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Research article

How banks adjust capital ratios: the most recent empirical facts

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Abstract: This paper aims to explore the behavior of major regulated commercial banks. The study is aimed to examine that how these banks adjust their leverage and regulatory ratios by applying a two-step GMM framework. The Utilization of asset growth facilitates well-capitalized banks to restore their intended capital ratio and under-capitalized banks use equity and earnings to achieve equilibrium. Findings showed that large commercial banks adjust their legislative capital ratio faster than leverage. The differential effect suggested that well-capitalized banks required less time to manage equilibrium than those of adequately capitalized banks. The Under-capitalized banks took more time than those of adequately capitalized banks to reach their targeted capital level. The findings also indicated that banks in the post-crisis setting adjusted their leverage level more rapidly than the pre-crisis period. The risk-based capital ratio is lower than in the pre-crisis era. Findings were obtained from the samples of different U.S. banks covering the period from 2002 to 2018. The results of this study have economic relevance for policy implications and future regulations.

Keyword: leverage ratio; risk-based capital ratio; tier-i ratio and speed of adjustment

JEL Codes: G20, G21, G28

1. Introduction

Following the 2007–2008 global-financial crisis, the regulators introduced significant changes to supervising banks, primarily by upgrading current regulatory capital qualification mechanisms and increasing oversight of so-called large financial institutions. There is rapidly growing literature discussing various specific elements of Basel III Dermine (2015) and Repullo and Suarez (2013) as well as potential bank output implications Berger and Bouwman (2013) and Ding and Sickles (2019)

bank capital and risk-taking Bitar et al. (2018), and Abbas et al. (2019b). This further work has examined that how quickly banks can adjust their capital ratios and the methods they could apply, (Berger et al., 2008; De Jonghe and Öztekin, 2015; Lepetit et al., 2015).

Extending the work of Bakkar et al. (2019) and De Jonghe and Öztekin (2015), the researcher investigated large insured commercial banks of the United States covering the most unique and extensive period from 2002 to 2018. The present study is the first to contribute to post-crisis US banking literature by connecting the two research strands with the aim to fill two distinct gaps in the current literature. Answers of the questions that how did banks adjust their regulatory capital ratio and leverage capital ratio, and how they were different in the mechanism of adjustments were the main area of research. While banks could set their desired leverage ratios by ignoring the restrictions imposed by regulatory ratios, how quickly they adjusted to leverage and regulatory ratios may vary. Secondly, while this first step results in unconditional, homogenous findings describing average bank attitude, we subsequently distinguished between well, adequately, and undercapitalized commercial banks' new regulatory and supervisory emphasis. The researcher evaluated both leverage and risk-weighted capital ratios with the aim of how large banks behaved differently in terms of adjustment frameworks and speed of adjustment.

During the first part of the discussion, we concentrated on the variations between the adjustments of leverage ratios[1], and two regulatory capital ratios[2]. We pursued literature and estimated a partial adjustment of bank capital to a bank-specific and time-based optimal capital ratio similar to (Bakkar et al., 2019; De Jonghe and Öztekin, 2015; Lepetit et al., 2015). The partial adjustment model assumed that banks had a target (or optimal) capital ratio. Still, there might be frictions (such as adjustment costs), which prevented them from instantaneously adapting to the target.

Hence, the actual capital ratio was a weighted average of the lagged capital ratio and the target capital ratio[3] at each point in time, where the weight was an indicator of the extent of the frictions. It was uncertain whether the adjustment pace for the regulatory capital ratios would be higher than the leverage ratio. On the one side, the modification of the Tier 1 ratio and risk-based capital ratios could be expected to be faster than the leverage ratio, despite the regulatory emphasis on those steps. On the other hand, the opposite could also be found because the set of adjustment mechanisms was smaller for the regulatory capital ratios vis-à-vis the leverage ratio because not all types of equity counts and because assets varied in risk weight. For example, government bonds were securities with a zero risk weight that are easy to adjust[4].

Our results showed that banks could change the regulatory capital at a more flexible and faster rate than leverage ratio. More precisely, the speed of change for the leverage ratio framework in our study of large insured commercial banks over the 2002–2018 period was 18.6%, which was lower than that for the Tier 1 ratio, 53.5%, and the risk-based capital ratio, 42.5%. These adjustments excelled correspond, in economic terms, to half-lives of 3.4, 0.9, and 1.3 years, respectively. The

[1] Total equity to total assets.

[2] Risk-based capital= tier I + tier II divided by risk-weighted assets, Tier one ratio= tier I divided by risk-weighted assets.

[3] For detail see Bakkar Y, De Jonghe O, Tarazi A (2019) Does banks' systemic importance affect their capital structure and balance sheet adjustment processes? *J Bank Financ.* De Jonghe O, Öztekin Ö (2015) Bank capital management: International evidence. *J Financ Intermediation* 24: 154–177.

[4] Bakkar Y, De Jonghe O, Tarazi A, (2019) Does banks' systemic importance affect their capital structure and balance sheet adjustment processes? *J Bank Financ.*

half-life was measured as log (0.5)/logs (1-Adjustment speed). It was equal to the amount of time required by banks to halve the difference between their actual capital ratio and targeted similar to the justification of De Jonghe and Öztekin (2015).

