THE IMPACT OF CAPITAL STRUCTURE ON BANK PERFORMANCE IN THE EURO AREA

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ABSTRACT

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Abstract
This master's thesis studies how banks have adapted to stricter capital requirements and what effect the level and structure of capital has on bank's performance. The empirical study covers an extensive data of 308 euro area banks over the period 2005-2020. The capital structure is examined both as a level of total capital in relation to risk-weighted assets and divided to the bank-specific capital requirement and the voluntary buffer exceeding it. Bank performance, on the other hand, is measured in terms of income in relation to both total assets and risk-weighted assets. Based on the results of an empirical study, the level of total capital has a positive effect on large banks, while no effect on small and medium-sized banks is observed. Capital requirements, on the other hand, have a positive effect on the performance of both small and large banks, but the effect on medium-sized banks is considerably negative. Voluntary capital has a positive effect on the returns of small and large banks. Overall, the positive impact of capital on performance is highlighted in terms of risk-adjusted returns, so it can be concluded that an increase in the level of capital will improve banks' risk tolerance in business. The impact of capital levels and minimum capital requirements on medium-sized banks is clearly different from that of small and large banks, and it would be interesting for further research to examine which factors in the group of medium-sized banks contribute to this. In addition, the control variables show that the performance of banks of different sizes reacts differently to changes in monetary policy and the macroeconomic environment.

Key words
Basel III, bank capital, bank performance

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Tiivistelmä – Abstract

Tässä pro gradu -työssä tutkitaan, miten pankit ovat sopeutuneet tiukempiin pääomavaatimuksiin ja miten pääoman taso ja rakenne vaikuttavat pankkien tulokseen euroalueella. Empiirisessä tutkimuksessa käytetään laajaa, 308 euroalueen pankkia kattavaa aineistoa ajanjaksolta 2005-2020. Pääomarakennetta tarkastellaan sekä kokonaispääomatasona suhteessa riskipainotettuihin varoihin, että jaettuna pankkikohtaiseen pääomavaatimukseen ja sen ylittävään, vapaaehtoiseen puskuriin. Pankin suorituskykyä taas mitataan tuotoilla suhteutettuna sekä kokonaisvaroihin että riskipainotettuihin varoihin. Empiirisen tutkimuksen tulosten perusteella kokonaispääoman tasolla on positiivinen vaikutus suuriin pankkeihin, kun taas pieniin ja keskisuuriin vaikutusta ei havaita. Pääomavaatimukset taas vaikuttavat positiivisesti sekä pienten että suurten pankkien suorituskykyyn, mutta keskisuuriin pankkeihin vaikutus on huomattavan negatiivinen. Vapaaehtoinen pääoma vaikuttaa positiivisesti pienten ja suurten pankkien tuottoihin. Kaiken kaikkiaan pääoman positiivinen vaikutus suorituskykyyn korostuu riskikorjatun tuoton osalta, joten voidaan päätellä, että pääomatason nousu parantaa pankkien riskinsietokykyä liiketoiminnassa. Pääomatason ja minimipääomavaatimusten vaikutus keskikokoisiin pankkeihin eroaa selvästi pienistä ja isoista pankeista, ja jatkotutkimuksen kannalta olisi mielenkiintoista tutkia, mitkä tekijät keskikokoisten pankkien ryhmässä vaikuttavat tähän. Lisäksi, kontrollimuuttujien avulla havaitaan, että erikokoisten pankkien suorituskyky reagoi toisistaan poikkeavalla tavalla muutoksiin rahapolitiikassa ja makrotaloudellisessa ympäristössä.

Asiasanat
Basel III, pankkipääoma, pankkien suorituskyky

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1 INTRODUCTION

The operating environment for banks has changed enormously in recent decades. Substantial to the change has been the need to harmonize banking legislation between countries and regions, and to make the banking system more resilient to shocks and crises through regulation, as the consequences are known to flow very quickly from banks to the wider economy. The Basel Committee has been in the core of providing guidelines and standards for banking on the global level. The key element of the 1988-published Basel I framework was the 8% capital requirement to risk-weighted assets. Basel II, launched in 2004, provided more sophisticated tools for risk determination, among other developments. However, it was unable - or, was simply released too late - to prevent the outbreak of the financial crisis in 2008. Before the global financial crisis, banks tended to adjust to stricter capital requirements by raising the level of lowest quality capital, so that they could minimize the costs of complying with capital requirements (Francis and Osborne, 2012).

The change in banking regulation following the 2008 crisis and the Basel III framework has emphasized the importance of both the quantity and quality of capital. The new regulatory requirements strive to guarantee banks' ability to continue operations especially in the event of disruption. Significant extensions on Basel III framework compared to its predecessor are new policy tools, such as special requirements for global systemically important banks (G-SIBs), constraints for leverage ratios, conservation and countercyclical buffers, and the division of Tier 1 capital into two sub-categories of capital, allowing improvements in capital quality standards.

