EFFECTIVENESS OF BANK CAPITAL REGULATIONS ON BANK STABILITY

By Ian McGettigan *

May 2, 2025

Abstract

The literature on bank capital regulations suggests that higher bank capital is in general preferred over lower bank capital. Using a two-way fixed effects model, controlling for country- and year-level shocks, I regress bank Z-score for the G7 and OECD countries against the ratio of regulatory capital to risk-weighted assets to determine whether regulatory capital increases bank stability. I find a positive and statistically significant association for both data samples, for both contemporaneous and lagged models.

I. Introduction

I.A. What is bank capital?

Bank capital is money that comes either from shareholders and investors or from retained earnings of banks. Bank capital is of utmost importance in ensuring the stability of banks; it acts as a buffer in case loans go bad or banks suffer other losses, for example, on their other asset holdings, helping to lower the risk of bank insolvency. Thus bank regulators have long argued for minimum bank capital requirements. However, banks do not want to hold more capital than they deem necessary, because it increases the opportunity cost of using that capital to fund loans or other projects. And many banks know that they are seen as "too big to fail" and that they may be rescued by Government in the event of capital falling too low. Therefore there is a fundamental conflict of interest between banks and regulators as to how much capital to hold.

*SNR: 2091280
i.j.mcgettigan@tilburguniversity.edu

I.B. Brief history of capital regulation

The Latin American Debt Crisis of the 1970s prompted a resurgence in discussions about the importance of bank capital regulations in acting as a buffer to prevent banks from failure and causing systemic crises. These discussions took place in Basel, Switzerland, among the G10 countries. The first Basel agreement—Basel I—was implemented in July of 1988. Its main difference to the previous capital regulations was the concept of risk-weighted assets. The idea is that a uniform capital ratio did not take into account differences in risks between banks; a bank who takes on significantly more risk should hold proportionately more capital than a bank that lends mostly to safe entities. Specifically, assets were assigned into one of five risk categories: 0%, 20%, 50%, 100%, no rating, with 0% risk rating assigned to the lowest risk assets and higher weights as asset risk increases. Basel I was not suited for the developments in the banking sector, such as securitization. While securitization has many benefits for both firms and consumers, it also allowed regulatory arbitrage among banks: Banks could, for example, use a Special Purpose Vehicle (SPV)—a separate legal entity—to hold their risky loans, effectively reducing their risk on paper, therefore lowering the capital they would need to hold. Moreover, because of the rather crude risk weights, certain loans could be given the same risk weight though they differ significantly in actual risk; for example, all corporate loans would be treated as having the same risk, but certainly not all corporations share the same risk profile.

Basel II was introduced to address these weaknesses by changing the way risk-weighted assets were calculated. Small banks could continue to adhere to Basel I standards. But larger banks had to use their own internal model to evaluate their risk. Unfortunately, the timing of Basel II was too late to prevent the Global Financial Crisis (GFC); Basel II's rules were supposed to be implemented in these years, but before the crisis, no US banks, for example, had fully adopted them. Moreover, banks had incentives to understate their risk as calculated by their own models, and as such even Basel II would not have been enough to prevent the GFC. As Ranjit Lall (2009) argues, "By hijacking the Basel process, large international banks effectively rewrote the rules of international capital regulation to give themselves free rein to set their own capital requirements." Indeed, an independent analysis by the Federal Deposit Insurance Corporation (FDIC) showed that average capital levels would decrease by up to 29% in response to the implementation of Basel II's proposed internal risk models.

Basel III was first drafted in 2010; though phase-in may take several years from 2025. Basel

III aims to improve upon Basel I and II through several means, such as increasing capital requirements, adding countercyclical capital buffers, requiring stress tests, including liquidity requirements, and overall stricter regulation, especially for globally systemically important banks (G-SIBs). There is disagreement over whether Basel III, especially related to its capital requirements, is enough to prevent future crises. The next section discusses the main arguments for and against higher capital requirements, and their effectiveness in promoting bank stability.

II. Literature Review

II.A. Arguments in favor of higher capital requirements

Thakor (2018), based on many existing articles on the subject, concludes that the GFC was primarily a solvency crisis; that is, banks' assets lost so much value that even if they could sell all their assets, it would not be enough to cover their debts. This contrasts with a liquidity crisis, which is when a bank may hold inherently valuable assets but cannot sell them quickly enough or at a fair price. Thakor's finding shows the importance of bank capital in preventing a future banking crisis, as by holding more capital banks will be better protected against insolvency.

