	0.670***
	(0.0312)	(0.0402)	(0.0363)	(0.154)	(0.111)	(0.104)
Profitability	−0.205*	−0.804***	−0.694***	0.217	0.0876	−0.434
	(0.119)	(0.221)	(0.177)	(0.407)	(0.422)	(0.388)
Credit Risk	0.224***	0.664***	0.553***	0.359***	0.640***	0.465***
	(0.0285)	(0.0496)	(0.0412)	(0.126)	(0.122)	(0.158)
Liquidity	0.0084***	−0.0120***	−0.0100***	0.0048	−0.0021	−0.0007
	(0.0013)	(0.0025)	(0.0018)	(0.0029)	(0.0031)	(0.0033)
Bank Efficiency	−0.0002	−0.0007***	−0.0006***	0.0005	−0.0005	−0.0006
	(0.0001)	(0.0002)	(0.0002)	(0.0005)	(0.0004)	(0.0004)
Income Diversification	0.0132***	0.0357***	0.0302***	−0.0026	0.0062	0.0088**
	(0.0041)	(0.0078)	(0.0062)	(0.0025)	(0.0049)	(0.0043)
Market Power	−0.0005	−0.0004	−0.0002	0.0003	−0.0004	0.0014
	(0.0007)	(0.0012)	(0.0009)	(0.0019)	(0.0025)	(0.0033)
Assets Diversification	0.0165***	0.0262***	0.0248***	−0.0011	0.0153**	0.0206***
	(0.0055)	(0.0099)	(0.0083)	(0.0035)	(0.0062)	(0.0061)
Industry Development	−0.0001	0.0012	0.0007	0.0075	0.0119	0.0132
	(0.0017)	(0.0028)	(0.0024)	(0.0096)	(0.0081)	(0.0088)
Bank Size	−0.0002	−0.0023***	−0.0019***	0.0001	0.00038	0.0012
	(0.00022)	(0.0005)	(0.0004)	(0.0006)	(0.0008)	(0.0009)
Financial Freedom	−0.0015***	−0.0012***	−0.0115***	−0.0155	−0.0010	−0.0027
	(0.0002)	(0.0003)	(0.0003)	(0.0001)	(0.0009)	(0.0009)
Investment Freedom	0.0005**	0.0002	0.0007	0.0009	0.0007	−0.0001
	(0.0003)	(0.0005)	(0.0004)	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	0.0010***	0.0001	0.0001	0.0012	−0.0005	0.0004
	(0.0002)	(0.0004)	(0.0003)	(0.0014)	(0.0010)	(0.0009)
Economic cycle	0.0003***	−0.0002	−0.0001	0.0003	−0.0008	−0.0012**
	(0.0001)	(0.0018)	(0.0001)	(0.0006)	(0.0006)	(0.0005)
Constant	0.0050	0.0569***	0.0335***	0.0196	0.0257	0.00414
	(0.00668)	(0.0133)	(0.00847)	(0.0307)	(0.0226)	(0.0151)
Observations	14,369	14,369	14,369	2,224	2,224	2,224
Number of ids	899	899	899	139	139	139
AR (2)	0.156	0.521	506	0.137	0.755	0.934
Hansen Statistics	0.927	0.198	0.380	0.904	0.418	0.178

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

factors. Often missing variables have a marginal impact as long as the results are set. The findings show that there is no misspecification in the predicted tests. The findings reported at the bottom of each table indicate that the instruments used are accurate and that there is no issue with over-identification and second-order serial autocorrelation.

The results show that the variables previously identified to affect capital ratios are important and relevant to test the speed of adjustment for financial institutions, as verified Gropp and Heider (2010). Applying the GMM two-step method estimator Blundell and Bond (1998), we found that the average adjustment pace for the overall sample is 20.2%, the total risk capital ratio is 26.7%, and the capital buffer ratio is 29%. The speed of adjustment suggests that the modification of the overall capital ratio, the total risk-based capital ratio, and the capital buffer ratio are partial. It indicates the difference between the actual and the target ratio, which is almost three years and two years to eliminate the effect of shocks similar to Fama and French (2002), and Lemmon et al. (2008). The period needed to reach the equilibrium

measured as a log of (0.5) with a log of (1-speed adjustment), similarly Berger et al. (2008) and Gropp and Heider (2010). The findings justify the quick implementation of regulators for capital restrictions to avoid unexpected shocks. The frequency of adjustment for the overall capital ratio is 20.2% (1-coefficient of the lagged capital ratio) which is higher than the total risk-based capital ratio and the capital-buffer ratio; the results are compatible with the observations of Huang and Ritter (2009) and Leary and Roberts (2005). The speed of adjustment shows that banks required higher time to restore their equilibrium capital ratio than total risk-based capital and capital buffer ratios, as concluded Bakkar et al. (2019).