At the same time as bank capital requirements have tightened, banks' traditional net interest income-based business model has had to adjust to a long period of negative interest rates. Negative interest rates and higher capital requirements may drive banks to increase the risk in lending activities in order to obtain higher interest income, and push banks to increasingly favor private sector loans on their balance sheets over government loans. The current Basel III framework requires bank capital levels to reflect their risk more than before. It is worth considering whether the business environment for banks is becoming too challenging to maintain high performance at all with the increasing regulation.

There is no consensus of the capital level that maximizes performance, and the evidence speaks both for and against of tightened capital requirements, in terms of bank performance. For the most part, recent studies prove that higher bank capital is in favor of bank survival and performance, and it contributes to the ability of banks to resume their normal business in the times of crisis (see, for example, Jordà, Richter, Schularick & Taylor, 2021; de Bandt, Camara, Maitre & Pessarossi, 2018; Coccorese & Girardone, 2021).

The purpose of this study is to investigate the relationship between bank capital ratio and performance, and whether the effect of capital on performance stems from capital requirements or voluntary capital. In this study, voluntary capital refers to the difference of total capital and regulatory capital requirement. The unbalanced panel data used in this study covers 308 eurozone banks from 2005 to 2020. Banks are divided into three size groups based on total assets, which allows to analyze the differences in the factors that affect the performance of banks of different sizes. Noteworthy, Berger and Bouwman (2013) point out that the importance of capital level on performance for banks of different sizes is essential information for the decision-making of regulators. The data period of 2005-2020 is interesting because it involves the transition from Basel I to Basel II and further to Basel III, i.e., the tightening of capital requirements. In addition, it includes the financial crisis of 2008, the eurozone sovereign debt crisis and the start of the COVID-19 pandemic. During this period, interest rate developments have also been exceptional.

Bank performance is measured by return on average assets (ROAA), which has also been used by de Bandt et al., (2018), Le et al. (2020) and Bagntasarian and Mamatzakis (2019), among others. Another performance indicator used is return on risk-weighted assets (RoRWA), which improves the comparability of banks' ability to generate returns, and it also captures the impact of variables on the riskiness involved in banks' business. In addition, the effects of bank lending and its riskiness, monetary policy, bank strategy and riskiness in the banking environment are controlled in the mathematical model.

The empirical research proceeds in two stages, in the first of which the variable describing capital is the ratio of total capital to risk-weighted assets. In the second stage, the total capital ratio is divided into two parts: the bank-specific capital requirement and voluntary capital. This is the first study to examine the importance of voluntary capital using such a large eurozone bank data.

The effect of total capital on performance differs between banks of different sizes. For small and medium-sized banks, total capital ratio has no noticeable effect on performance. However, capital proves to be a significant variable on bank performance when, in the second part of the empirical study, total capital is divided into bank-specific capital requirements and voluntary capital. For the small banks, voluntary capital has a slight positive effect on both performance measures. Capital requirement appears to have a high, positive impact on ROAA of small banks, but this impact disappears for RoRWA. Voluntary capital does not result in any statistically significant effect on bank performance of medium-sized banks, whereas capital requirement has a negative impact, accentuated on RoRWA. This outcome highlights the differences between bank size groups and also raises the question of whether there is a distinguishing factor in the characteristics of banks of different sizes that is not controlled in this study. Both voluntary capital and capital requirement have a positive relation with performance of large banks, and the effect is emphasized on RoRWA. The results strongly indicate that the division of total capital ratio into the capital requirement and the voluntary part better explains performance of banks of different sizes.

This thesis is structured as follows: chapter 2 covers the concept of bank capital and the development of the Basel framework from Basel I to Basel III, as well as a summary of the main content of the current Basel III framework. Chapter 3 reviews the literature on the relationship between capital level, capital structure and bank performance, and chapter 4 focuses on the literature regarding voluntary capital. Chapter 5 describes the data, method and variables used, and chapter 6 presents and discusses the results by mirroring them with previous findings. Conclusion is drawn in chapter 7.

2 BANK CAPITAL AND BASEL PROCESS

The need for regulatory requirements for minimum capital stems from, as in Berger, Herring & Szegö (1995), the costs of bank downfalls for governments, taxpayers, real economy and financial system. Regulation that harmonizes banking at the global level ensures that a competitive advantage in banking is not sought by applying for the lowest possible capital requirements.

2.1 Basel Committee on Banking Supervision

The financial market distress that followed the collapse of the Bretton Woods system caused extensive exchange rate losses for several banks, and various banks also went bankrupt. In response to this and other financial market turmoil, the Central Bank directors of G-10 countries set up a new committee in 1974, later renamed the Basel Committee on Banking Supervision. The main objective of the Committee was and continues to be to increase and improve the quality and competence of banking supervision worldwide with an ongoing process in order to achieve financial stability (Bank for International Settlements [later BIS], 2014.) The recommendations of the Basel Committee have become globally an integral part of the banking regulation. A key part of the resulting regulation concerns minimum capital level and the principles of its determination, as well as the quality of capital. The work of the Committee is an ongoing process that aims to improve the stability of banks and financial markets worldwide.