Indeed, Benink (2020) notes that "banks with higher capital ratios were more likely to survive the crisis and gain a market share during the crisis, took fewer risks prior to the crisis, and had smaller contractions in lending during the crisis." Benink argues for higher capital requirements than currently proposed under Basel III because capital ratios are still at historically low levels. According to Benink, these current low capital ratios make it "unlikely that banks will be able to withstand future crises without having to be bailed out by taxpayers." Thus, in order to protect banks from insolvency, to preserve the stability of the financial system at large, and to protect consumers in the process, banks should hold Tier 1 (highest-quality) equity capital ratios of at least 15%.

Miles et al. (2013) investigate what should be the optimal level of bank capital. Using data on UK banks from 1997–2010, the authors regress banks' average equity betas (risk) on their leverage ratios to see whether holding more debt (and less equity) makes equity more risky. They find that for a 1-unit increase in leverage, equity beta, or risk, increases by 0.025–0.031. To establish the "optimal" levels of capital banks should hold, the authors compare the marginal benefit of holding more capital—as defined as the reduction in the expected cost of future financial crises—to the marginal cost—the fall in GDP per head, as a result, for example, of

lower bank lending. Their model suggests that the marginal benefit of holding more capital decreases as more capital is held; specifically, the benefit of holding more capital falls below the cost for capital to risk-weighted assets of 16–20%. The primary concern of increased capital requirements being passed on to consumers in the form of higher borrowing costs is found to be negligible: a doubling in bank capital is associated with only a 10–40 basis point rate increase in the long run. The authors conclude that a "far more ambitious reform would ultimately be desirable—a capital ratio which is at least twice as large as that agreed upon in Basel would take the banking sector much closer to an optimal position."

Another cause of banking crises is bank runs. Cooper and Ross (2002) argue that deposit insurance alone cannot prevent bank runs because of the problem of market discipline—if depositors are fully insured, they have little incentive to monitor banks, and banks will therefore take on more risk, increasing the probability of a banking crisis that results from non-depositors fleeing. If banks are required to hold more capital, however, this can "provide sufficient incentive to owners managers to overcome the moral hazard problems without the need for monitoring by depositors," therefore reducing the risk of bank runs and consequent crises, protecting both consumers and banks.

Finally, Anginer et al. (2024) follow the same method I will follow in this paper; that is, the authors use bank Z-score—the sum of return on assets and equity to assets ratio divided by the standard deviation of return on assets—as a measure of bank stability, and regress this measure on bank capital holdings and capital quality (Tier 1 capital) to investigate how bank capital affects risk in over 14000 banks that were affected by the GFC. They find that capital level and quality are significantly positively associated with bank Z-score (a reduction in bank risk); specifically, a 1% increase in a bank's capital ratio is associated with a 2.049 increase in Z-score, and a 1% increase in Tier 1 capital ratio (Tier 1 assets divided by risk-weighted assets) is associated with a 2.073 increase in Z-score, both significant at 1%. While the authors do not justify in detail why they choose to use bank Z-score as a proxy for bank stability, it is no less a good measure of bank stability, because it gives the distance a bank is from insolvency. It estimates the number of standard deviations a bank's ROA would have to fall to eliminate its equity, rendering a bank insolvent. Therefore, it is also easy to measure: A higher Z-score corresponds to a lower risk of insolvency, all else equal. It is also easily comparable across banks internationally, as the data are widely available. However, the measure is not perfect; ROA and equity may lag behind actual risk, so Z-score for a given year may not be reliable and should

be interpreted with caution. Additionally, Z-score fails to capture market sentiment, therefore potentially understating true risk. Nonetheless, it is a widely used measure in the literature, and as such, even if it may not be reliable in itself, it is comparatively reliable; if one country's average Z-score is significantly higher than another country's Z-score, all else equal, it is safe to assume that the country with the higher average Z-score has a safer banking system. And relative changes in Z-score are good indications of changing bank stability.

II.B. Arguments against increased capital requirements

The literature on arguments against increased capital requirements is relatively scarce. Below, I go over some of the more cited arguments against increased capital requirements. I then conclude the literature review section with a comparison of the arguments, for and against capital requirements, by arguing that the arguments in favor of higher capital requirements are more prevalent and convincing.