In the second section of the study, we analyzed whether or not well-adequate and undercapitalized large commercial banks acted differently during changes to the capital structure. Although large banking institutions had undertaken prudential legislation and extensive research, the way that they managed their capital structure and re-equilibrium to comply with their optimum capital ratios remained an open question with significant policy implications see Laeven et al. (2016) and Barth and Schnabel (2013). Because they received favorable treatment in terms of higher leverage levels, lower interest rates from financial markets. There was a possibility that these banks might not be able to weigh up the need to adjust quickly if they expected public support and bailout, or because their complexity and opacity made it more costly for them to raise external capital.

The second part provides theoretical and empirical literature. Section 3 presents information related to the sample construction and variables, particularly the methodological perspective. Section 4 contains the discussion of empirical findings. Section 5 consists of conclusion.

2. Hypotheses development

The early studies explored two types of analysis to adjust their capital ratios. The first analysis investigated the adjustment of the size of the asset and the portfolio risk required to achieve the RWA[5] target. The second analysis examined the behavior of banks to adjust the level of regulatory capital and RWA to attain the target capital ratio Shimizu (2015). The banks could increase their capital ratios by issuing new equity, alternatively using other balance sheet components to adjust their regulatory capital ratios. Studies include Teixeira et al. (2014) conclude that capital regulations alone are not sufficient to determine bank capital. Lin et al. (2019) provide conflicting results that capital regulations are promoting financial stability. Niţoi et al. (2019) conclude that conventions are useful for leverage in normal economic conditions for domestic and forging banks; however, the effect is inverse in the economic recession. Kalemli-Ozcan et al. (2012) investigate the behavior of commercial and investment banks to adjust their leverage ratio. The study concludes that investment banks increase their leverage ratio in crisis, but a similar increase is not found for commercial banks. 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 good margin of profit and under well going economic situations, firms adjust their capital quickly. In light of the above literature, the researcher developed the following hypothesis:

Hypothesis (H): The pace of capital adjustment is faster in the post-crisis period than before-crisis phase.

Previous studies have provided evidence that Shrieves and Dahl (1992) have used a 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) 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

[5] Risk-weighted assets.

capital ratio in a year. They favor that firms have their target capital ratio and try to achieve that possibly at a lower cost. Huang and Ritter (2009) ensure that firms use external financing to adjust 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) conclude 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 argue 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) employ a partial adjustment model to investigate the capitalization process of firms. The empirical findings of most recent studies include Valencia and Bolaños (2018) argue that banks maintained a higher surplus capital ratio in developed economies and lower in developing countries. De Jonghe and Öztekin (2015) explain that banks primarily use equity to adjust their capital instead of assets liquidation. They conclude that banks usually 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 change their capital ratio faster than the regulatory capital ratio. They classify the sample according to size and find 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. In light of the above literature, the researcher developed the following hypothesis:

Hypothesis (H1): Large commercial banks adjust their regulatory capital ratios faster than leverage capital ratio.

Hypothesis (H2): Well-capitalized banks change their regulatory capital ratios rapidly than adequate and undercapitalized banks.

3. Data: sample and variables

3.1. Study sample selection criteria and data sources

To obtain results on how major US commercial banks manage their different capital ratios, bank-specific data was collected from the balance sheets and an income statement that was explicitly reported to the Federal Deposit Insurance Corporation (FDIC)[6]. The economic information was collected from the World Bank[7] economic indicators web. The annual dataset comprised financial institutions that were recovered for a long-term period from 2002 to 2018. The study sample also contained U.S. insured commercial banks as defined in FDIC reports and, further, assets based on a consolidated basis. In nearly 1806, several banks were listed as on dated 31 December 2018[8].

[6] https://www7.fdic.gov/idasp/advSearchLanding.asp.

[7] https://data.worldbank.org/indicator.

[8] https://www.federalreserve.gov/releases/lbr/current/.

Nevertheless, the criterion for inclusion of the study sample units for sufficient and reliable data analysis was based on the following criteria: on the stated date, the active status of listed banks must exist. It was ensured that incomplete results for any particular long-run research variables of at least two years must not be included. Banks' total assets reached $300 million, as of December 31, 2018. After filtering properly used parameters, 937 banks were selected for the study. For more in-depth understanding and enrichment of knowledge, the sample was classified into well-adequate and undercapitalized banks based on guidelines provided by regulators. If the overall risk-based capital ratio of banks is 10 percent or above is well-capitalized, if the ratio is less than 10 percent and equal to 8 percent is graded as adequately capitalized, if the ratio is less than 8 percent is considered undercapitalized.

3.2. Partial adjustment model

In the present situation of stringent regulations, banks usually maintain their desire capital ratio. 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 may operate by keeping the higher ratio of capital as suggested by a regulator or lower. The situations where the cost of adjustment of capital is higher than the cost to bear by operating at a lower capital ratio than required. 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 been developed and practiced in the previous studies to model capital ratio using a partial adjustment process (Bakkar et al., 2019; De Jonghe and Öztekin, 2015; Flannery and Hankins, 2013). In a capital adjustment model, a bank's current capital (leverage ratio, risk-based capital ratio, and tier-one ratio) is X_{it} , it is a weighted average of required capital ratio (leverage ratio, risk-based capital ratio, and tier-one ratio) X^*_{it}, and the last period's capital ratio, X_{it}-1, as well as a random shock, ε_{it}. The equation of the partial model is as under:

$$X_{it} = \gamma X^*_{it} + (1 - \gamma) X_{it}-1 + \varepsilon_{it} \quad (1)$$

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 $(1 - \gamma)$ as the part of the capital that is inertial.

