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Bank Risk Management: A Regulatory Perspective

Nguyen Thi Thieu Quang and Christopher Gan

Abstract

The globalization of financial markets, information technology development, and increasing competition have largely affected bank business and its risk management. Together with these forces, regulatory factors play a significant role. This chapter approaches bank risk management under the regulators' perspective with an emphasis on the risk-based capital regulation. Specifically, how bank risk is regulated under the risk-based capital regulation and whether the regulation shapes bank risk are discussed in detail. In such a way, the chapter provides better understanding of the risk-based capital regulation and bank risk-taking behaviors.

Keywords: Basel Accords, capital regulation, bank risk, risk management, credit risk

1. Introduction

Risk management is important for a bank to ensure its profitability and soundness. It is also a concern of regulators to maintain the safety and soundness of the financial system. Over the past decades, banking business has developed with the introduction of advanced trading technologies and sophisticated financial products. While these advancements enhance bank's intermediation role, promote profitability, and better diversify bank risk, they raise significant challenges to bank risk management. The risk management of banks has been considered to be weak compared to the rapid changes in the financial markets [1]. In the light of the recent global financial crisis, bank risk management has become the major concern of banking regulators and policy makers.

Basel Committee for Banking Supervision (hereafter, the Basel Committee), which was established in 1974 by the central bank governors of G-10 countries¹, acts as the primary global standard setter for banking prudential regulation. The Committee sets international standards and guidelines for national regulators to assess and supervise their banking system. Its landmark publication—the Basel Accord—largely affects the way banks manage their capital and risk as well as the way they are monitored and supervised by the regulators.

This chapter approaches bank risk management under the regulators' perspective with an emphasis on the risk-based capital regulation. Section 2 provides a brief overview about bank risk and risk management. Since the regulation practice in most countries is pretty much based on the guidelines of the Basel Committee, this section primarily follows the Committee's documents. Section 3 introduces

¹ The Group of Ten (G-10) is made up of 11 industrial countries, including Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the UK, and the USA.

the Basel Accords (i.e., Basel I, II, and III), which set the international standards for bank capital regulation, and clearly states how and what types of bank risk are covered by the Accords. Although the Accords, and the capital regulation in general, are expected to discipline the risk-taking behavior of banks, such effect is still under debate. Sections 4 and 5, respectively, present theoretical arguments and global evidences about whether the capital regulation reduces bank risk-taking. For the purpose of the chapter, only risk-based capital regulation is concerned. Section 6 provides a summary of the chapter.

2. Overview of risk and risk management in banking

Bank risk is usually referred as the potential loss to a bank due to the occurrence of particular events. Key risks in banking include credit risk, interest rate risk, market risk, liquidity risk, and operational risk.

Credit risk is “the potential of a bank borrower or counterparty that will fail to meet its obligations in accordance with agreed terms” [2]. Exposure to credit risk is the largest and major source of problems in most banks. Credit risk does not only derive from loans but also from other activities on both banking book and trading book, as well as on- and off-balance sheets. Therefore, credit risk also comprises counterparty risk (the risk that a party in a financial transaction will default).

Interest rate risk (in the banking book) is related to the adverse movements in interest rates of bank assets, liabilities, and/or off-balance sheet items. A change in the interest rate affects a bank’s expected interest incomes and expenses and thus affects its future marginal profits. The Basel Committee [3] identifies three main types of interest rate risk including gap risk, basic risk, and option risk. Gap risk arises from the term structure of the interest rates. Basic risk is related to the relative changes in interest rates for financial instruments with similar tenors but priced using different interest rate indices. Option risk, on the other hand, arises from option derivatives or from options embedded in a bank’s assets, liabilities, and/or off-balance sheet items. This third type is indirect interest rate risk because it depends on the decisions of the bank and/or its customers.

Market risk is “the risk of losses in on and off-balance-sheet positions arising from movements in market prices” [4]. This definition covers both interest rate risk related to instruments and equity marked to market, foreign exchange risk of positions in foreign currencies, and the price risk of commodities that can be traded on a secondary market.

Liquidity risk refers to the bank’s inability to fund the increase in assets and meet obligations at a reasonable cost. Two types of liquidity risk include funding liquidity risk and market liquidity risk. Funding liquidity risk is the risk that the bank cannot meet efficiently current and future cash flow and collateral needs without affecting its daily operations or the financial condition. Market liquidity risk is the risk that the bank is unable to easily offset or eliminate a position at the market price due to inadequate market depth or market disruption [5]. Liquidity risk is inherent in banking since there is usually a maturity mismatch related to bank’s transformation of short-term liabilities into longer-term assets.

Operational risk is “the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events” [6]. Operational risk can arise from any banking products, activities, processes, and systems.