4.4. Adjustment of capital before, during, and in the post-crisis period

In Table 7 panel-A, the speed of adjustment for the total capital ratio is 37.8%, like Huang and Ritter (2009), the total risk-based capital ratio is 38.9%, and the capital buffer ratio is 39.9% findings are similar to Fama and French (2002). The results are consistent with the findings of Bakkar et al. (2019), Berger et al. (2008), and Lepetit et al. (2015). In the post-crisis period, the significant factor of quick adjustment is the profitability of banks, as argued by Flannery and Rangan (2006) and Huang and Ritter (2009). In Table 7 panel-B during the crisis period, the speed of adjustment and time to achieve equilibrium capital ratios are significantly different than before and post-crisis periods. The banks use equity to adjust their capital ratios because, in a crisis period, bank operations remain limited, and due to that, the contribution of profits to boost capital ratios remains lower. The results show that during the crisis period, banks try to adjust their total capital ratio faster than the total risk-based capital ratio and capital buffer ratio. The adjustment for the total capital ratio is 34.2% Flannery and Rangan (2006), which is greater than the total risk-based capital ratio and capital buffer ratio 19.6% and 29.7%, respectively Fama and French (2002). In a Table 7 before-crisis, results show that banks' speed of adjustment for the total capital ratio is lower than the total risk-based capital ratio and capital buffer ratio.

4.5. Adjustment of capital ratios for well, adequately, under, significantly undercapitalized banks

In Table 3, the well-capitalized adjustment speed of banks is stated to be 26.1% lower than the total risk-based capital and capital buffer ratio of 30.4% and 33% respectively similar to Berger et al. (2008), De Jonghe and Öztekin (2015) and Bakkar et al. (2019). Well-capitalized banks adjust their total risk-based capital ratio, capital buffer ratios faster than the total capital ratio. In Table 4, the results of adequately capitalized banks show that the speed of adjustment for the total capital ratio is 36.6%, which is higher than the total risk-based capital ratio of 23.5% and capital buffer ratio 21.8% similar to Flannery and Rangan (2006). In contrast, the rate of the total risk-based capital ratio is consistent with Fama and French (2002) and Huang and Ritter (2009). The results explore that adequately banks take 1.5 years to achieve total capital ratio on equilibrium after a financial shock, as reported by Kayhan and Titman (2007). In contrast, the total risk-based capital ratio and capital buffer ratio required

Table 4. A two-step system GMM results: Dependent variables: total capital ratio (TCAPR), total risk-based capital ratio (TRBCR) and buffer capital ratio (BTRBCR).

	Adequately-capitalized Banks		
VARIABLES	(1) TCAPR	(2) TRBCR	(3) BTRBCR
Lagged. Dependent	0.634***	0.765***	0.782***
	(0.132)	(0.0709)	(0.114)
Profitability	0.0804	0.379	−0.158
	(0.533)	(0.521)	(0.523)
Credit Risk	0.330*	0.812***	0.647***
	(0.181)	(0.150)	(0.168)
Liquidity	0.0074	0.0015	0.0022
	(0.0044)	(0.0031)	(0.0033)
Bank Efficiency	0.0004	0.0002	0.0001
	(0.0005)	(0.0003)	(0.0003)
Income Diversification	0.0051	−0.0015	0.0005
	(0.0048)	(0.0033)	(0.0041)
Market Power	−0.0038	0.0002	−0.0006
	(0.0046)	(0.0029)	(0.0025)
Assets Diversification	−0.0112	0.0045	0.0070
	(0.0088)	(0.0048)	(0.0052)
Industry Development	−0.0082	0.0036***	0.0026***
	(0.0012)	(0.0005)	(0.0004)
Bank Size	−0.0017*	−0.0015***	−0.0013**
	(0.0009)	(0.0006)	(0.0006)
Financial Freedom	−0.0004***	−0.0009	−0.0001
	(0.0001)	(0.0009)	(0.0001)
Investment Freedom	0.0002	0.0002	−0.0001
	(0.0001)	(0.0001)	(0.0001)
Inflation Rate	0.0005	−0.0023**	−0.0021*
	(0.0013)	(0.0011)	(0.0011)
Economic cycle	0.0007	0.0011**	0.0011*
	(0.0006)	(0.0005)	(0.0005)
Constant	0.0671**	0.0378	0.0404
	(0.0298)	(0.0237)	(0.0266)
Observations	1,649	1,649	1,649
Number of ids	104	104	104
AR (2)	0.724	0.699	0.703
Hansen Statistics	0.823	0.157	0.110