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

$$X^*_{it} = \beta Z_{it-1} + V_t + u_i \quad (2)$$

To incorporate the bank characteristics, we followed the model of Bakkar et al. (2019) that was recently used the data of banks and find out the speed of adjustment of bank capital ratio. In an earlier study of Gropp and Heider (2010) show the adjustment of capital by using the data of non-financial firms. There are various theories, which explore the influence of capital structure on the value of firms like MM theory, signaling theory, trade-off theory, and pecking order theory. Considering capital

structure theories, we included different factors like size, profitability, liquidity, risk, non-interest income, assets growth, asset diversification, income diversification, economic freedom, and inflation. Most of the factors were used in different studies as per Gropp and Heider (2010), Bakkar et al. (2019) and Berger et al. (2008). In the entail model, we used a similar set of indicators for the leverage ratio, risk-based capital ratio, and tier-one ratio. Then revised the model and only included the influential factors of each capital ratio to explore the difference in speed of adjustment to reduce the proxy definition and measurement bias.

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 included the efficiency of management, risk behavior, economic conditions, financial and business freedom and governance of banks as well as of the country in which the financial intuition was in operation, the USA in this case. The inclusion of fixed effects in the capital adjustment model was supported by (Bakkar et al., 2019; Gropp and Heider, 2010; Huang and Ritter, 2009). Putting the equation of required capital, Equation (2), in Equation (1) and the specification would become like:

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

In the existence of a lagged value of the dependent variable, the use of ordinary least squares and fixed effects would provide biased estimators. Due to the biasedness of OLS and fixed effects model, we estimated 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). The model was to apply separately for the leverage ratio, risk-based capital ratio, and tier one ratio.

4. Results and discussion

Table 1 contained descriptions, sources, and essential information on bank-level capital ratios and control variables were used in our predictions. Both the factors were mentioned at the top and bottom 1% rates to remove the adverse effects of outliers and misreported results. The Average Leverage ratio, Tier 1 ratio, and Risk-based Capital ratios were 10.2%, 14.1 %, and 12.8 %, respectively. In comparison, the fifth percentile of the Tier 1 ratio and Risk-based Capital Ratio indicated that regulatory capital levels were well above the minimum requirement of Pillar 1 for the majority of banks throughout the sample era. Although the population of the study was only the large insured commercial banks of The USA, the sample still has significant heterogeneity across banks, which was observed from the statistics of 5^{th} and 95^{th} percentile. Relatively, larger institutions had higher economic importance than lower ones. Table 2 represented the Pearson correlation matrix among the explanatory variables of the model. Most of the coefficients were less than 5%, except the capital ratios, which was the dependent variable. The sign of relationship supporting the economic theory and, the statistics were as per the previous studies, information Bitar et al. (2016), and De Jonghe and Öztekin (2015).

Table 1. Descriptive statistics. Sources: (author's calculations Stata output).

Variables	Definitions	Mean	Std.Dev.	P^{5}	P^{50}	P^{95}
Leverage Ratio	Total Equity/Total Assets ratio	0.102	0.018	0.07	0.09	0.13
Risk-Based Capital (RBCR)	Tier I + II/Total Risk-weighted assets ratio	0.141	0.027	0.11	0.13	0.19
Tier-I Ratio	Tier I /Total Risk-weighted Assets ratio	0.128	0.02	0.10	0.12	0.15
SIZE	Natural logarithm of banks total assets	13.554	0.95	12.2	13.4	15.4
Credit risk	Loan loss Provision/Net loans ratio	0.003	0.003	0.00	0.013	0.022
RWATA	Risk-weighted assets to total assets ratio	0.723	0.11	0.50	0.73	0.90
Funding	Customer Deposits/Total funding ratio	0.902	153.118	−0.15	0.05	0.28
Liquidity	Liquid assets/Total deposit ratio	1.359	33.135	0.02	0.04	0.09
Loan growth	Net Loans/Total Assets ratio	0.01	0.122	0.45	0.68	0.82
Income Diversity	Non-interest income/Total income ratio	0.463	0.098	0.26	0.48	0.59
Efficiency	Non-interest expenses/Total income ratio	3.048	1.756	0.90	2.58	6.85
Profitability	Net income/Total assets ratio	0.01	0.005	−0.00	0.009	0.02
RGDPR	Annual growth in gross domestic product	2.084	1.038	−0.291	2.27	3.34

Table 2. Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Leverage	1.000												
RBCR	0.508	1.000											
Tier-I ratio	0.533	0.922	1.000										
Size	0.131	−0.103	−0.137	1.000									
Credit risk	−0.038	−0.114	−0.153	0.013	1.000								
RWATA	0.029	−0.522	−0.566	0.094	0.153	1.000							
Funding	−0.015	0.010	−0.013	0.013	0.004	0.002	1.000						
Liquidity	0.031	0.015	0.016	0.033	0.038	0.033	0.000	1.000					
Loan growth	0.003	−0.002	−0.003	−0.002	0.008	0.011	0.000	0.000	1.000				
Income Div	0.122	0.093	0.079	0.305	−0.370	−0.011	0.006	−0.001	−0.002	1.000			
Efficiency	−0.061	−0.010	−0.015	−0.038	0.168	−0.049	0.009	−0.022	−0.003	−0.221	1.000		
Profitability	0.097	0.086	0.066	−0.016	−0.275	0.048	−0.016	0.037	−0.002	0.581	−0.491	1.000	
RGDPR	0.018	0.042	0.054	−0.021	−0.350	−0.021	−0.001	−0.001	−0.010	0.228	−0.094	0.169	1.00

Sources: (author's calculations Stata output).