2.2 Definition of Capital

Bank capital refers at its simplest to the difference between bank assets and liabilities, also referred as net worth. Bank capital enables a bank to withstand unexpected losses, thus it functions as a buffer against losses. Strong capital structure allows a bank to continue its normal operations despite losses, and it guarantees a bank's survival in the event of a borrower's insolvency, as well as the impairment of a bank's assets. Capital protects creditors in the event of bank liquidation, but also prevents the bank from drifting to bankruptcy. A bank's need for capital depends mainly on its level of risk, i.e., the higher the risks associated with its business, the higher is the capital needed. In order to determine the need for capital, banks constantly assess the risks and potential losses in different areas, and the supervisory bodies review and evaluate banks' assessments.

2.2.1 Regulatory Capital

Within Basel Accords, regulatory capital consists of Tier 1 capital and Tier 2 capital. Tier 1 capital is going-concern capital, and its function is to cover bank's regular business activities as soon as they are incurred. Tier 1 capital is divided into two categories, the first of which is common equity Tier 1 capital (CET1), which comprises common shares and stock surplus, retained earnings, accumulated other comprehensive income and other reserves. Additional Tier 1 capital (AT1) also works to cover current expenses on going-concern basis, but its criteria is not as strict as for CET1. There are some debt instruments, for instance, that are included in AT1, but do not meet the conditions of CET1. Tier 2 capital is gone-concern capital with a criterion less stringent than those for AT1. Tier 2 consists of, for instance, subordinated debt and general loan-loss reserves. (BIS, 2021a.)

2.2.2 Capital Adequacy Ratio

Minimum capital requirement in the Basel Accords defines the ratio of capital to bank risk, and this is also known as capital adequacy ratio (CAR). CAR is calculated as capital to risk-weighted assets. Risk-weighted assets mean that safer assets require less capital, while riskier assets are more risk-weighted. Therefore, the riskier the assets, the more capital a bank must hold against it. In this thesis, the term capital level refers to total bank capital as a percentage of risk-weighted assets. The methods for determination of the amount of risk-weighted assets are discussed later in this chapter.

In order to increase the capital level, a bank can either increase an own funds-item, for example, by not distributing profits to shareholders, or by reducing the risk-weight in the asset portfolio.

2.3 Basel I

The Basel I agreement was published in 1988 with the aim of improving banks risk management, as banks' weak capital adequacy had become a concern (BIS, 2014). With the entry into force of Basel I, the development of the financial sector in which the competitive advantage of international banks was created by the application of banking activities subject to lower capital requirements can be considered to have ended. (Jokivuolle & Vauhkonen, 2010.) In addition to the G-10 member states, the new capital requirements were introduced in all countries where international banks operated.

The most important reform of Basel I was the 8% capital requirement for risk-weighted assets, which had to be implemented in practice by the end of 1992 (BIS, 2014). The framework focused primarily on credit risk, and the agreement included five main categories according to which credit risk weights were allocated. For instance, cash and liabilities from the state belonged to the zero-risk group, mortgage loans had a risk weight of 50% and private sector loans 100%.

The agreement thus defined the risk weights rather roughly and did not consider the difference in credit risks between companies, for example. Tier 1 capital had to cover at least 50% of the banks' total capital stock, the rest of the capital was allowed to be Tier 2 capital. The Tier 1 capital requirement was therefore 4% overall. (Basle Committee on Banking Supervision, 1988.)

The Basel I framework was clarified in 1996 with a Market Risk Amendment, which supplemented banks' capital requirements not only against credit risk but also against market risk, i.e., the risk of banks being exposed to losses due to changes in market prices, such as interest rates and exchange rates. This addition to the regulation also allowed banks to use internal models to calculate the market risk. (Basle Committee on Banking Supervision, 1996.)

2.4 Basel II

Basel I regulations were not sufficient to address financial market risks, especially in terms of consistency in corporate loan risk assessments. The need for a new agreement arose from the replacement of the relatively simple capital requirements of Basel I by broader supervisory measures that ensured more effective supervision of bank solvency. (Shakdwipee & Mehta, 2017.) Basel II was published in 2004, after which a more comprehensive version of Basel II, prepared in cooperation with the International Organization of Securities Commissions, was published in 2006. The key purpose of the new Basel II agreement was to improve the reflection of various risks on capital requirements. (BIS, 2014.) The latter publication focused on both trading book and banking book related items (BIS, 2014).

Basel II had three approaches to measure risk, presented as three pillars. The first pillar concerned minimum capital requirements, dividing risk into credit risk, operational risk and market risk. The calculation of risk weights was determined by the credit rating of each customer, while the method of calculating market risk remained almost unchanged. The new operational risk included in the agreement referred to the risk of loss due to deficiencies or malfunctions of internal operations, persons and systems. The second pillar included a control framework for the overall assessment process of the bank's solvency and capital planning. The third was the pillar of market discipline, the disclosure requirements of which allowed market participants to assess each other's solvency. (BIS, 2006.)

The purpose of the new Basel II agreement was to improve the reflection of risks on capital requirements. The minimum capital requirements remained at 8% of risk-weighted assets, as did the 4% minimum requirement for Tier 1 capital, while the definition of credit risk was significantly revised. The Basel II framework provided two ways to determine credit risk. The first method, the standardized approach, is defined by an external body, a credit rating agency, while the second is the internal ratings-based approach (IRB), in which a bank defines a credit rating to a counterparty using its own methods. The bank had to meet

certain requirements in order to use the IRB method. (BIS, 2006.) The Basel II framework was based on the belief that measuring banks' risks separately and requiring capital against these internally classified risks would be the most effective way to manage also the systemic risk (Jokivuolle & Vauhkonen, 2010).