Risk management is important for banks to ensure their profitability and soundness. It is the process established by bank managers to ensure that all risks

Types	Documents	First issued	Last revised
Standards	Core principles for effective banking supervision	Sep 1997	Sep 2012
Guidelines	Corporate governance principles for banks	Sep 1999	Jul 2015
Guidelines	Principles for sound stress testing practices and supervision	May 2009	None
Standards	Basel III: A global regulatory framework for more resilient banks and banking systems	Dec 2010	Jun 2011
Standards	Basel III: The liquidity coverage ratio and liquidity risk monitoring tools	Dec 2010	Jan 2013
Standards	Basel III: The net stable funding ratio	Dec 2010	Oct 2014
Standards	Basel III: Finalizing post-crisis reforms	Dec 2017	None
Standards	Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework—Comprehensive Version	Jun 2004	Jun 2006
Guidelines	Principles for the Management of Credit Risk	Sep 2000	None
Guidelines	Best Practices for Credit Risk Disclosure	Sep 2000	None
Guidelines	Principles for Sound Liquidity Risk Management and Supervision	Feb 2000	Sep 2008
Guidelines	Principles for the Sound Management of Operational Risk	Feb 2003	Jun 2011
Standards	Interest rate risk in the banking book	Sep 1997	Apr 2016

Source: Authors' compilation from Basel Committee's publications (available at <https://www.bis.org/bcbs/publications.htm?m=5%7C28%7C427>).

Table 1.
Basel Committee documents on bank risk management.

associated with the bank's activities are identified, measured, limited, controlled, mitigated, and reported on a timely and comprehensive basis [7]. A sound risk management system is necessary to support the regulators in assessing bank's soundness and to reinforce the market participants' confidence in the banking system. The Basel Committee [1] suggests that a sound risk management system should have: (i) active board and senior management oversight; (ii) appropriate policies, procedures, and limits; (iii) comprehensive and timely identification, measurement, mitigation, controlling, monitoring, and reporting of risks; (iv) appropriate management information systems at the business and firm-wide level; and (iv) comprehensive internal controls.

The Basel Committee sets out a number of standards and guidelines for bank risk management. **Table 1** summarizes main documents related to regulation of bank risk management by the Basel Committee.

3. Regulation of bank risk under the Basel Accords

Bank risk management and capital management are inseparately related to each other. As specified under Principle 15 in Core Principles for Effective Banking Supervision by the Basel Committee [8], the bank's risk management process should be able to assess the adequacy of their capital in relation to their risk profile as well as market and macroeconomic conditions. In a similar way, Principle 16

requires that the capital adequacy requirements should reflect all risks taken and presented by a bank given the markets and macroeconomic conditions that it operates. In such manner, the Basel Accords specify capital requirements to adequately cover bank risks. The following provides details of how and what types of risks are regulated under Basel Accords.

3.1 Basel I

The risk-based capital adequacy standards were introduced by the Basel Committee in 1988 and commonly known as Basel I Accord. The Accord not only sets standards for capital adequacy but also affects the bank's risk management. Initially, only credit risk is addressed since it is the major risk of banks. Under Basel I, banks are required to hold an adequate amount of capital to cover their credit risks related to different categories of on- and off-balance sheet assets. For on-balance sheet assets, the Accord assigns a risk weight ranging from 0, 10, 20, and 50 to 100% on different asset categories. For off-balance sheet exposures, credit conversion factors are applied to different types of off-balance-sheet instruments or transactions based on their estimated size, the likely occurrence of the credit exposure, and the relative degree of credit risk. These credit conversion factors are then multiplied by the weights applicable to the category of the counterparty for an on-balance-sheet transaction to determine the amount of risk-weighted assets [9].

Efforts to address other risks other than credit risk have been made continuously. As a result, Basel I was refined in January 1996 to comprise requirements for market risk which arose from exposures to foreign exchange, traded debt securities, equities, commodities, and options. In measuring market risk, banks are allowed to choose between standardized approach and internal models approach, subject to the approval of the national authorities. By incorporating market risks into the risk framework, Basel Committee clarifies that credit risk requirements exclude debt and equity securities in the trading book and all positions in commodities but include the credit counterparty risk on all over-the-counter derivatives whether in the trading or the banking books [10].

3.2 Basel II

The framework was revised in June 2004, commonly referred as Basel II, with the introduction of operational risk in addition to the existing credit risk and market risk. Under the Basel framework, operational risk includes legal risk but excludes strategic and reputational risk. Basel II provides three available methods to calculate capital charges for operational risk, including basic indicator approach, standardized approach, and advanced measurement approach. The use of standardized approach and advanced measurement approach is subject to supervisory approval [11].