4.1. Overall sample results

In Table 3, column 1, 2, 3 contained the results for the overall sample, where column one represented leverage ratio, column two showed a risk-based capital ratio, and column three indicated tier one ratio. Our results showed that banks could change the regulatory capital ratios at a more flexible and faster rate than leverage ratio. More precisely, the speed of change for the leverage ratio framework in our study of large insured commercial banks over the 2002–2018 period is 18.6%, which was lower than that for the Tier 1 ratio, 53.5%, and the risk-based capital ratio, 42.5%. The pace of adjustment was in line with the findings of (Bakkar et al., 2019; Berger et al., 2008; Gropp and Heider, 2010). These adjustment speeds corresponded, in economic terms, to half-lives of 3.4, 0.9, and 1.3 years, respectively. The half-life was measured as log (0.5)/logs (1-Adjustment speed) and was equal to the amount of time required by banks to halve the difference between their actual capital ratio and target. The findings were contradicting with the conclusion of Bakkar et al. (2019) in the sense that the large commercial banks of the USA adjust their regulatory capital ratios faster than traditional leverage ratio. The explanations for this difference might be due to the implementation of recent regulations for large financial intuitions from regulators[9].

4.2. Well, adequately and undercapitalized bank's results.

In Table 3, column 4, 5, 6 reported the results for well-capitalized banks. More precisely, the speed of change for the leverage ratio framework in our study of well-capitalized banks was lower than the base results is 17.6%, which was lower than that for the Tier 1 ratio, 32.4%, and the risk-based capital ratio, 37%. The pace of adjustment was in line with the findings of (Abbas and Masood, 2020; Bakkar et al., 2019; Berger et al., 2008; Gropp and Heider, 2010). These adjustment speeds corresponded, in economic terms, to half-lives of 3.6, 1.8, and 1.5 years, respectively. The findings explored that well-capitalized banks adjusted their risk-based capital ratio faster than a tier-one ratio. In Table 4, column 1, 2, 3 presented the results for adequately capitalized banks. The speed of adjustment for leverage ratio was 17.5%, which was lower than well-capitalized banks and main results. Adequately capitalized banks adjusted their tier-one ratio faster than the risk-based capital ratio. Table 4, columns 4, 5, 6, contained the findings for undercapitalized banks. The speed of adjustment for undercapitalized banks was substantially lower than well-capitalized, adequately capitalized banks and base results. The results showed that undercapitalized banks required double time than base time to restore their leverage ratio, and three-time higher period to manage their regulatory capital ratios. The outcomes had economic meanings in the sense that well-capitalized banks have easy access to the capital market than adequately capitalized banks and adequately capital banks than undercapitalized banks other things held constant. Due to this theoretical reason, the speed of adjustment was justified in terms of bank categories.

[9] http://www.bis.org/bcbs/basel3.htm.

Table 3. A two-step GMM method is used to approximate the partial adjustment model separately using three alternative capital ratios: Leverage ratio (TCAPR), risk-based capital ratio (TRBCR), and Tier I ratio (TIRBCR). Robust standard errors are reported in parentheses.

	Overall Sample Results			Well-capitalized Banks		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	TIRBCR	TCAPR	TRBCR	TIRBCR
LDV	0.814***	0.575***	0.465***	0.825***	0.630***	0.676***
	(0.0252)	(0.0475)	(0.0860)	(0.152)	(0.110)	(0.0856)
SIZE	0.000167	−0.00261***	−0.00264***	0.00062	−0.00094	−0.00026
	(0.000190)	(0.000373)	(0.000526)	(0.00123)	(0.00110)	(0.000636)
Credit Risk	−0.197*	0.242	−0.272	−0.255	0.394	−0.0143
	(0.119)	(0.171)	(0.200)	(0.392)	(0.463)	(0.153)
RWATA	0.00642***	−0.0633***	−0.0552***	0.0130	−0.0266***	−0.0177***
	(0.00224)	(0.00586)	(0.00595)	(0.0114)	(0.0099)	(0.00545)
Funding	−0.00291***	0.00402***	−0.00803***	−0.00368	0.00454***	−0.00334*
	(0.00108)	(0.00131)	(0.00168)	(0.00335)	(0.00521)	(0.00194)
Liquidity	0.00628***	0.00149***	0.00177***	0.000982	0.00388	0.000134
	(0.00169)	(0.00236)	(0.00331)	(0.00467)	(0.00412)	(0.00219)
Loan Growth	0.00797***	0.00462**	0.00504***	−0.0828	0.0863	−0.0386
	(0.00012)	(0.00023)	(0.00016)	(0.139)	(0.129)	(0.0576)
Income Div	0.0170**	0.0512***	0.0567***	0.0575	0.00527	0.0425
	(0.00795)	(0.00859)	(0.0115)	(0.0637)	(0.0625)	(0.0259)
Efficiency	0.00139	−0.00164	0.00275	0.0107	−0.1055	0.0054
	(0.00164)	(0.00229)	(0.00241)	(0.0113)	(0.0113)	(0.00407)
Profitability	−0.226***	−1.211***	−0.958***	0.469	0.174	−0.0261
	(0.0565)	(0.118)	(0.114)	(0.335)	(0.466)	(0.146)
GDPR	0.00031***	−0.00015	0.00018	0.00061	−0.00047	−0.008415
	(0.00010)	(0.00014)	(0.00014)	(0.00042)	(0.00050)	(0.00023)
Constant	0.00251	0.134***	0.119***	−0.0573	0.0745	0.0297
	(0.00779)	(0.0186)	(0.0169)	(0.0837)	(0.0659)	(0.0247)
Observations	14,942	14,946	14,942	2,277	2,281	2,277
Number of id	936	937	936	143	144	143
Hansen Value	0.066	0.361	0.09	0.575	0.209	0.191
AR (2)	0.297	0.768	0.596	0.504	0.688	0.227

Note: Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4. A two-step GMM method is used to approximate the partial adjustment model separately using three alternative capital ratios: Leverage ratio (TCAPR), risk-based capital ratio (TRBCR), and Tier I ratio (TIRBCR). Robust standard errors are reported in parentheses.