2.5 Financial crisis of 2008

The financial crisis of 2008 highlighted the excessive leverage of banks and an insufficient liquidity buffer as a result of, among other things, emerging incentive structures and poor risk management (BIS, 2014). Brunnermeier (2009) lists components that led to the crisis, such as that banks did not favor keeping loans on their balance sheets, but packaged loans to new forms and transmitted them on to several other investors, for an urge to reduce and diversify the risk, which led to that the costs of bank insolvency were not limited to their own stakeholders. Brunnermeier (2009) adds how banks also increasingly financed their assets with shorter maturities, followed by an increased vulnerability of banks to liquidity depletion.

The Basel II framework in force at the time of the financial crisis has been blamed for – at least partially - causing the crisis. The IRB approach weakened the comparability of banks (BIS, 2017) when different banks performed credit ratings using different methodologies, and it allowed banks to be partially arbitrary in setting risk parameters. Internal credit ratings allow for the reporting of lower-than-actual risk weights, and thus lower capital held, which benefited particularly poorly capitalized banks (Mariathasan & Merrouche, 2014). Capital requirements of Basel II consider credit risk, but not the type of portfolio in which they will be included, which either reflects the importance of diversification as a part of portfolio risk (Atkinson & Blundell-Wignall, 2010).

The general allegations against Basel II listed in the study of Cannata and Quagliariello (2009) have concerned, among other things, the inadequacy of capital requirements and Basel II's assumption that banks' for measuring risk would be sufficient. According to Cannata and Quagliariello (2009), most of the allegations that the Basel II framework played a key role in causing the financial crisis are unfounded, although the financial crisis revealed the shortcomings of Basel II. Jokivuolle and Vauhkonen (2010) also consider the accusations unjustified, pointing out that perhaps replacing Basel I with Basel II at a much earlier stage could have at least mitigated the crisis. However, the introduction of Basel II came very close to the onset of the crisis, when the ingredients of the crisis had been simmering in the financial markets already for a long time.

2.6 Basel III

The Basel Committee sought to respond quickly to the crisis and published a list of principles in 2008 to emphasize the importance of establishing a sound framework for liquidity risk management and raising standards in many areas of risk management (BIS, 2008). This regulatory response of the Basel Committee to the global crisis was necessary due to the widespread unsustainable structures and trends in the banking sector. At the end of 2010, under the leadership of the G20 leaders and the Basel Committee, a proposal for Basel III framework was published, consisting of two publications (BIS, 2014). The first publication addressed regulatory standards for bank solvency and liquidity risk (BIS, 2010a), while the second addressed a framework for a more flexible banking system to avoid systemic vulnerabilities and support the real economy throughout the business cycle (BIS, 2010b). The regulations of Basel III have since been updated various times. One essential addition was the introduction of the concept of CET1 in 2014. Even though the minimum total capital ratio remains at 8%, together with the capital conservation buffer the required minimum capital over risk-weighted assets is 10,5%.

The central objectives of Basel III are to improve banks' risk tolerance and reduce systemic risks. Basel III targets to both improve the quality and to increase the funds of minimum capital. The main requirements and areas of Basel III framework are reviewed as in the following tables 1-5.

Table 1. **Basel III - Capital requirements: Pillar I**

CAPITAL
Minimum equity $\frac{\text{Tier 1 capital}}{\text{risk−weighted assets (RWA)}} \geq 6\%$ $\frac{\text{CET1}}{\text{RWA}} \geq 4{,}5\%$ $\frac{\text{total capital}}{\text{RWA}} \geq 8\%$
Conservation buffer Designed to build up outside of periods of strain and use in the event of losses to prevent breaches of minimum capital requirements. $\frac{\text{CET1}}{\text{RWA}} = 2{,}5\%$
Countercyclical buffer Bank-specific buffer, which depends on a bank's geographic structure of credit exposure portfolio. $\frac{\text{CET1}}{\text{RWA}}$-% varies between 0 and 2,5

Capital loss absorption at the point of non-viability
Reduction of moral hazard in a situation where a bank is unviable by allowing writing off or conversion of capital instruments into ordinary shares.

RISK COVERAGE

Credit risk
Two approaches to calculate RWAs for credit risk:
- Standardized approach: Supervisors set the risk weights, which banks directly apply to determine RWAs. The only method allowed to calculate RWA for equity exposures.
- IRB approach: Foundation IRB and Advanced IRB, depends on the exposure class when any approach can be used. When using the IRB Approach, there are minimum levels defined for the probability of default and other inputs.

Market risk
Interest rate risk, general market risk, foreign exchange risk.

Credit valuation adjustment risk
Capital requirement for potential losses on derivative instruments due to a worsening in the creditworthiness of the counterparty.

Operational risk
The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events

Counterparty credit risk
The risk of counterparty default when the risk of loss is bilateral

Securitizations
Limiting approaches for calculating capital charges; increasing requirements for riskier exposures.