The revised framework also provides more flexibility in calculating capital requirements for credit risk. Accordingly, banks are allowed to choose between standardized approach and internal rating-based approach, depending on which approach is more appropriate for their operations and financial market infrastructure. The credit risk measurement is also more risk sensitive than in Basel I. Specifically, standardized approach is supported by external credit assessments, and the risk weights have a wider range from 0 up to 350% (for the case of securitization tranches that are rated between BB+ and BB-). There is also consideration for past due loans more than 90 days, treatments of credit risk mitigation, and securitization exposures [11].

Despite attempting to capture most risks in the minimum capital requirements, Basel Committee acknowledges that it is impossible to cover all risks. For such reason, they introduce Pillar 2 for Supervisory Review and Pillar 3 for Market Discipline to complement the minimum capital requirement, which is regarded as Pillar 1.

The Pillar 2 aims to treat risks that are not fully included or considered in Pillar 1 such as credit concentration risk, interest rate risk in the banking book, business and strategic risk, and factors external to the bank such as business cycle effects. In addition to ensure that banks have adequate capital to support their risks, Pillar 2 encourages banks to develop and use better risk management techniques. Therefore, banks are required to have an overall capital adequacy assessment process according to their risk profile and a capital maintaining strategy. This involves the board and senior management oversight, a sound capital assessment, a comprehensive assessment of risks, monitoring and reporting, and an internal control review. Bank's self-assessment will be then reviewed and evaluated by supervisors [11].

The Pillar 3 complements the other two pillars by requiring banks to disclose information about their scope of application, capital, risk exposures, risk assessment processes, and the capital adequacy. The disclosure is expected to inform the market about the bank's risk exposures and provide a consistent and understandable framework that enhances the comparability among banks [11].

The 2004 Basel framework focuses primarily on the banking book. More attention to trading book as well as exposures to the *double default* is expressed in a consensus document released in July 2005 [12]. Accordingly, the Basel Committee provides detailed treatment of counterparty credit risk and cross-product netting, treatment of double-default effects, short-term maturity adjustments in the internal rating-based approach, improvements to the current trading book regime, and specific capital treatment for failed transactions and transactions that are not settled through a delivery-versus-payment framework. These changes ensure the risk sensitivity of capital requirement for credit risk and market risk in Pillar I, as well as enhance the requirements for bank's internal capital adequacy assessment and market disclosure, particularly for the counterparty credit risk, concentration credit risk, and trading book. The document was then incorporated into the existing framework in June 2006 [4].

3.3 Basel III

The massive failure of the banking system during the global financial crisis 2007–2009 forced the revision of Basel II. Consequently, Basel III was issued in mid-December 2010 and consequently revised in June 2011. The new framework enhances the risk coverage in three Pillars, particularly credit risk and market risk by raising capital requirements for the trading book and complex securitization exposures, introducing a stressed value-at-risk (VaR) capital requirement based on a continuous 12-month period of significant financial stress, requiring higher capital charges for so-called resecuritizations in both the banking and the trading books and strengthening the capital requirements for counterparty credit exposures arising from banks' derivatives, repo, and securities financing activities [13].

Basel III also introduces liquidity requirements to address bank's liquidity risk, which was considered as not properly managed during the early phase of the financial crisis in 2007. Two minimum standards for funding, namely, liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR), are proposed. These two standards are designed to promote both short-term and long-term resilience

of a bank's liquidity risk profile. Specifically, the LCR ensures that the bank has sufficient high-quality liquid resources to survive an acute stress scenario lasting for 1 month. And the NSFR creates additional incentives for a bank to fund its activities with more stable sources of funding on an ongoing structural basis (1 year). In supporting supervisors to monitor banks' liquidity risk profiles, Basel Committee develops a set of common metrics to be considered as the minimum types of information for supervisors. These include contractual maturity mismatch, concentration of funding, available unencumbered assets, LCR by currency, and market-related monitoring tools [13]. The regulation on liquidity risk was revised in January 2013 for the liquidity coverage ratio and liquidity risk monitoring tools and in October 2014 for the net stable funding ratio [14, 15].

In December 2017, the Basel Committee completed its Basel III post-crisis reforms. Accordingly, the revised framework enhances the robustness and risk sensitivity of the standardized approaches for credit risk and reduces the reliance of its external credit ratings. The use of internally modeled approaches is more constrained. For operational risk, the framework replaces the advanced measurement approaches and the existing three standardized approaches with a single risk-sensitive standardized approach. The new standardized approach is determined based on bank's income and bank's historical losses [16].