	Adequately capitalized banks			Undercapitalized banks		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	TIRBCR	TCAPR	TRBCR	TIRBCR
LDV	0.883***	0.745***	0.691***	0.897***	0.981***	0.984***
	(0.107)	(0.0900)	(0.141)	(0.0634)	(0.110)	(0.184)
SIZE	−0.00262	−0.00243***	−0.00941	0.000879***	−0.000630	−0.000545
	(0.00087)	(0.00077)	(0.00157)	(0.000327)	(0.000831)	(0.000985)
Credit Risk	−0.817	0.954**	−0.837	0.292	1.474**	1.255
	(0.723)	(0.464)	(0.830)	(0.293)	(0.678)	(0.810)
RWATA	0.0211*	−0.0538***	−0.0285**	−0.0204**	−0.0881***	−0.0761***
	(0.0112)	(0.00850)	(0.0124)	(0.0102)	(0.0170)	(0.0168)
Funding	−0.000196	−0.006985	−0.000323	−0.00118	−0.00108	−0.000959
	(0.000169)	(0.000108)	(0.000225)	(0.00111)	(0.00294)	(0.00205)
Liquidity	0.00715	0.00612*	0.00163**	0.0131***	0.0185***	0.0145**
	(0.00516)	(0.00361)	(0.00684)	(0.00307)	(0.00594)	(0.00599)
Loan Growth	−0.00323	0.0872*	0.0404	0.000561***	−0.000117	−0.000416
	(0.0341)	(0.0455)	(0.0630)	(0.000145)	(0.000349)	(0.000354)
Income Div	0.0152	0.0167	0.0550*	−0.0176	−0.0307	−0.0295
	(0.0211)	(0.0181)	(0.0292)	(0.0193)	(0.0418)	(0.0446)
Efficiency	0.00537	−0.00412	0.0101	−0.00588	−0.0173*	−0.0170*
	(0.00564)	(0.00309)	(0.00712)	(0.00397)	(0.00892)	(0.0100)
Profitability	0.108	−0.782**	−0.401	−0.0152	−0.628**	−0.705**
	(0.235)	(0.338)	(0.404)	(0.152)	(0.276)	(0.282)
GDPR	0.000340	0.000470	0.000455	−0.000100	−0.00149**	−0.00115*
	(0.000334)	(0.000410)	(0.000414)	(0.000253)	(0.000645)	(0.000678)
Constant	−0.0207	0.119***	0.0256	0.0302	0.137***	0.129***
	(0.0348)	(0.0272)	(0.0510)	(0.0232)	(0.0404)	(0.0357)
Observations	1,690	1,690	1,690	10,894	10,894	10,894
Number of id	106	106	106	682	682	682
Hansen Value	0.815	0.116	0.111	0.959	0.433	0.700
AR (2)	0.470	0.500	0.725	0.555	0.138	0.148

Note: Standard errors in parentheses*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3. Bank balance sheet and adjustment of capital ratios

Within this segment, we looked at how banks change the structure of their balance sheet to close the divergence from the target capital ratios. We followed the technique of Bakkar et al. (2019) and De Jonghe and Öztekin (2015) to achieve outcomes. The approximate vector of the coefficients of Equation (3) allowed one to determine the correct time changing target capital ratios for each particular bank. Subsequently, we quantified and described the time-varying capital deviation for a bank I at period t-1, after this known "the gap," in capital ratios. According to Equation (3), the fixed

bank results thus shaped part of these approximate targets and gaps. If the banks adjusted when a difference occurs, such changes would be mirrored in the balance sheet transactions they made. We followed De Jonghe and Öztekin (2015) and Bakkar et al. (2019) to analyze the percentage growth levels of three quintiles of the difference (1st, middle and fifth) on different balance sheet components. We first assigned banks at the end of the year to quintiles, depending on their distance. We then measured the average shift in the related variable for the next year. Therefore, all bank-year resulted in that quintile compared such growth levels.

Table 5 showed the average growth rates of the primary balance sheet items for banks assigned to the first quintile after this well-capitalized bank, the third quintile after this adequately capitalized bank with a negligible gap and the fifth quintile after this under-capitalized bank based on their year-end gaps. For each capital ratio, we showed the difference p-values in means tests using the adequately capitalized banks as a benchmark. The p-values were reached at 500 replicated by the bootstrap method to correct the approximate existence of the intended capital ratio of the banks[10]. Throughout academic research, this method of bootstrap had become standard practice with selective modifying templates for organizational capital structure (Bakkar et al., 2019; Çolak et al., 2018; De Jonghe and Öztekin, 2015).