Exposures to central counterparties and equity investments in funds
Capital requirements to ensure sufficient capitalization and support a sustainable financial system.

A revised output floor
Limits the amount of capital gain a bank can derive from the use of internal models compared to the use of standardized approaches.

LEVERAGE

A non-risk-based leverage ratio

$$\frac{\text{Tier 1 capital}}{\text{total leverage exposure}} \geq 3\%$$

Total leverage comprises exposures in on-balance sheet, off-balance-sheet, derivatives and securities financing transactions.

Table 2. **Basel III - Capital requirements: Pillar II**

RISK MANAGEMENT AND SUPERVISION
Supplemental requirements Four principles describe the supervisory review process to ensure that a bank's capital and liquid assets are adequate in relation to a bank's risk profile. The four principles essentially complement requirements in both Pillar 1 and Pillar 3. One important area is the assessment of corporate governance, including the risks of misconduct and company-wide risk management.
Requirements on assessing interest rate risk in the banking book (IRRBB) IRRBB means the current or future risk to a bank's capital and earnings, resulting from adverse changes in interest rates, thus affecting the present value and timing of future cash flows. The principles cover general application for the management of IRRBB, set out the expectations for market disclosures and banks' internal assessment of capital adequacy with respect to IRRBB and the supervisory approach to banks' IRRBB management framework and capital adequacy. Banks must implement the IRRBB principles in relation to the nature, size, complexity and the overall risk profile of the bank.

Table 3. **Basel III - Capital requirements: Pillar III**

MARKET DISCIPLINE
Disclosure requirements A dashboard of key prudential metrics to support market discipline through regulatory disclosure requirements. It reduces data asymmetries and facilitates the comparability of banks' risk profiles within and between jurisdictions. These requirements increase transparency of key information about a bank's regulatory capital and risk exposures, improving confidence in a bank's risk exposure and capital adequacy.

Table 4. **Basel III - Liquidity requirements**

GLOBAL LIQUIDITY STANDARDS AND SUPERVISORY MONITORING
Liquidity Coverage Ratio (LCR) $\frac{\text{Stock of high-quality liquid assets}}{\text{Total net cash flows over the next 30 calendar days}} \geq 100\%$ In addition to this stress test meter, banks are expected to conduct their own stress tests and assess scenarios that may cause difficulties for their business. Internal stress tests should comprise longer time horizons than 30 calendar days. 30-day liquidity stress is the minimum period considered necessary for a bank's management to be able to take the needed corrective action.
Net Stable Funding Ratio (NSFR) $\frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}} \geq 100\%$ Requires banks to have a stable funding profile relative to the structure of assets and off-balance sheet activities. Reduces excessive dependence on short-term wholesale funding and promotes better financial risk assessment of balance sheet items.

Table 5. **Basel III - Large exposures**

Requirements to limit the maximum loss to a bank in the event of a sudden failure of a counterparty to a level that does not expose to danger a bank's solvency. Banks must measure their exposures to a single counterparty or group of related counterparties and limit the size of large exposures related to their capital.

Note: Tables 1-5 are based on BIS (2021a).

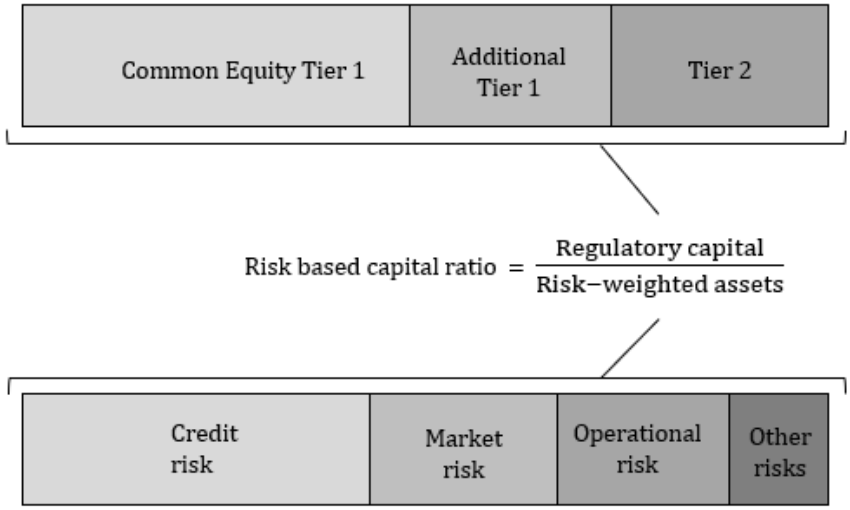

Figure 1. Calculation of risk-based capital ratios. Based on BIS (2021a).

2.6.1 Systemically Important Banks

The regulation listed above is binding for all banks. In addition, Basel III framework includes specific requirements for global systemically important banks (G-SIBs), as their stability is particularly critical for the global economic system and therefore G-SIBs must have a higher loss-bearing capacity. Five categories are used to identify G-SIBs, which are cross-jurisdictional activity, size, interconnectedness, financial institution infrastructure and complexity. The additional regulation for G-SIBs applies to a number of categories in the framework, for instance, requirements for higher leverage ratio and an additional capital buffer. (BIS, 2021a.)