4. The effect of risk-based capital requirements on bank risk behavior

The risk-based capital requirements aim at creating a discipline for bank risk behavior, through which they help ensure the global financial stability. However, there are controversies whether they shape bank risk. Since the introduction of Basel Accord in 1988, continuing efforts have been concentrated on showing how these risk-based capital requirements affect bank risk. Studies fall into four theories, which focus on different factors to explain bank risk behavior. These factors include moral hazard, franchise value, capital buffer, and agency problem.

4.1 Moral hazard theory

Given the limited capital and the existence of information asymmetry, banks are induced to take excessive risk. This is often regarded as the moral hazard problem, whereby one party to a transaction engages in activities detrimental to the other party [17]. The problem is exacerbated with the existence of the deposit insurance. In order to improve the depositors' confidence in the banking system and stabilize the financial system, the government usually provides banks with the deposit insurance (either implicitly or explicitly). Under the protection of deposit insurance, the depositors incur no risk of depositing into the bank. Thus, they lose incentives to monitor bank operations. Consequently, banks have incentives to take greater risks. Therefore, researchers examining the effect of risk-based capital requirements on bank risk-taking in a context of the moral hazard focus on the limited liability of banks and the existence of the deposit insurance. However, using different models and assumptions, these studies arrive at different conclusions. Negative effect of capital requirements on bank risk-taking is suggested by Kim and Santomero, Flannery, Furlong and Keeley, Gjerde and Semmen, and Zweifel, Pfaff, and Kühn [18–22]. However, Gennotte and Pyle and Rochet suggest a positive effect [23, 24]. Mixed result is proposed by Calem and Rob, Blum, and Silva [25–27].

Kim and Santomero [18] adopt a single-period mean-variance model, which assumes that banks are single-period risk-averse expected utility maximizers.

The bank's objective function is to maximize the utility, which depends on the mean and standard deviation of return on equity. The capital requirements will set a bound on the bank's expected return on equity and alter its choices of risk and return. Consequently, bank hesitates to extend credit to assets with high-risk weights and shuffles the asset portfolio toward more safe assets and less risky assets.

Flannery [19] explains the effect of risk-based capital requirements on bank risks by unifying the above utility function with an option price function. The option price function regards deposit insurance as a put option, which the bank can maximize by selecting the riskiest available asset portfolio. The model assumes that bank asset decision is two periods and bank chooses a loan portfolio that maximizes its expected return on equity. This return is affected by the value of the deposit insurance option, which depends on the permissible leverage. The capital requirements penalize higher risk with more capital, which imply a negative relationship between risk and leverage. In such way, the capital requirements lower banks' preferred loan risk while they pursue high portfolio risk to maximize the deposit insurance's put option value.²

Furlong and Keeley [20] employ both state-preference model and option model. In the state-preference model, the authors consider an insured bank that aims to maximize its current value of equity through two possible future states. With a given initial capital, the bank that seeks to maximize the current value of its equity will try to maximize the value of the deposit insurance option. This is equivalent to the option model, in which the bank's objective is to maximize the value of the deposit insurance. This can be done by maintaining the highest degree of leverage (i.e., the lower capital ratio) allowed by the regulation and increasing asset portfolio risk. The gain from increasing asset risk depends on the asset size rather than the leverage. However, the change in leverage directly affects the asset size. Therefore, the marginal gain from increasing asset risk is positively correlated to the leverage change. This means that lower leverage caused by the capital requirements will reduce the bank's marginal gain from increase in asset risk and, thus, reduce bank's incentive to increase asset risk. In addition, for a given level of leverage, the insurance subsidy's value is positively correlated with asset volumes. This suggests that bank prefers to increase capital rather than shrinking assets and retiring deposits to reduce the leverage. In such way, they can maximize their asset volume and, thus, the value of the insurance subsidy.

Using the same two-period state-preference model, Gjerde and Semmen [21] extend Furlong and Keeley's study [20] by examining both risk-based capital requirements and leverage restriction. They show that under the leverage restriction, bank managers maximize both the leverage up to the regulator's restriction and the asset risk to exploit the most benefit of the deposit insurance. However, the total value of the bank is a negative function of the risk-based equity ratio. The higher risk-based equity ratio reduces the possible investment in riskiest asset and, thus, lowers the value of deposit insurance. Therefore, with a constrained amount of equity, banks will minimize the leverage to be able to invest in high-risk assets. When the amount of equity is not constrained, bank managers will increase the equity until all funds are invested into the riskiest assets. The authors add that either minimum leverage ratio or risk-based capital ratio is efficient in regulating bank risk if the risk weights are optimal. However, if there is suboptimal risk weights (which is very likely in practice), a combination of both requirements is necessary to control bank portfolio risk.

² This is because bank portfolio choice not only depends on the regulation but also other factors such as monopoly power, liquidity, scale or scope of economies, risk aversion, or special information availability.