Standard errors in parentheses*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

2.6 and 2.8 years to achieve equilibrium findings are similar to Leary and Roberts (2005), Flannery and Rangan (2006), and Huang and Ritter (2009). In Table 5 represents the results that undercapitalized banks increase their capital significantly, and managers remain busy to secure the desired capital level De Jonghe and Öztekin (2015). The results show that the adjustment of the total risk-based capital ratio is 37.3%, which is faster than the total capital ratio of 17.8%. These results indicate that undercapitalized banks are more fixable to adjust their regulatory capital before than total capital ratio. The total capital ratio required 3.5 years, similar to Huang and Ritter (2009), to achieve their desired level after an economic shock. The undercapitalized banks remain tight to adjust their capital ratios due to their operations. In Table 5, shows the adjustment of significantly undercapitalized banks total capital ratios 21.6%, which is lower than total risk-based capital ratio and capital buffer ratio of 23.3% and 22.9%. The significantly undercapitalized banks required greater period to achieve their equilibrium capital ratios than undercapitalized banks; the outcomes are similar to Huang and Ritter (2009) and Flannery and Rangan (2006).

Table 5. A two-step system GMM results: Dependent variables: total capital ratio (TCAPR), total risk-based capital ratio (TRBCR) and buffer capital ratio (BTRBCR).

	Undercapitalized Banks			Significantly Undercapitalized Banks		
VARIABLES	(1) TCAPR	(2) TRBCR	(3) BTRBCR	(4) TCAPR	(5) TRBCR	(6) BTRBCR
Lagged. Dependent	0.822***	0.627***	0.653***	0.784***	0.767***	0.771***
	(0.119)	(0.0554)	(0.0678)	(0.0646)	(0.0492)	(0.0532)
Profitability	0.0649	−0.521*	−0.798**	0.0879	−0.344**	−0.811***
	(0.353)	(0.278)	(0.342)	(0.317)	(0.146)	(0.270)
Credit Risk	0.390***	0.740***	0.761***	−0.0487	0.526***	0.692***
	(0.0987)	(0.0753)	(0.0912)	(0.103)	(0.0553)	(0.0870)
Liquidity	0.0037*	−0.0035*	−0.0017	0.0065***	0.0009	−0.0022*
	(0.0019)	(0.0018)	(0.0021)	(0.0020)	(0.0009)	(0.0013)
Bank Efficiency	0.0008	−0.0002	0.0005	0.0002	−0.0001	−0.0003
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0001)	(0.0002)
Income Diversification	0.0025	0.0073**	0.0113***	0.0087***	0.0034**	0.0088***
	(0.0046)	(0.0029)	(0.0040)	(0.0026)	(0.0014)	(0.0024)
Market Power	−0.0014**	−0.0013	−0.0023	0.0007	0.0002	0.0004
	(0.0006)	(0.0010)	(0.0023)	(0.0010)	(0.0003)	(0.0005)
Assets Diversification	−0.00269	0.00376	0.00433	−0.00750**	0.00212	0.00540
	(0.0046)	(0.0029)	(0.0035)	(0.0035)	(0.0022)	(0.0036)
Industry Development	−0.0243**	0.0029	0.0019	−0.0037	0.00059	−0.0021
	(0.0119)	(0.0059)	(0.0063)	(0.0049)	(0.0011)	(0.0021)
Bank Size	0.0007	−0.0006**	−0.0006	0.0021***	−0.0037	−0.0024
	(0.0006)	(0.0003)	(0.0004)	(0.0006)	(0.0001)	(0.0002)
Financial Freedom	−0.0001	−0.0006	−0.0004	−0.0003***	−0.0005*	−0.0001*
	(0.0001)	(0.0006)	(0.0009)	(0.0008)	(0.0003)	(0.0006)
Investment Freedom	0.0008	0.0001	−0.0008	0.0002**	0.0006	−0.0003
	(0.0001)	(0.0007)	(0.0009)	(0.0009)	(0.0004)	(0.0008)
Inflation Rate	0.0006	−0.0011*	−0.0018**	−0.0005	−0.0003	−0.0023***
	(0.0009)	(0.0006)	(0.0008)	(0.0007)	(0.0003)	(0.0006)
Economic cycle	0.0008	0.0007*	0.0008*	0.0013***	−0.0001	0.0003
	(0.0006)	(0.0004)	(0.0004)	(0.0004)	(0.0002)	(0.0004)
Constant	0.0014	0.0328**	0.0245	0.0063	0.0091	0.0198*
	(0.0153)	(0.0147)	(0.0155)	(0.0137)	(0.0104)	(0.0110)
Observations	3,950	3,950	3,950	6,848	6,848	6,848
Number of ids	247	247	247	409	409	409
AR (2)	0.240	0.809	0.945	0.215	0.877	0.991
Hansen Statistics	0.620	0.504	0.320	0.860	0.231	0.941