The first and most apparent criticism of raising bank capital requirements is provided by Gorton (2012), who shows that bank capital ratios in the US used to be far higher—greater than 50% 200 years ago and greater than 10–15% 100 years ago—yet the frequency of financial crises was even higher historically than in recent years; from 1834–1934, there were seven financial crises while from 1934–2024 there were two. According to Gorton, this suggests that "there is almost no evidence that links capital to bank failures."

In *Connectedness and Contagion* by Hal Scott (2016), the author argues that the most important risk of bank failures is that of contagion, defined as "an indiscriminate run by short-term creditors of financial institutions that can render otherwise solvent institutions insolvent." That is, bank runs may occur for seemingly no reason at all, other than that others are running; and therefore bank runs may be the very causes of bank failures themselves. Scott argues that "no realistic level of capital can prevent a run on banks" because of fire sales. According to Scott, crises are more about cash, and not about capital; that crises are about liquidity, not insolvency; and therefore that imposing higher capital requirements serves no purpose other than to increase banks' and consumers' costs.

Sarin and Summers (2016) evaluate whether measures of bank risk have decreased as a result of increased regulation. While their paper does not focus exclusively on capital requirements, it is one of three main regulations discussed (the other two being leverage ratios and stress tests). Using equity volatility, beta, CDS spreads, PE ratios, preferred stock yields, and option-based

future volatility, they find no statistically significant improvements in any of the measures post-GFC compared to pre-GFC despite higher bank-capital holdings. However, it could simply be that, absent regulation, the measures of volatility would be far worse than they are now. The authors acknowledge this limitation, but argue still that "more effective than increasing capital requirements will be steps to assure prompt response to situations where markets suggest capital shortfalls."

There are several problems with the above arguments.

First, the result in Gorton (2012) is valid only if the banking sector stayed the same throughout this time, so that different capital ratios could be accurately compared. Moreover, it ignores other factors that could lead to financial crises, such as war or other adverse economic shocks. It is indeed not the case that capital ratios can be accurately compared across such a large time horizon: Government bailouts and TBTF policy did not exist 100–200 years ago; therefore, a lower capital ratio today may be just as effective as a higher capital ratio in the early twentieth century.

Second, while Scott (2016) is correct in noting the importance of market psychology in causing bank runs for seemingly no reason, Cooper and Ross (2002) show that if banks hold more capital, consumers will no longer need to spend valuable time and energy in monitoring their banks, because banks will have less of an incentive to undergo riskier projects, and therefore there is a lower probability that bank runs will occur in the presence of heightened capital requirements. With stronger capital requirements, consumers have less to fear, and bank stability would not rely so strongly on market discipline.

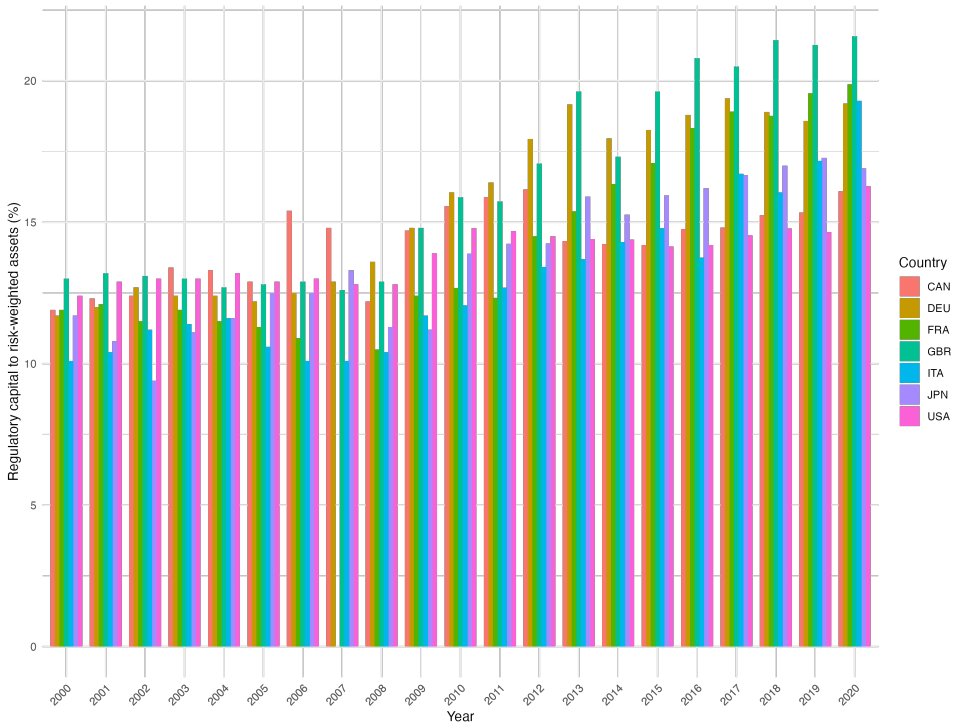
Finally, even Sarin and Summers (2016) are skeptical of the bold assertion that increasing capital requirements would have no positive effect on bank stability; they write, "... we suspect that without increases in capital requirements, levels of volatility would have increased even more than we observe."