Nevertheless, the reducing-risk effect of capital requirements is not always supported. Gennotte and Pyle [23] depart significantly from previous research by relaxing the assumption about bank assets as zero net present-value projects and show that under certain circumstances, increased risk-based capital requirements lead to higher asset risk. Arguing that evaluating and monitoring loans are costly, the authors assume that bank assets are nonzero net present-value investments. The bank determines its optimal asset portfolio based on the tradeoff between the portfolio's net present value and subsidy value. Bank's response to the increase in capital requirements depends on the sign of the net present value of the asset portfolio, which is a function of the asset risk and the level of investment. Although the market value of bank equity decreases with an increase in asset risk under tightened capital requirements, if the net present value of the asset portfolio is sufficiently negative and large, bank can offset this decrease by increasing the risk and reducing the level of investment simultaneously. Thus, bank asset portfolio comprises both relatively safe assets and risky assets with higher fraction of riskier assets.

Taking into consideration the limited liability of banks, Rochet [24] claims that the constraint in capital ratio can induce banks to choose very "extreme" asset portfolios with specialization on some assets. This negative effect eventually dominates the risk aversion characteristic, and even correct risk weights cannot prevent banks from inefficiently asset allocations.

Arguing that static framework, as in aforementioned studies, might neglect the intertemporal consequences of risk-taking behaviors of banks and preclude cross-sectional predictions of banks with different capital positions, Calem and Rob [25] develop a dynamic model which allows for the variation of bank's capital position over time and across banks to predict bank risk-taking behavior under the capital regulation. In this model, banks are considered to operate in a multi-period setting and aim to maximize the discounted value of their profits. In each period, based on a specific capital position, the bank will determine its portfolio by choosing between its safe and risky assets. From this portfolio choice, the bank's returns are realized. This realization of returns together with the preexisting capital position would then determine the next period's capital position. The process is carried out in such a way that the bank faces the same portfolio choice with different capital positions in each period and equivalently for different banks with different capital positions. Calibrating the model using empirical data on the US banks in 1984–1993, the authors show that under increasingly stringent capital requirements, the level of bank's risk-taking depends on the bank's current capital position with a roughly U-shaped relationship, and bank risk-taking is restrained only if the risk-based capital standard is stringent enough.

In terms of the dynamic of capital regulation, Blum [26] analyzes the effect of capital regulation on bank risk-taking in a multi-period framework. The author shows that if the bank faces capital requirement only in the first period, it would decrease the risk due to the increase in equity. However, tightening capital ratio in the second period generates two possible effects. First, it lowers the expected profit of the banks. Bank managers are induced to take more risk with the perception that they have less to lose in the case of bankruptcy. Second, the binding regulation increases the marginal return on risk and reinforces the first effect. Consequently, the overall risk of regulated banks goes up. Silva [27] completes Blum's model by providing the computed values of the threshold requirements for which the risk chosen by the bank converges to the zero bankruptcy cost and social optimum. These values, in turn, depend critically on the initial equity of the bank. The author confirms that constant capital requirements could efficiently reduce bank's

risk-taking and thus achieve the zero bankruptcy cost as well as socially efficient level of risk. However, this effect requires a very high level of capital requirement, which might not be practicable.

Recently, Zweifel et al. [22] consider bank's objective as maximizing the risk-adjusted return on capital (RAROC). The model assumes that bank's optimal capital level is determined through a three-stage process. In the first stage, the bank faces exogenous shocks on expected return and volatility, which affects its solvency-level adjustment in the second stage in a way of maximizing the RAROC. In the third stage, the bank rebalances its assets in response to changes in the solvency level by choosing new values for expected returns and risk. An internal efficiency frontier is formed with its slope depending on the capital regulation such as Basel I and Basel II. Against the expectation that these regulations can reduce the slope of the efficient frontier (i.e., banks choose lower expected return and volatility), the study shows that both Basel I and Basel II may lead banks to choose higher-risk positions than it would otherwise. The risk is likely to increase even in the case of Basel III regulation.

4.2 Franchise value theory

The capital requirements are expected to reduce bank's excessive risk-taking. However, analysis under the moral hazard theory does not always support this argument. A substantial part of researchers has relied on the franchise value to explain the effect of risk-based capital requirements on bank risk-taking. Franchise value is the accumulated present value of a bank's expected future profits if it operates continuously and represents an opportunity cost if the bank goes bankrupt [28]. The higher the franchise value, the more the bank stands to lose by becoming insolvent. In contrast, with no franchise value, the bank has nothing to protect and no worry about bankruptcy. Two main sources of bank's franchise value are *market-related* and *bank-related* factors [29]. *Market-related* factors such as competition environment, legislation restrictions, and technology innovation create the differences in franchise value in banks across geographic or product markets, while *bank-related* factors can originate from efficiency variations in bank operations, relationship management, or branch networks. Researchers under franchise value theory usually take into account the competition of the banking environment to explain the effect of capital requirements on bank risk.