Standard errors in parentheses*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

4.6. Adjustment of capital ratios for high liquid and low liquid commercial banks

In Table 6, results show that the speed of adjustment of the total capital ratio is 23.6%, which means high liquid banks required 2.6 years to restore equilibrium as reported by Fama and French (2002) after an economic shock. The high liquid banks are more concerned about adjusting their total risk-based capital ratio and capital buffer ratio. The findings are in line with Memmel and Raupach (2010) and Huang and Ritter (2009). In Table 6 shows that adjustment for the low liquid total capital ratio is 17.%, which is lower than the high liquid banks' total capital ratio this rate is consistent with the findings of Fama and French (2002). The speed of adjustment for total risk-based capital ratio and capital buffer ratio is 22.4% and 25.7% that is similar to Leary and Roberts (2005). The findings indicate that low liquid banks needed a lower time to adjust the total risk-based capital ratio and capital buffer ratio than high liquid banks.

Table 6. A two-step system GMM results: Dependent variables: total capital ratio (TCAPR), total risk-based capital ratio (TRBCR) and buffer capital ratio (BTRBCR).

	High Liquid Banks			Low Liquid Banks		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	BTRBCR	TCAPR	TRBCR	BTRBCR
Lagged. Dependent	0.764***	0.635***	0.724***	0.830***	0.780***	0.743***
	(0.0786)	(0.0531)	(0.0487)	(0.0657)	(0.0550)	(0.0555)
Constant	0.0371**	0.0513***	0.0621***	−0.0005	0.0049	0.0127
	(0.0182)	(0.0185)	(0.0140)	(0.0123)	(0.0122)	(0.0115)
Observations	7,233	7,233	7,233	7,520	7,520	7,520
Number of id	453	453	453	446	446	446
AR (2)	0.170	0.833	0.418	0.134	0.394	0.483
Hansen Statistics	0.566	0.129	0.940	0.270	0.213	0.431

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

Table 7. A two-step system GMM results: Dependent variables: total capital ratio (TCAPR), total risk-based capital ratio (TRBCR) and buffer capital ratio (BTRBCR).

	Post-Crisis Periods Results			Before-Crisis Period Results		
Panel-A	(1)	(2)	(3)	(1)	(2)	(3)
VARIABLES	TCAPR	TRBCR	BTRBCR	TCAPR	TRBCR	BTRBCR
Lagged. Dependent	0.622***	0.611***	0.601***	0.483***	0.530***	0.629***
	(0.144)	(0.0503)	(0.0484)	(0.0702)	(0.0682)	(0.226)
Observations	7,384	7,384	7,384	3,692	3,692	3,692
Number of ids	899	899	899	899	899	899
AR (2)	0.662	0.471	0.350	0.236	0.472	0.694
Hansen Statistics	0.579	0.372	390	0.183	0.134	0.109
Panel-B				During-Crisis Period Results		
Lagged. Dependent				0.658***	0.804***	0.703
				(0.0825)	(0.0681)	(0.3411)
Observations				1,847	1,847	1,847
Number of ids				899	899	899
No. of Instruments				17	17	17
AR (2)				0.123	0.234	0.341