Even if a bank is not significant for the global financial stability, the impact of its crisis can be significant in the domestic perspective. Basel III framework includes valuation methods and a higher loss absorbency requirement for domestic systemically important banks (D-SIBs) as well. Except for the cross-jurisdictional activity, the identification of D-SIBs in terms of the importance for the domestic economy follows similar criteria as for G-SIBs. The requirements for D-SIBs are assessed by national authorities. (BIS, 2021a.)

2.6.2 Implementation of Basel III

The adoption of Basel III requirements varies among banks in different countries and different areas of the framework. At the time of October 2021, all

member jurisdictions have final rules in force for risk-based capital, LCR requirements, capital conservation buffers, the countercyclical capital buffers and final or draft rules for the NSFR. In addition, all members that are domestic jurisdictions of G-SIBs have adopted the requirements for G-SIBs. (BIS, 2021b.) Deadlines for the implementation of different regulations are at different times, and some are still in the future. Some of the most important regulations, such as LCR, has been fully introduced to force in every member jurisdiction already from 2016 (BIS, 2020).

Table 6. Summary of capital requirements of Basel I, Basel II and Basel III.

	Basel I	Basel II	Basel III
Quantity of capital, percentage of risk-weighted assets			
Minimum total capital	8,0	8,0	8,0
Minimum CET1	-	-	4,5
Minimum Tier 1 capital	4,0	4,0	6,0
Capital Conservation buffer	-	-	2,5
Countercyclical buffer	-	-	0 - 2,5
Buffer for G-SIBs	-	-	0 - 2,5
Buffer for D-SIBs	-	-	0 - 2
Leverage ratio*	-	-	3,0

Based on BIS (2021a). The capital should be met fully by CET1 in capital conservation buffer, countercyclical buffer, buffer for G-SIBs and buffer for D-SIBs. The capital should be met fully by Tier 1 in leverage ratio.
* = % of total leverage exposure

3 CAPITAL STRUCTURE AND BANK BEHAVIOR

Optimal financial decision-making in business has been approached in the research literature from many different perspectives. An influential theorem of business valuation of Modigliani and Miller (1958) states that a company's market value is the present value of its future earnings and underlying assets, and capital structure has no impact on it. Modigliani-Miller theorem was followed by some challenging theories, such as the pecking order theory of Myers and Majluf (1984). It states that the cost of financing increases with asymmetric information, and internal financing is better than debt, and equity comes as an alternative only after debt. Therefore, retained earnings would be the most favorable source of financing for banks. Later, Baker & Wurgler (2002) introduced the market timing theory, which identifies the market timing as the most important factor on a company's financing decisions.

Where companies have a lot of room for maneuver in this respect, the operating environment for banks is much more regulated, and banks need to continually adapt their business models to the prevailing regulation. Capital requirements are usually not constantly binding on all banks, as argued in van den Heuvel (2008). Benes and Kumhof (2015) view the banking regulation as a system that imposes sanctions on banks if they do not meet the minimum requirements, which in turn creates incentives for banks.

Berger, Herring & Szegö (1995) regard the postulation of optimal capital level in terms of performance. They define the optimal capital level in the absence of all capital regulations as a markets-driven ratio that maximizes the value of the bank. This ratio varies among banks, but in the long term each bank tends to approach their optimal ratio, and capital regulation may be harmful for a bank when its optimal capital level differs from the required. Later, Mehran and Thakor (2011) describe how each bank has its own optimal capital structure, which varies due to factors such as bank size or the market situation, and banks strive toward this level of capital. Mehran and Thakor (2011) find bank capital and total bank value to be positively related.

3.1 Benefits and Costs of Bank Capital

There is a common view in the banking literature that higher level of capital is associated with higher financial stability. The relationship between capital and bank performance is a more nuanced debate. Equity acts as a buffer against stressful periods and protects against insolvency, as well as keeps shareholders and directors in discipline by increasing their involvement (Mariathasan & Merrouche, 2014). The belief in "too big to fail" is an example of a moral hazard phenomenon in banking. The last financial crisis witnessed that a bank's large size and entrenched position are not sufficient guarantees for its survival. Dam and

Koetter (2012) find bank bailouts causing moral hazard on a dataset of German banks over 1995-2006, as when banks are considered more likely to be rescued in the event of insolvency, banks increase risky behavior.

For shareholders, the amount of capital is the risk with which they are involved in a bank's operations. Higher capital is seen as lowering the problem of moral hazard, as managers and shareholders have more skin in the game, which in turn acts as an incentive for higher prudency and risk reduction (Dautović, 2019). The study of Duran and Lozano-Vivas (2015) on banks in EU countries during 2002-2009 identifies moral hazard behavior of banks during the pre-crisis period, as the increase in risk-taking was accompanied by a decrease in the relative amount of capital, and the financial structure of banks became unable to support the level of risk-taking.