With the notion that competition contributes to the erosion of bank's franchise value and reduces its motivation to take less risk, Hellmann [30] investigates the effect of capital standards in the environment of competition. They argue that capital requirements reduce bank's moral hazard by putting their equity at risk, which they regard as the capital-at-risk effect. However, they can have adverse effect by harming bank's franchise value due to lower per-period future profits and thus induce them to take more risk. The latter consequence is known as franchise-value effect. Liberalization will intensify the competition among banks and encourage them to offer inefficient deposit rates to steal shares from their competitors. In such event, bank can only increase their franchise value by gambling. Therefore, capital requirements in a competitive deposit environment cannot make banks pursue a prudent investment strategy. The authors then suggest that a combination of deposit rate ceiling and capital requirement will help address the problem.

This effect is reexamined by Repullo [31] but in an explicit model of imperfect competition. The author discovers that the Hellmann's conclusion [30] is only true in the case of a very competitive deposit market where intermediaries can earn low return margins. In markets where banks can earn an intermediate margins, they can

invest in both risky and safe assets. In the extreme case of monopolistic markets, only prudent investments exist. Moreover, if the cost of capital due to the increase in capital requirements exceeds the returns of the safe asset, capital requirements are always effective in preventing banks from taking excessive risks. This is because banks can fully transfer all the cost of higher capital requirements to the depositors. This makes the equilibrium expected margins unchanged and so does the franchise values. In such case, the increased capital reduces the equilibrium deposit rate in a way that the bank's franchise value does not vary and, thus, reduce bank's incentive to take very risky assets.

Following Repullo's approach [31], Zhang et al. [32] show that bank franchise value decreases with an increase in the capital ratio. With the enforcement of capital requirements, the bank holds a capital ratio as near the minimum capital requirement as possible to maximize its franchise value. In maximizing the franchise value, bank invests less in risky assets with an increase in the capital ratio. Consequently, capital requirements are effective in changing bank risk preference and reducing bank's incentive to take risk.

Behr [33] also examines how stricter capital requirement affects bank's risk-taking in different market structures. The results bear a slight resemblance to Repullo [31] except for the case when the bank operates in a moderate competitive environment. The difference may be in the assumption of the objective functions of the bank. Behr [33] shows that in low concentrated markets, banks have low franchise values. The bank's objective in such an environment is to maximize the short-term profits and, thus, have great incentives to take risks to increase the franchise values. Therefore, capital requirements will play the discipline role to reduce bank's risk-taking. On the other hand, in highly concentrated markets, the banks do not have to compete severely with each other, and their franchise values are higher. The bank's objective now is not only to maximize the short-term profits but also the expected future profits, which are the franchise values. Bank, therefore, will be less induced to engage in high-risk assets as they would threaten its high franchise values. The role of capital regulation in this case becomes less clear.

4.3 Capital buffer theory

Extending from the franchise value literature, emerging studies have focused on the dynamic of bank's franchise value, which forms a new theory of bank behavior under capital regulation—capital buffer theory. Accordingly, there are costs in changing the level of capital and falling below the required capital level. These costs can be implicit or explicit. Implicit costs can arise from the regulatory intervention to limit the likelihood of a deposit insurance, whereas explicit costs refer to the regulators' restrictions or penalties due to noncompliance with the minimum capital requirement or even liquidation [34]. In order to avoid these costs, banks have incentives to hold a buffer above the minimum capital requirement.

Taking into account this incentive effect of capital regulation, Milne and Whalley [35] show that bank's attitude toward risk depends on its capital buffer and that in the long run, the capital regulation has no impact on bank risk behavior. However, this is true only when deposit is not remunerated. When allowing for deposit repayment, an increase in capital requirements increases bank's franchise value³ and affects the desired capital buffer. The risk-taking incentive

³ This is because capital is viewed as an endogenous response to capital regulation. This means that an increase in capital constraint leads to bank recapitalization either through reducing dividend or issuing new equity. Although the shareholder value declines, the present value of all future expected payments to shareholders is higher. Therefore, higher capital requirements are associated with higher franchise value.

is thus reduced. But if the bank has adequate earnings, capital requirements exert little impact on bank risk-taking. In the short run, the bank risk behavior is similar to the prediction of franchise value theory. Specifically, fully capitalized banks, which have successfully built up the desired level of capital, are insured against the cost of recapitalization and liquidation, so they aim to minimize the cash flow uncertainty and be risk-averse. However, if those banks suffer from severe deterioration of cash flow but not so much to destroy the value of shareholder, they will take greater risk to avoid costly equity issuance. Whereas, banks with less than minimum required capital (normally when regulatory audit is random) are under the threat of regulation intervention and thus, become risk lovers to maximize the cash-flow uncertainty.