Based on the work of Anginer et al. (2024) and Miles et al. (2013), this paper aims to contribute to the existing literature on the effectiveness of higher capital requirements by following a similar method in Anginer et al. (2024), regressing bank Z-score on bank capital ratios to confirm the positive association. This paper differs in that it looks at country- and year-level averages, to better assess the stability of a given country's financial system as a whole. More detail about the method is given in the following section.

III. Method

Capital ratios have, in general, increased over time. My aim is to investigate the relation between capital ratios and bank stability.

Figure 1: G7 Capital Ratios Over Time



To measure bank stability, I use Bank Z-score, defined as

$$\frac{\text{ROA} + \frac{\text{Equity}}{\text{Assets}}}{\text{sd(ROA)}},$$

where ROA is return on assets and sd is standard deviation.

Bank Z-score is used as a proxy for the distance of a bank from insolvency; generally, a higher bank Z-score indicates a safer bank. It is important to note that Z-scores are an imperfect measure of bank stability. First, they do not capture market sentiment, therefore potentially understating (or, though unlikely, overstating) bank risk. Second, ROA and equity may lag behind contemporaneous risk; Z-score for a given year, therefore, is not reliable; though Z-scores become a good measure of the *evolution* of bank stability over time, even if the value itself may not depict an accurate picture of a bank's stability. That is, if Z-scores are found to increase, all else equal this indicates an increase in bank stability. I therefore focus on within-country variation. Additionally, it is a measure that is widely available across my dataset and

is used in peer-reviewed articles such as in Anginer et al. (2024). To measure capital holdings, I use bank regulatory capital to risk-weighted assets (%).

III.A. Data

I collected data on bank Z scores, bank concentration, and bank capital to risk-weighted assets from the World Bank Global Financial Development databank. Macro controls—inflation and GDP—were collected from the World Bank World Development Indicators databank. Data are annual from 2000–2020. I first estimate my model across the G7 countries because they are of similar institutional quality and therefore may be more easily compared. However, this sample clearly suffers from a small N; so I expand the dataset to the full OECD sample as well, using GDP, inflation, and bank concentration (%) as controls.

III.B. Estimation strategy

I estimate a two-way fixed effects (TWFE) model,

$$Z_{it} = \alpha_i + \lambda_t + \beta \text{CapRatio}_{it} + \gamma' \mathbf{X}_{it} + \varepsilon_{it},$$