Banks are often concerned that holding high levels of capital would endanger the bank performance and reduce lending (Berger & Bouwman, 2013). In theory, the cost of higher capital may be due to the consequent tighter lending conditions, as the adjustment to higher level of capital might require higher rates on lending i.e., higher risk credit customers, and lower credit supply (Aikman, Haldane, Hinterschweiger & Kapadia, 2019).

In addition to costs, which can include agency costs, costs caused by adverse selection, et cetera, Mehran and Thakor (2011) define two types of benefits for a bank from holding capital, direct and indirect benefits. The direct benefits are related to an assumption that higher capital improves a bank's survival probability and that, in turn, increases the marginal benefits of monitoring loans in the former time period, leading banks with higher capital to do more loan monitoring. An increased probability of survival means a higher probability of collecting the returns in the future from loans of the current moment, and thus loan monitoring is cost-effective. The indirect benefit stems from loan monitoring because greater monitoring of loans, stemming from higher capital, improves the value of loan portfolio. Banks could also reach the indirect benefit by simply choosing to monitor more, and not by holding more capital, hence banks can privately choose their optimal level of capital (Mehran & Thakor, 2011).

The cost of bank capital also includes social and macroeconomic factors. Jordà et al. (2021) do not identify capital ratios to have a link with an occurrence of systemic financial crises, based on a long-run dataset of banks in 17 advanced economies over the period of 1870-2015. Instead, their study provides evidence that, rather than preventing crises, the role of well-capitalized banks is emphasized in reducing the economic and social costs of crises, and enabling faster recovery from crises. An important factor in that process, as argued by Jordà et al. (2021), is the rapid recovery of lending in the aftermath of a crisis, as better capitalization strengthens banks' loss absorption capacity. Better-capitalized banks are expectedly in a better position during the crisis to continue their normal business operations, as their ability to meet loan demand will not be shaken critically. There are also studies suggesting that higher bank capital acts as a crisis preventive factor, for example Aikman et al. (2019).

3.2 Capital Structure and Performance

The impact on bank performance when moving to capital requirements of Basel III framework varies depending on the indicator used, according to Le, Nasir and Huynh (2020). Their study reviews the largest commercial banks in UK and Australia between 2000-2019, and the findings indicate that higher capital requirements of Basel III increase bank EBIT, while they have a negative impact on ROE and ROA. Increasing the retained earnings, which is among the main procedures to generate capital, improves the resilience of banks to shocks, but Le et al. (2020) find that excessive holding of liquid assets weakens profitability as it limits banks' expansion and lending.

In order to both adapt to Basel III capital requirements while also improving their ROE and ROA, Le et al. (2020) suggest banks to diversify and expand their lending, generally extend maturities of liabilities and move towards more sound sources of funding. Le et al. (2020) expect banks to increase capital level by amending loan portfolio as described above, and they also believe these changes would have a positive effect on ROE. Yet, performing empirical tests to determine the optimal level of capital that maximizes bank performance, Le et al. (2020) obtain similar results as what is the actual CET1 requirement of Basel III. The macroeconomic factors seem to affect differently to bank performance in Australia and Britain, as Le et al. (2020) find that increases in inflation and interest rates do not harm performance for British banks but seem to harm it for banks in Australia.

Stricter capital regulation will not lead directly to a reduction in bank lending, as argued by Deli and Hasan (2017) in a study on banks worldwide from 1998 to 2011. They do find evidence of disadvantageous effects of tightened capital regulation on loan growth, but that effect is rather small, and diminishing in the long term. Moreover, they prove that banks can compensate the negative effects on credit availability by higher capital buffer. The evidence of Deli and Hasan (2017) is in favor of enforcing more stringent risk-related capital regulation during an economic upswing. They also test whether the impacts of tighter capital regulations on lending will turn positive in the long run, but do not find significant results to support this.

Moreover, Gambacorta and Shin (2018) propose that higher bank capital is associated with higher credit supply, which is due to lower funding costs for better capitalized banks. They find a significant cost advantage for well-capitalized banks on a worldwide bank data from advanced economies between 1994 and 2012. More specifically, 1 percentage increase in equity-to-total-assets ratio leads to a decrease of roughly 4 basis points in the costs of deposits, bonds, and other borrowing activities, as documented by Gambacorta and Shin (2018).

Banks that took more risk in the pre-crisis period, had weaker structural liquidity and greater leverage, were more prone to fail later, according to Vazquez and Federico (2015). Their data from the period of 2001-2009 covers both European and US banks, and divides banks into groups according to whether

they operate globally or only in their domestic markets. The results suggest a presence of threshold effects, as the benefits of stronger liability structure and capital buffer are remarkable for the small domestic banks, while they appear to have rather low effects for global or average banks. The evidence of Vazquez and Federico (2015) also identifies differences between bank types in what is most likely to lead to their collapse. The small local banks were more prone to fail due to weak liquidity structure and too high dependence on short-term wholesale funding, whereas a weak capital buffer and excess leverage were the likely causes for the collapse of large global banks.

Berger and Bouwman (2013) study the effect of bank capital on performance among different bank size classes, focusing in particular to the impact of pre-crisis capital held, and its impact on performance during the crisis. They find a positive impact of capital on bank performance for all sizes of banks during crisis times, and for small banks at all times. The data consists of US banks between 1984 and 2010, which captures two banking crises and three financial crises. Berger and Bouwman (2013) measure bank performance by survival and market share, with various variables controlled, such as competition, risk, organizational structure, location and profitability.