Milne [36] examines this incentive effect of capital requirements on bank's portfolio choice. The author shows that in the short run, banks struggling to meet the regulatory capital requirements will reduce the holding of highly risky assets, while well-capitalized banks face little pressure from regulatory in allocating their portfolio. An exceptional case is failing banks which consider the capital regulation breaches as unavoidable and choose their portfolio without regarding the effect of the regulation. However, to the extent that the value of bank assets can be realized (e.g., through loan trading or securitization), the risk-based capital requirements have no impact on bank's portfolio choice. In the medium term, banks raise capital until the marginal expected cost of breaching the regulatory requirement equals the marginal financing cost of equity and debt. The effect of capital requirements on bank's asset portfolio, thus, depends on the marginal costs of debt and equity finance.

4.4 Agency problem theory

While higher capital level can help reduce the conflicts between the bank's shareholders and debt holders, in this case the depositors, it may reinforce the conflicts between the shareholders and the managers [37]. In banking, the shareholders normally delegate the operations of the bank to the managers. Both parties aim to maximize their benefits, and it would be difficult for the shareholders to ensure that the managers are acting in the best interests of the shareholders. The agency problem refers to the divergence in the interest of managers and shareholders when managers indulged to maximize their own utility rather than the bank value [38].

Besanko and Kanatas [39] argue that the underpriced deposit insurance adds to the bank's surplus from lending. This motivates bank's managers to manage the loans efficiently in order to realize the surplus (i.e., when loans are repaid). However, increasing capital requirements lead to higher cost of fund which reduces the managers' surplus. Together with the issuance of new equity to satisfy the higher capital standards, the insiders' ownership is diluted sufficiently to reduce their incentives to make effort in monitoring the loans. This negative effect of enforced capital requirements can be greater than the benefit of asset substitution by requiring the shareholders to have more capital. The net effect is a rise in the overall riskiness of bank assets.

Taking the effect of general equilibrium into concern, Gale [40] also suggests that increasing capital requirements may have adverse effect on bank risk-taking. Given the nature that the manager's private benefit can be damaged if the bank goes bankruptcy, the managers have incentives to be risk-averse. They will aim to maximize the probability of the success state of the investment subject to the bank's capital constraints. Hence, they will choose the asset with the lowest return but larger than the case without capital constraint. Given the high-risk, high return assumption, the bank risk will increase.

Incorporating the difference in manager’s incentives with those of the shareholders and deposit insurers in a model with four distinct characteristics on the risk-return asset profiles, Jeitschko and Jeung [41] show that under capital regulation, the bank risk varies with the relative forces of these agents. If the shareholder’s objective dominates, the bank risk might decrease with higher capital requirement. In contrast, a manager-driven bank is inclined to undertake more risk under tightened capital requirements because in such case, the manager’s private benefit is larger with the increase in asset risk.

5. Global evidences

Reviews of theoretical models that explain the effect of capital requirements on bank risk behaviors show that the prediction of these models highly depends on model assumptions. This makes the results vary when certain assumptions are relaxed. Thus, a substantial effort has relied on empirical evidences to investigate the effect of the risk-based capital regulation on bank risk-taking. Most researches are carried out in the USA and the European countries, which are members of the Basel Committee. The results, however, differ across countries and time period (see Table 2).

Country	Time period	Authors	Risk proxy	Capital regulation proxy	Effect of capital regulation on risk
The USA	1990–1991	Jacques and Nigro [42]	Risk-weighted asset ratio	Gap approach	+ No effect for undercapitalized banks + Negative effect for well-capitalized banks
The USA	1990–1997	Aggarwal and Jacques [43]	Risk-weighted asset ratio	Dummy approach	+ Positive and no effect before 1993 + Negative effect during 1993–1996
The USA	2000–2005	Teply and Matejasák [44]	Risk-weighted asset ratio	Gap and Probabilistic approach	+ Negative effect for undercapitalized banks + No effect for well-capitalized banks
The USA	2003–2006	Abreu and Gulamhussen [45]	Risk-weighted asset ratio	Dummy and gap approach	Positive effect
Switzerland	1989–1995	Rime [46]	Risk-weighted asset ratio	Dummy and probabilistic approach	No effect
Germany	1994–2002	Heid et al. [47]	Risk-weighted asset ratio	Probabilistic and rolling-window approach	+ Negative effect for banks with low capital buffer + Positive effect for banks with high capital buffer
The USA, Canada, France, Italy, the UK, Japan	1988–1995	Van Roy [48]	Risk-weighted asset ratio	Probabilistic approach	No effect