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

4.7. Robustness check

In the first round, we test the speed of adjustment of total capital ratio and risk-based capital ratio for the overall sample. Then we extended out the analysis with the inclusion of different categories of banks. In each case, we use capital buffer to test the robustness of risk-based capital ratio, and in most cases, results are robust. The findings indicate that the capital buffer ratio remains consistent in each case, which provides confidence about the robustness of results. In the next simulations for robustness check, we use tier-I capital ratio, tier-I risk-based capital ratio, and tier-one buffer ratio. Each capital measure is replaced with base capital measures for all the categories of banks. Theoretically, there would be a slow pace to attain the core capital ratios due to the higher cost of equity issues. Table 8 panel-A reports the results for the overall sample with and without subordinated debts. Table 8 panel-B contains the findings of well-capitalized banks and adequately capitalized banks. The findings are in support of the main results of overall, well-capitalized, and adequately capitalized banks with minor variation due to the importance of core capital ratios.

Table 8. A two-step system GMM results: Dependent variables: Tier one capital ratio (TITA), Tier I risk-based ratio (TIRBCR) and Tier-I buffer ratio (BTIRBCR).

	Overall Sample Banks			Effect of Sub-ordinated debts		
Panel-A	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TITA	TIRBCR	BTIRBCR	TITA	TIRBCR	BTIRBCR
Lagged. Dependent	0.850***	0.795***	0.768***	0.819***	0.749***	0.742***
	(0.0318)	(0.0279)	(0.0350)	(0.0496)	(0.0310)	(0.222)
Observations	14,369	14,369	14,369	2,224	2,224	2,224
Number of id	899	899	899	139	139	139
AR (2)	0.910	0.342	0.397	0.650	0.512	0.709
Hansen value	0.061	0.123	0.330	0.189	0.174	0.508
Panel-B	Well-capitalized Banks			Adequately-capitalized Banks		
Lagged. Dependent	0.759***	0.729***	0.642***	0.872***	0.855***	0.807***
	(0.0596)	(0.0610)	(0.122)	(0.130)	(0.101)	(0.118)
Observations	2,224	2,224	2,224	1,633	1,633	1,633
Number of id	139	139	139	103	103	103
AR (2)	0.750	0.912	0.709	0.556	0.330	0.311
Hansen value	0.289	0.074	0.608	0.916	0.318	0.332

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

Table 9. A two-step system GMM results: Dependent variables: Tier one capital ratio (TITA), Tier I risk-based ratio (TIRBCR) and Tier-I buffer ratio (BTIRBCR).

	Undercapitalized Banks			Significantly Undercapitalized Banks		
Panel-A	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TITA	TIRBCR	BTIRBCR	TITA	TIRBCR	BTIRBCR
Lagged. Dependent	0.879***	0.807***	0.739***	0.823***	0.805***	0.805***
	(0.0473)	(0.0451)	(0.0519)	(0.0400)	(0.0412)	(0.0436)
Observations	3,855	3,855	3,855	6,576	6,576	6,576
Number of id	241	241	241	411	411	411
AR (2)	0.407	0.814	0.969	0.422	0.195	0.257
Hansen value	0.139	0.140	0.150	0.235	0.632	0.502
Panel-B	High Liquid Banks			Low Liquid Banks		
Lagged. Dependent	0.815***	0.754***	0.757***	0.818***	0.789***	0.759***
	(0.0397)	(0.0365)	(0.0425)	(0.0411)	(0.0373)	(0.0498)
Observations	7,137	7,137	7,137	7,232	7,232	7,232
Number of id	447	447	447	452	452	452
AR (2)	0.670	0.631	0.995	0.248	0.212	0.310
Hansen value	0.341	0.245	0.430	0.190	0.065	0.132

Standard errors in parentheses*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Author's Calculations by using Stata.

Table 9 panel-A represents the results of high liquid banks, and panel-B contains the findings of low liquid banks. The results are as per the expectations, and there is no significant difference with baseline findings of the high and low liquid banks. Due to the limitation of space, only relevant results are reported. Besides, we estimate the different regression that is not reported, and conclusions remain similar.

5. Conclusion

In this study, we explore how large insured commercial banks adjust their capital ratios to attain their required levels by the two-step GMM method for a period ranging from 2002 to 2018. This study concludes that the average adjustment pace for the

Table 10. Names and Measurements of Variables.