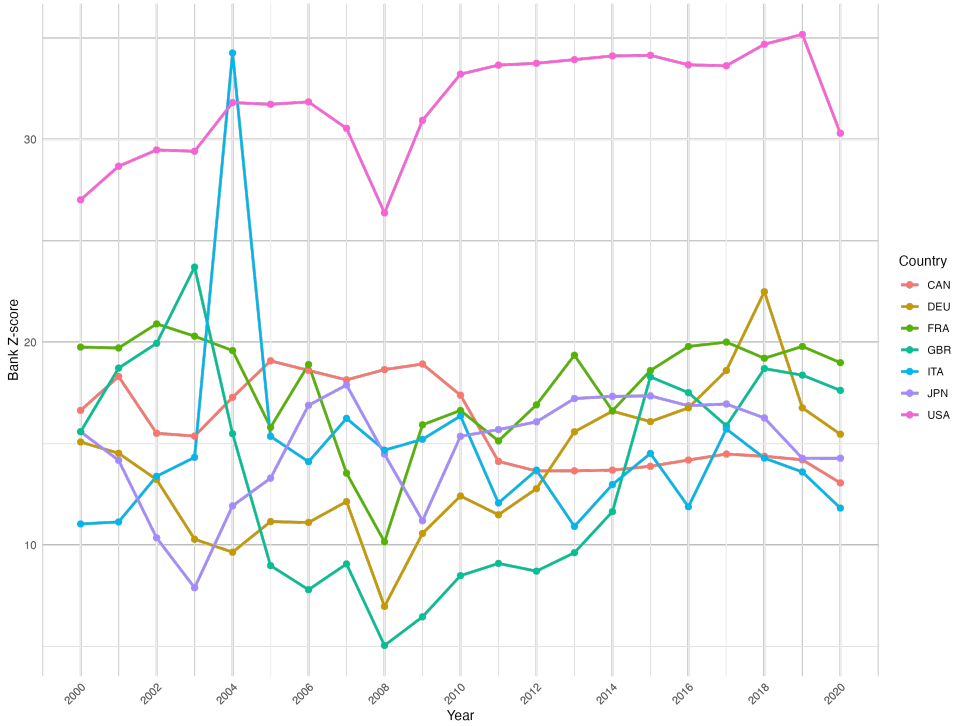
where Z_{it} is bank Z-score for country i in year t; α_i are country fixed effects to capture time-invariant heterogeneity; λ_t are year fixed effects to control for global shocks; CapRatio_{it} is the regulatory capital to risk-weighted assets (%) for country i in year t, and $\mathbf{X}_{it}$ is a vector of controls. Standard errors are clustered at the country level to account for within-country autocorrelation. From this model, β measures the within-country association between capital ratios and Z-scores, controlling for time and country effects that could otherwise affect the results, and which would severely limit an ordinary least squares regression.

I also run the model with a lagged capital term, to account for the possibility that changes to capital holdings may take time to have an effect on bank Z-score.

From graphing Bank Z-scores over time for the G7, I find that the US has far higher Z-scores than the other G7 members (Figure 2).

In case the Z-score data for the US are influencing my regression results, I estimate the TWFE model both with and without the US. Column (a) shows the contemporaneous regression results for the full sample, and column (b) shows the lagged regression results for the full sample. Column (c) shows the contemporaneous regression results for the sample without

FIGURE 2: G7 BANK Z-SCORES OVER TIME



the US, and column (d) shows the lagged regression results for the sample without the US. The association between a given country's capital ratio for the full G7 and its bank Z-score is not statistically different from zero, whereas when the capital ratio term is lagged, there is a significant association; a 1-percentage point increase in capital ratio is associated with a 0.893 point increase in bank Z-score. When the US is removed from the dataset, both the contemporaneous and lagged models show a highly statistically significant association between capital ratios and bank Z-scores, suggesting that the US was initially distorting the regression results, and that the capital–Z-score relationship in the US is flatter.

Excluding the US from the regression has a few important econometric implications. Firstly, a TWFE model forces a single slope to the data; and because the Z-scores for the US are visible outliers, removing the US means that the regression line is fitted to more homogeneous slopes, such that $\hat{\beta}$ increases and its standard error decreases. Secondly, Z-scores for the US post 2011 are mostly stable; whereas they are not as stable for the other G7 members; therefore by removing the US the within-country variation is more accurately captured. Finally, and perhaps most importantly, despite the visual appeal of removing the US from the dataset, this reduces the number of clusters from seven to six, and with fewer than 10 clusters there is a risk of downward-biased standard errors, artificially inflating significance. One way to address the

Table 1: Regression Results, G7 Sample

	(a)	(b)	(c)	(d)
Capital Ratio	0.673		1.166***	
	(0.380)		(0.259)	
ln(GDP) PPP	10.941	14.194	4.964	7.493
	(12.748)	(12.965)	(13.882)	(14.066)
Bank Concentration	0.025	0.047	−0.032	−0.005
	(0.091)	(0.093)	(0.087)	(0.096)
Inflation	−0.387	−0.082	−0.074	0.114
	(1.054)	(1.013)	(1.069)	(1.073)
Capital Ratio (lag)		0.893**		1.322***
		(0.345)		(0.317)
Num. obs.	146	139	125	119
Num. groups: CC	7	7	6	6
Num. groups: Year	21	20	21	20
R^2 (full model)	0.814	0.828	0.414	0.440
R^2 (proj model)	0.097	0.155	0.160	0.208
Adj. R^2 (full model)	0.766	0.782	0.235	0.266
Adj. R^2 (proj model)	0.066	0.124	0.125	0.173

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

latter is to wild cluster bootstrap; though this goes beyond the scope of this paper.