Table 5 columns 1 2 and 3 contained the results of the leverage ratio of well, adequately, and undercapitalized banks. First, overcapitalized banks had a negative and substantial shift in the leverage ratio relative to the adjustment rate of the adequately capitalized banks (−8.41% vs. 0.03%), indicating that banks lower their capital ratio to meet their target capital ratio. Indeed, facing an opportunity expense, banks had little reason to sit over their planned leverage level. Therefore, bank managers made constructive attempts to exploit to translate their target, thus increase continuing capital surplus costs. In a sample of the USA large commercial banks, our findings provided that well-capitalized banks increased the growth of their assets of 15.09% against adequately capitalized banks rate of 13.37%. The liability growth was 7.12%, whereas equity development was substantially lower as compared with adequately capitalized banks. The average increase in loans was higher for well-capitalized banks and lower for undercapitalized banks against the benchmark. We found different results than Bakkar et al. (2019) in case of risk-weighted assets growth. The outcomes of this study revealed that well-capitalized banks increase their risky assets than adequately and undercapitalized banks. Along with the same graph, banks with a capital surplus reduced their internal borrowing, growth along banks' retained earnings was around 0.99%, and an increase in external funding capital was significantly smaller 6.62% against adequately capitalized banks 9.85%. These findings showed that banks continue to borrow by investing more in risky investments, funding more with long-term loans, albeit without any significant improvement in their lending policies or capital-level reduction.

[10] Pagan A (1984) Econometric issues in the analysis of regressions with generated regressors. *Int Econ Rev*, 221−247.

Table 5. Mechanisms for balance sheet change in reaction to capital surplus and capital deficit. The table demonstrates the estimated growth ratios of bank capital ratios (equity-to-total assets, risk-based capital measure as tier one plus tier two scaled by risk-weighted assets, and tier one ratio calculation by tier-one equity to risk-weighted assets). For well-capitalized banks, we use quintile one quintile three for adequately capitalized banks and quintile five for undercapitalized banks. Both factors are in relation. We do mention the p-values of the medium measures.

	Leverage Gap			Tier I Gap				Risk-based gap		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Adjustment System	WC	AC	UC	WC	AC	UC	WC	AC	UC	p-values
Δ Capital Ratio	−8.41	0.03	5.10	−2.41	0.01	3.21	−7.51	0.02	5.89	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
G Capital Ratio	−8.10	1.80	13.1	−3.10	2.89	6.11	−4.10	0.98	5.91	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
Total Assets	15.09	13.37	−12.38	9.29	10.17	1.38	9.13	10.37	2.18	0.0***
	3213	3213	3213	3213	3213	3213	3213	3213	3213	
Total Liabilities	7.12	13.10	5.37	8.23	9.10	6.27	7.62	7.98	4.17	0.0***
	3212	3212	3212	3212	3212	3212	3212	3212	3212	
Common Equity	4.12	12.70	14.12	6.24	11.89	15.12	6.82	10.56	12.12	0.0***
	3210	3209	3210	3210	3209	3210	3210	3209	3210	
Net Loans	6.62	5.61	3.78	8.92	5.71	3.78	2.29	4.61	2.78	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
Risk-Weighted Assets	7.30	6.80	5.50	8.40	7.81	3.35	9.13	7.20	2.12	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
LT Borrowing	2.78	1.17	0.20	1.82	0.81	0.22	2.80	2.17	0.19	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
ST Borrowing	0.63	0.41	0.21	0.83	0.81	0.22	0.63	0.41	0.21	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
Internal Capital	0.991	3.120	2.980	1.292	5.201	2.180	2.100	5.409	2.080	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	
External Capital	6.62	9.85	13.01	6.12	8.89	15.21	7.67	8.51	14.21	0.0***
	3210	3210	3210	3210	3210	3210	3210	3210	3210	

Table 5 columns 4, 5, and 6 reported the tier-I ratio of well, adequately, and undercapitalized banks. The following definition of capital was the tier-I ratio, where the overcapitalized banks had a negative capital ratio increased that was slightly different from the shifting trend in the third adequately capitalized banks of the range −2.41% against the adequately capitalized rate of 0.01%. Therefore, we examined growth levels of change processes that lead these banks to raise their capital surplus to their optimum regulatory point. Findings revealed that banks allocated a substantial and robust rise in their asset growth, whereas equity growth was slightly smaller relative to benchmark growth levels. Thus, overcapitalized banks continued by substantially altering all the balance sheet subcomponents concerning the benchmark. Therefore, a Tier 1 capital surplus lead banks to leverage by combinations of an asset accumulation policy, risk-taking practices, conservative lending policies, long-term and short-term debt funding policies, and slower equity growth, but without any capital-level reduction.

As far as undercapitalized regulatory banks were concerned, the findings indicated that their Tier 1 capital ratio shift was slightly higher than that of adequately capitalized banks. Consequently, banks were required to increase their regulatory capital to achieve their internal regulatory capital ratio and to comply with capital requirements. They started with a significant fall in asset growth and debt growth relative to the average growth rate and just a modest rise in the equity growth rate. Based on these findings, we could examine the main processes under which these banks de-lever and rebalance their capital structure. Similarly, we noted that these banks respond aggressively by substantially altering all sub-components of the balance sheet concerning the benchmark. Therefore, in the context of a financial resource deficit, deleveraging takes place through the introduction of external capital but not through the usage of earnings retention. Deleveraging is often accomplished by downsizing, tightening up monetary policies, selling volatile assets, and rising long-term and short-term funding. In the section on the right, we also displayed the modification processes for the overall capital ratio. Table 5 columns 7 8 and 9 presented the risk-based capital ratio well, adequately, and undercapitalized banks. The following definition of capital is a risk-based capital ratio, where the overcapitalized banks have a negative capital ratio increase that is slightly different from the shifting trend in the third adequately capitalized banks of the range −7.51% against the adequately capitalized rate of 0.02%. Therefore, we examined growth levels of change processes that lead these banks to raise their capital surplus to their optimum regulatory point. Findings revealed that banks allocated a substantial and robust rise in their asset growth, whereas equity growth was slightly smaller relative to benchmark growth levels.