Name of Variable	Measurement of Variables
Total Capital Ratio (TCAPR)	Total Equity to Total Assets (Lee & Hsieh, 2013)
Total Risk-Based Capital Ratio (TRBCR)	Tier I Plus Tier II to Risk-Weighted Assets (Guidara et al., 2013)
Capital Buffer Ratio (BTRBCR)	Actual Capital Ratio less 8% (Guidara et al., 2013), (Jokipii & Milne, 2011)
Tier I Capital ratio (TITA)	Tier I equity to Total Assets (Bitar et al., 2018)
Tier I Risk-based capital ratio (TIRBCR)	Tier I equity to Risk-Weighted Assets (Abbas et al., 2019a)
Tier I buffer ratio (BTIRBCR)	Tier I Capital ratio less 6% (Abbas et al., 2019a)
Profitability (ROA)	Net Income to Total Assets (Sufian & Habibullah, 2010)
Credit Risk (ALLGL)	Allowance for Loan Losses to Gross Loans (Lee & Hsieh, 2013)
Liquidity (LTOD)	Loans to Deposits
Bank Efficiency (BE)	Overhead to Revenue (Bitar et al., 2016)
Income Diversification (INDIV)	Non-interest income to gross revenue (Shim, 2013)
Market Power (MP)	Deposits to Industrial Assets (Bitar et al., 2016)
Assets Diversification (AD)	$1 - ((CLOANi/, tEAi, t)2 + (BLOANi,/tEAi,t)2 + (SECi,/tEAi,t)2 + OTHERAi,/tEAi,t)2)$
Industrial Development (INDD)	Total Assets of Bank to Total Industrial Assets
Bank Size	Natural Log of Total Assets (Lee & Hsieh, 2013)
Investment Freedom (INVFD)	Investment freedom is taken from the Heritage Foundation (2018) (Sufian & Habibullah, 2010)
Financial Freedom (FFD)	Financial freedom is taken from the Heritage Foundation (2018) (Sufian & Habibullah, 2010)
Inflation Rate	Annual change in Consumer Price Index (Lee & Hsieh, 2013)
Economic cycle (RGDPR)	Growth in the real gross domestic product (Lee & Hsieh, 2013)

Source: Author's Calculations by using Stata.

total capital ratio is 20.2%, the total risk-based capital ratio is 26.7%, and the capital buffer ratio is 29.0%. The adjustment pace indicates that the adjustment of the total capital ratio, the total risk-based capital ratio, and the capital buffer ratio is partial and expresses the difference between the actual and the target ratio approximately three to two years to reduce the impact of shocks. In such a situation, banks may increase their capital by readjusting their risky assets. It is also suggested that a bank can boost its target capital ratios to cut its dividend payments and increase retained earnings. The speed of adjustment and time required to achieve equilibrium capital ratios were significantly different in the crisis-era than those of befoore and after crisis periods. Banks use equity to adjust their capital ratios because, in crisis banks, operations remain limited, and, as a result, the contribution of profits to boosting capital ratios suffers.

The well-capitalized banks change the total risk-based capital ratio and capital buffer ratios more rapidly than the total capital ratio. The adequately capitalized banks adjust total capital ratios by issuing new shares and adjusting the balance sheet assets side of the portfolio in specific risk-weighted securities. Under-capitalized banks are more fixable than the total capital ratio to adjust their regulatory capital ahead. These results show economic worth in the sense that undercapitalized banks primarily adjust the required ratio of capital to avoid the regulatory cost. The undercapitalized banks remain tight to adjust capital ratios due to operations. The significantly undercapitalized insured banks required a higher period to achieve their equilibrium capital ratios than undercapitalized banks. The high liquid banks are more concerned about adjusting their total risk-based capital ratio and capital buffer ratio. The speed of adjustment of capital is higher for the high liquid banks than the low liquid total capital ratio. The findings of this study contribute to the adjustment of bank capital ratios and have significant guidelines for regulators. The influence in our sample may

be limited as we focus on large insured commercial banks of the USA for which the institutional setting is homogeneous. However, we remain restricted due to the limitations of time and cost to investigate the investment banks, cooperative banks, and saving banks. Furthermore, researchers may use the data for other categories of banks for deeper insights.

Notes

1. Federal Deposit Insurance Corporation for detail, https://www.fdic.gov/
2. Risk-weighted assets
3. https://research2.fdic.gov/bankfind/
4. Federal Financial Institutions Examination Council and Thrift Financial Report: for detail see https://www.ffiec.gov/forms041.htm
5. https://www.federalreserve.gov/releases/lbr/current/

Disclosure statement

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