Additionally, it is important to note that my model is certainly not causal. I have established a clear and significant association between Z-scores and capital holdings, although the direction of the effect cannot be ascertained from this model, nor can it dismiss the possibility of omitted variables playing a role. Adding a lagged capital term helps partially address simultaneity bias; that is, that bank Z-scores and capital ratios may be jointly determined. However, it is not strong enough to justify causality. Furthermore, my model does not account for non-linearity; a change in capital ratio from 5% to 6% would be treated the same as an increase from 19% to 20%, but these may not have equal impacts on a bank's lending practices and consequent stability.

To explore the relation between bank Z-scores and capital ratios further, I extended my analysis to the OECD countries. In Figure 3, I plotted the average Z score for all OECD members and separately plotted the US Z-score. The US Z-scores are far higher than the OECD average, although because of a larger sample, the US does not pull the regression results as much as previously. Indeed, for both the contemporaneous and lagged models, an increase in capital ratio significantly increases bank Z score for a given OECD country, by 0.418 and 0.456, respectively. As expected, removing the US from the larger OECD sample has minimal effect

on the magnitude of β both in the contemporaneous and lagged models (c) and (d). However, the effect is still present, confirming the result that the capital–Z-score relation in the US is flatter than average.

Figure 3: Average OECD Bank Z-scores Over Time, compared to US

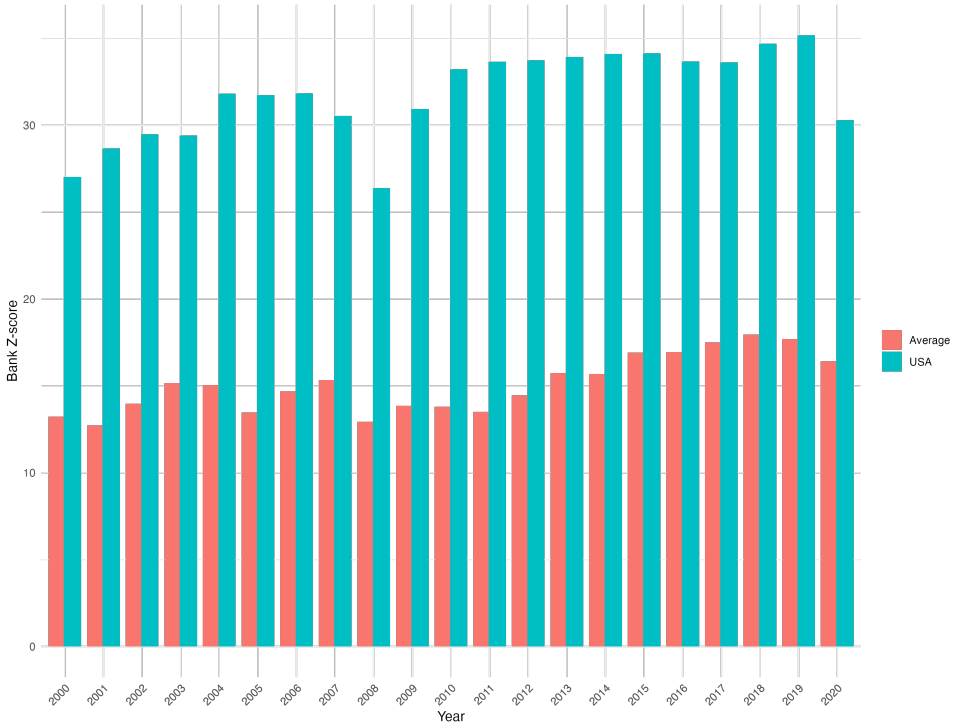


Table 2: Regression Results, OECD sample (2000–2020)