4.4. Post and Before-crisis period results

Table 6 columns 1 2 and 3 contained the findings for the post-crisis period, and columns 4, 5 and 6 reported the results for the before-crisis period. The literature explored that most of the regulation took place during the last two decades, which contained a period of financial crisis ranging from 2007 to 2009. To analysis, the difference before and after-crisis, we divided the data into two parts, first was before crisis comprises 2002 to 2006, and second, was post-crisis ranging from 2010 to 2018. The findings provided confidence to regulators to analyze the post-performance and current conditions. The results revealed that in the post-crisis period, banks adjusted their leverage ratio faster than the before-crisis period. In the post-crisis period, the pace of the risk-based capital ratio was lower than before-crisis era. The pace of change in the tier-one ratio was lower in the post-crisis period than before-crisis. Theoretically, faster adjustment of the capital ratio was due to more regulations that were stringent and monitoring. One possible explanation for the slower pace of the tier-one capital ratio was the cost of raising new equity and access to the capital market. The faster adjustment in before-crisis for the risk-based capital ratio was due to lower monitoring of banks where the manager could manipulate the assets side to boost their risk-based capital ratio quickly.

Table 6. A two-step GMM method is used to approximate the partial adjustment model separately using three alternative capital ratios: Leverage ratio (TCAPR), risk-based capital ratio (TRBCR), and Tier I ratio (TIRBCR). Robust standard errors are reported in parentheses.

	Post-crisis results			Before-crisis results		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	TIRBCR	TCAPR	TRBCR	TIRBCR
LDV	0.560***	0.552***	0.767***	0.723***	0.510***	0.739***
	(0.212)	(0.0826)	(0.0703)	(0.141)	(0.0650)	(0.112)
SIZE	−0.00181	−0.00338***	−0.00172***	−0.000195	−0.00245**	−0.000221
	(0.00136)	(0.000763)	(0.000393)	(0.000961)	(0.000956)	(0.00142)
Credit Risk	−0.512*	0.220	0.233*	0.147	0.650***	0.247
	(0.277)	(0.194)	(0.125)	(0.185)	(0.235)	(0.183)
RWATA	0.0292***	−0.0637***	−0.0354***	0.00236	−0.0731***	−0.0422***
	(0.00877)	(0.00967)	(0.00532)	(0.00765)	(0.00814)	(0.00977)
Funding	−0.00018***	0.00042***	−0.00018	−0.000173	−0.0007	−0.000126
	(0.00047)	(0.0006)	(0.0001)	(0.000130)	(0.000160)	(0.000122)
Liquidity	0.00247***	0.00131**	0.00462*	0.00022	0.00013	0.0009
	(0.0066)	(0.0056)	(0.0024)	(0.000168)	(0.0009)	(0.000118)
Loan Growth	0.000939**	−0.00605	0.00772	0.0173	0.00404	0.00634
	(0.000376)	(0.000188)	(0.0096)	(0.0198)	(0.0358)	(0.0231)
Income Div	0.143***	0.0377	0.0130	0.00464	−0.0133	−0.0279
	(0.0420)	(0.0312)	(0.0107)	(0.0373)	(0.0166)	(0.0321)
Efficiency	0.0146***	−0.00117	−0.00254**	−0.00405	−0.00194	0.00427
	(0.00414)	(0.00303)	(0.00123)	(0.00489)	(0.00397)	(0.00654)
Profitability	−1.768***	−0.913*	−0.563***	−0.580	0.575	1.569
	(0.591)	(0.470)	(0.128)	(1.676)	(0.873)	(1.704)
GDPR	0.000927**	−0.00152***	−0.00131***	−0.00201	−0.000715	−0.000213
	(0.000428)	(0.000347)	(0.000279)	(0.00155)	(0.000954)	(0.00139)
Constant	−0.0492	0.155***	0.0898***	0.0493	0.157***	0.0483
	(0.0305)	(0.0253)	(0.0136)	(0.0308)	(0.0358)	(0.0570)
Observations	7,488	7,488	7,488	3,716	3,716	3,716
Number of id	937	937	937	934	934	934
Hansen p Value	0.399	0.672	0.642	0.659	0.103	0.617
AR (2)	0.150	0.226	0.190	0.462	0.772	0.491

Note: Standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1.

4.5. Robustness checks

We conducted several tests and several sample divisions to observe the reliability and robustness of our findings. Where the first choice was used to test the model with alternative capital ratios like tier-one equity to total assets, capital buffer ratio, and tier one-buffer ratios[11]. Then we

[11] Risk-based capital ratio less 8%, tier one risk-based ratio less 6% for detail see Abbas F, Butt S, Masood O, et al. (2019a) The Effect of Bank Capital Buffer on Bank Risk and Net Interest Margin: Evidence from the US. *Global J Social Sci* 5: 72–87; Guidara A, Soumaré I, Tchana FT (2013) Banks' capital buffer, risk and performance in the Canadian banking system: Impact of business cycles and regulatory changes. *J Bank Financ* 37: 3373–3387.

classified our sample in more parts to reach the right conclusion. The findings boosted the confidence that the result remained consistent with the sign and significance of coefficient except for minor variation. To save the space, we only reported the results for high liquid, low liquid[12], and significantly undercapitalized banks'[13] speed of adjustment. In Table 7 Panel-A column 1, 2, and 3 reports the speed of adjustment of the leverage ratio, risk-based capital ratio, and tier-one ratio for high liquid insured commercial banks. Columns 4, 5, and 6 contained the results of low-liquid banks' capital adjustment pace. In Table 7, Panel-B column 1, 2, and 3 included the outcomes of significantly undercapitalized banks resulted in similar accounting ratios. The rates of change in capital ratios were robust with the base results. To increase the scope of the study, we consider the role of off-balance sheet items to influence the speed of capital ratios adjustment. Table 8 columns 1 to 3 contains the findings of the overall sample and columns 4 to 6 show the results of well-capitalized banks. The conclusions remain consistent with a minor variation, which shows that the inclusion of off-balance sheet items increases the period for commercial banks to restore equilibrium.