Country	Time period	Authors	Risk proxy	Capital regulation proxy	Effect of capital regulation on risk
Italy	1994–2003	Cannata and Quagliariello [49]	+ Risk-weighted asset ratio + Bad debt ratio	Dummy approach	+ Positive effect for risk-weighted asset ratio + No effect for default risk
EU 15	2000–2005	Teply and Matejasák [44]	Risk-weighted asset ratio	Gap and Probabilistic approach	No effect
17 EU countries	1992–2006	Camara et al. [50]	+ Risk-weighted asset ratio + Nonperforming loan ratio + Default risk + Z-score	Dummy approach	+ Positive effect for highly capitalized and undercapitalized banks + Negative effect for adequately and strongly undercapitalized banks
G-10 Countries	1995–2005	Saadaoui [51]	Nonperforming loan ratio	Gap approach	No effect
India	1997–1998	Nachane and Saibal [52]	Risk-weighted asset ratio	Gap approach	No effect
China	2004–2006	Zhang et al. [32]	Risk-weighted asset ratio	Gap approach	No effect
Indonesia	2000–2005	Parinduri and Riyanto [53]	Risk-weighted asset ratio	Dummy and Probabilistic approach	Negative effect
42 Asian countries	1994–2008	Lee and Hsieh [54]	+ Variance of ROE + Loan loss reserve ratio	Capital regulatory index	+ Positive effect for variance of ROE + Negative effect for loan loss reserve ratio
Tunisia	1992–2005	Bouri [55]	+ Risk-weighted asset ratio + Loan loss provision ratio	Gap approach	+ Positive for risk-weighted asset ratio + No effect for loan loss provision ratio
Tunisia	2000–2013	Bouheni and Rachdi [56]	Risk-weighted asset ratio	Probabilistic approach	No effect
Brazil	2001–2009	Pereira and Saito [57]	Risk-weighted asset ratio	Dummy approach	Negative effect
Emerging markets	1996–2001	Godlewski [58]	Nonperforming loan ratio	Dummy and gap approach	+ No effect for dummy approach and for well-capitalized banks under gap approach + Negative effect for undercapitalized banks under gap approach
Emerging markets	1995–2005	Saadaoui [51]	Nonperforming loan ratio	Gap approach	Positive effect
Developing countries	1994–2002	Hussain and Hassan [59]	Risk-weighted asset ratio	Gap approach	Negative effect

Country	Time period	Authors	Risk proxy	Capital regulation proxy	Effect of capital regulation on risk
The US and non-US developed and developing countries	2003–2009	Lin et al. [60]	Nonperforming loan ratio	Probabilistic approach	Negative effect
GCC countries	1996–2011	Ghosh [61]	Z-score	Dummy approach	No effect
MENA countries	2004–2012	Bougatef and Mgadmi [62]	Loan loss provision ratio	Dummy approach	No effect
11 Dual banking countries	2006–2010	Alam [63]	Loan loss reserves ratio	Capital regulatory index	Negative effect
107 Countries	1999	Barth et al. [64]	Nonperforming loan ratio	Capital regulatory index	Negative effect

Notes: + Gap approach measures capital regulation as the distance of bank capital ratio from certain threshold, usually the minimum capital requirement.
+ Dummy approach assigns value 1 for banks whose capital ratios are less than certain threshold and 0 otherwise.
+ Probabilistic approach assigns value 1 for banks which are probably to be under regulatory pressure and 0 otherwise.

Table 2.
Global evidences about the effect of capital regulation on bank risk.

6. Conclusion

Efficient risk management is crucial for banks to ensure their profitability and maximize the shareholder’s value. Over the past decades, the risk management practice has changed dramatically under the forces of the business environment and technology development. An important factor contributes to the way banks manage their risk is the regulation. This chapter shows how the regulators regulate bank risk with an emphasis on the risk-based capital regulation. It also reviews theoretical studies on how the risk-based capital regulation affects bank risk-taking. These studies explain the effect of capital regulation on bank risk considering different factors such as moral hazard, franchise value, capital buffer, and agency problem. The prediction of these studies is restricted by and depends on model assumptions. The chapter also provides empirical evidences from countries worldwide and shows that the effect of capital regulation on bank risk is not homogenous among countries.

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Author details

Nguyen Thi Thieu Quang¹ and Christopher Gan^{2*}

¹ Faculty of Banking, University of Economics, The University of Danang, Danang, Vietnam

² Faculty of Agribusiness and Commerce, Lincoln University, Christchurch, New Zealand

*Address all correspondence to: christopher.gan@lincoln.ac.nz

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