	(a)	(b)	(c)	(d)
Capital Ratio	0.418***		0.437***	
	(0.149)		(0.152)	
ln(GDP) PPP	4.590	4.888	4.966	5.178
	(4.051)	(4.004)	(4.103)	(4.051)
Bank Concentration	−0.036	−0.033	−0.041	−0.037
	(0.026)	(0.028)	(0.026)	(0.028)
Inflation	−0.012	−0.037	−0.012	−0.037
	(0.051)	(0.066)	(0.050)	(0.065)
Capital Ratio (lag)		0.456***		0.470***
		(0.158)		(0.161)
Num. obs.	742	705	721	685
Num. groups: CC	38	38	37	37
Num. groups: Year	21	20	21	20
R^2 (full model)	0.870	0.876	0.858	0.864
R^2 (proj model)	0.083	0.099	0.089	0.104
Adj. R^2 (full model)	0.859	0.864	0.845	0.851
Adj. R^2 (proj model)	0.077	0.093	0.084	0.098

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

IV. Conclusion

This paper investigates the effectiveness of the ratio of regulatory capital to risk-weighted assets on promoting bank stability as measured through Z-score. Z-scores are an imperfect measure of bank stability when taken alone for a given year, but over time, and within-country upward trends indicate a general increase in bank stability, which is captured according to the TWFE model mostly through the increase in regulatory capital to risk-weighted assets. My results add to the existing suggestive evidence that regulatory capital minimums are an effective way to increase bank stability, not just within banks, but within countries, and therefore to reduce the probability of future crises. Overall, the results—both for the G7 and OECD—find a positive and statistically significant association between bank capital ratios and Z-scores. A 1-percentage point increase in lagged capital ratio is positively and significantly associated with a 0.893 point increase in Z-score for a given G7 country. Removing the US because of its much higher Z-scores than the G7 sample leads to an increase in the coefficient to 1.166 in the contemporaneous model and 1.322 in the lagged model. It is important to note that there were already fewer than 10 clusters, so the results from removing the US should be interpreted with caution. As a robustness check, I extended the analysis to the OECD countries, and found still positive and significant, though smaller, results. A 1-percentage point increase in lagged capital ratio is associated with a 0.456 point increase in Z-score. When the US is removed, the coefficient increases still, but only to 0.470. Both samples suggest that, within countries, higher capital buffers are associated with increased bank stability, controlling for macroeconomic conditions, bank concentration, and country- and year-shocks. Causality cannot be determined from the data, but using a lagged capital term partly addresses joint-determination of Z-scores and capital ratios, and remains statistically significant, with even stronger coefficients than in the contemporaneous models, suggesting that capital may take time to have an effect on bank stability. My results do not imply a particular capital ratio; but the majority of the literature advocate for capital ratios substantially higher than those proposed under Basel III.

In future work, my results could be extended through several robustness checks, such as using wild-cluster bootstrap to enhance inference; changing the measure of bank risk, such as to non-performing loan ratio or stock-price volatility; and heterogeneity analysis, for example by examining whether higher capital is more important for some banks than others.

References

Anginer, D., Bertay, A. C., Cull, R., Demirgüç-Kunt, A., and Mare, D. S. (2024). Bank capital regulation and risk after the global financial crisis. *Journal of Financial Stability*, 74:100891.

Benink, H. (2020). Global bank capital and liquidity after 30 years of basel accords. *Journal of Risk and Financial Management*, 13(4).

Cooper, R. and Ross, T. W. (2002). Bank runs: Deposit insurance and capital requirements. *International Economic Review*, 43(1):55–72.

Gorton, G. B. (2012). *Misunderstanding Financial Crises: Why We Don't See Them Coming*. Oxford University Press.

Miles, D., Yang, J., and Marcheggiano, G. (2013). Optimal bank capital. *The Economic Journal*, 123(567):1–37.

Sarin, N. and Summers, L. H. (2016). Understanding Bank Risk through Market Measures. *Brookings Papers on Economic Activity*, 47(2 (Fall)):57–127.

Scott, H. S. (2016). *Connectedness and Contagion: Protecting the Financial System from Panics*. The MIT Press.

Thakor, A. V. (2018). Post-crisis regulatory reform in banking: Address insolvency risk, not illiquidity! *Journal of Financial Stability*, 37:107–111.

World Bank (2025a). Global Financial Development Database.

World Bank (2025b). World Development Indicators.