Table 7. Robustness check results. A two-step GMM method is used to approximate the partial adjustment model separately using three alternative capital ratios: Leverage ratio (TCAPR), risk-based capital ratio (TRBCR), and Tier I ratio (TIRBCR). Robust standard errors are reported in parentheses.

Panel-A	High Liquid Banks			Low Liquid Banks		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	TIRBCR	TCAPR	TRBCR	TIRBCR
LDV	0.816***	0.776***	0.630***	0.818***	0.548***	0.667***
	(0.0483)	(0.161)	(0.0541)	(0.0701)	(0.186)	(0.149)
Constant	0.00311	0.125***	0.0974***	0.0547**	0.120***	0.107***
	(0.0121)	(0.0329)	(0.0146)	(0.0257)	(0.0305)	(0.0209)
Observations	7,360	7,364	7,360	7,582	7,582	7,582
Number of id	462	463	462	474	474	474
Hansen value	0.521	0.511	0.136	0.357	0.463	0.864
AR (2)	0.595	0.597	0.760	0.297	0.320	0.217
Panel-B				Significantly Undercapitalized Banks		
LDV				0.811***	0.956***	0.904***
				(0.0358)	(0.0543)	(0.0513)
Constant				0.0412**	0.0335	0.0102
				(0.0186)	(0.0283)	(0.0241)
Observations				6,576	6,576	6,576
AR(2)				0.938	0.714	0.262
Hansen value				0.690	0.264	0.351

[12] The banks are divided on the basis of liquid assets index. We arrange the banks in ascending order based on liquidity ratio index and divided into two equal parts, where the first part is high liquid and second part is low liquid banks.

[13] The banks having risk-based capital ratio less than 6% considered as significantly undercapitalized.

Table 8. Robustness check results when off-balance sheet items are considered. A two-step GMM method is used to approximate the partial adjustment model separately using three alternative capital ratios: Leverage ratio (TCAPR), risk-based capital ratio (TRBCR), and Tier I ratio (TIRBCR). Robust standard errors are reported in parentheses.

Panel-A	Overall sample			Well-capitalized banks		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	TCAPR	TRBCR	TIRBCR	TCAPR	TRBCR	TIRBCR
LDV	0.871***	0.591***	0.511***	0.868***	0.680***	0.710***
	(0.0253)	(0.047)	(0.0541)	(0.271)	(0.121)	(0.0769)
Constant	0.00351	0.234***	0.211***	−0.0473	0.0615	0.0327
	(0.00671)	(0.0681)	(0.0241)	(0.0738)	(0.0561)	(0.0345)
Observations	14,942	14,946	14,942	2,277	2,281	2,277
Number of id	936	937	936	143	144	143
Hansen value	0.264	0.461	0.192	0.752	0.312	0.215
AR (2)	0.261	0.675	0.665	0.414	0.488	0.327

5. Conclusion

The Basel III Agreement introduced more rigorous capital requirements in the form of new leverage ratios for larger banks. In this paper, by concentrating on two dimensions, we analyzed how banks changed their capital ratios to their desired levels. We investigated how the levels and processes of change varied from those of regulators and bank managers (leverage) internally targeted and concentrated on the large insured commercial banks of the USA. The study used a period from 2002 to 2006 before Basel III and 2010 to 2018 after Basel III to analyze how banks handled their capital ratios of large insured commercial banks in The USA. We increased standard partial adaptation models of bank capital to banking specific and time-specific optimum capital ratios with different categories of commercial banks.

Our results indicated that there were significant variations between the level at which the banks adapted and the direction they changed for the adjustment of capital ratios. We observed the differential effect of well-capiutilized adequately capitalized and undercapitalized banks to adjust their leverage ratio and regulatory ratio. Larger banks adapted to change their capital management requirements quicker and more effectively. In comparison, banks closest to minimum regulatory thresholds would be limited to make improvements to their capital level contributing to a slower pace of transition. The larger banks were typically more agile and easier to adjust their regulatory capital ratio than leverage ratio while other things held constant. The undercapitalized banks usually remained in problem to adjust their regulatory capital ratios quickly as compared to adequately and well-capitalized banks. The well-capitalized banks adjusted their risk-based capital ratio and tier-one ratio faster than others. The well-capitalized banks delivered their capital by increasing the growth of their assets higher than adequately capitalized banks. The outcomes confirmed that adequately capitalized banks adjusted their risk-based capital ratios quicker than undercapitalized and significantly undercapitalized banks. The findings explored that adequately banks and undercapitalized banks had higher growth in new equity issues than well-capitalized banks. Our results added to the literature on the transformation of the bank capital structure and had numerous policy consequences. These findings are also expected to be particularly useful for supervisors when assessing and adjusting the specific capital requirements that each bank in the industry can impose differently and separately through pillar 2 of the Basel III agreement.

Conflict of interest

All authors declare no conflicts of interest in this paper.

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