The empirical findings in Berger and Bouwman (2013) of a positive effect of higher capital level on the survival of small banks holds at all times, regardless whether capital is considered as equity capital or as regulatory capital alone. Their second main result is that higher pre-crisis capital has a favorable effect on market share for small banks at all times, whereas for medium-sized and large banks during crises. Berger and Bouwman (2013) also find the impact of capital on market share to be different subject to the different growth strategy of a bank. The market share effect is stronger for small and medium size banks when their growth is organic, and for large banks the effect is stronger when they grow through mergers and acquisitions.

Different findings in Berger and Bouwman (2013) for banks of different sizes suggest that just as capital, also size can generate economic strength for a bank, both having a diminishing marginal value. While medium and large banks are challenged mostly during crisis times and then can have benefits from holding higher capital, small banks seem to be endangered at all times. These results can explain why small banks have consistently lost market share to medium and large banks. (Berger & Bouwman, 2013.)

Košak, Li, Lončarski and Marinč (2015) study what role the quality of bank capital had on bank lending during the last financial crisis, using a worldwide bank data over 2000-2010. They divide banks to quartiles based on the ratio of Tier 1 capital to risk-weighted assets. Although each quartile strongly reduced lending at the onset of the crisis, higher levels of Tier 1 capital held correlated with faster recovery in lending. This effect is particularly clear for banks operating in developing countries. They also find that higher quality of bank capital, i.e., higher Tier 1 capital level, promotes lending during the crisis. However, they do not find this positive effect for high Tier 2 capital ratio, which indicates that

Tier 2 capital is unable to provide sufficient support for bank lending activities in times of crisis.

High-quality capital also appears to improve banks' competitive position during the crisis, according to Košak et al. (2015), as they find that banks react by reducing lending when competing banks have high Tier 1 capital ratios. This supports other findings that higher capital helps banks to cope better with a criss (Jordà et al., 2021). Košak et al. (2015) also note differences for banks of different sizes, as small banks lend more when their capital ratio is higher, also during the crisis. In turn, large banks lend more during the crisis if their competitor banks are weakly capitalized, but less in normal times. Thus, a higher level of capital during the times of crisis helps large banks to gain a better competitive position, and directly helps smaller banks to survive. Košak et al. (2015) also provide some limited evidence of a negative impact of interbank deposits on bank lending during the crisis, while customer deposits were a rather stable source of funding and were positively related to lending growth during the crisis.

Francis and Osborne (2012) study the effects of capital regulation on bank capital ratios, lending behavior and balance sheet management in the UK between 1996 and 2007. Each bank has an internal target capital ratio, and Francis and Osborne (2012) examine how capital requirements affect its determination and how banks adjust their balance sheets and lending as they move towards their own target capital ratios. The study also extends the review from capital regulation to bank-specific capital requirements set by the UK's Financial Services Authority on UK banks. These individual capital requirements combine the Basel I framework in force during the time of the study, with assessments of, for example, a bank's corporate governance and risk management, and the prevailing market conditions.

Regulatory capital requirements have a significant impact on banks' determination of their own unique target capital ratios. Francis and Osborne (2012) refer as "bank capitalization" to the difference between the actual and a bank's target capital ratio, which is positively linked to growth in lending, total assets and risk-weighted assets. Instead, they find bank capitalization having a negative association with regulatory capital and Tier 1 capital. Based on the results, banks appear to adjust their capital ratios especially with low-quality Tier 2 capital during the research period, before the 2008 crisis and following changes in capital regulation.

The results in Francis and Osborne (2012) on changes in bank-specific capital requirements set by UK supervisions support the conclusion that banks seek to strengthen their capital ratios primarily through low-quality capital. Banks also modified their asset portfolio structures towards lower regulatory risk-weights instead of adapting the volume of lending or assets. Based on the findings of Francis and Osborne (2012), it can be concluded that post-crisis changes in capital requirements, especially for quality of capital, became necessary.

3.3 Sources and Horizon of Capital

The literature on bank capital requirements focuses largely on the level and structure of capital, while less attention is paid to who provides the capital and what is its maturity. Instead of concentrating solely on a question of the level of capital, Garel and Petit-Romec (2017) study how the investment horizon of capital providers affects bank performance, measured by stock returns. The study consists of publicly listed US banks and the focus is on bank performance during crisis times, as it is in those times that the importance of the stability of bank capital as a source of funding is emphasized. Banks, whose pre-crisis investor holdings consist mainly of short-term funding, suffer from lower stock returns during the crisis, according to the study of Garel and Petit-Romec (2017). They also clarify that this result does not depend on long-term institutional ownership, which does not seem to have any impact on bank performance during crisis times. Whereas higher bank capital is, in fact, related with poorer performance during a crisis when it is provided by short-term institutional investors, argued by Garel and Petit-Romec (2017).

Garel and Petit-Romec (2017) suggest two possible explanations for the adverse impact of short-term investor ownership on bank performance. The first explanation is that short-term investor ownership indicates higher risk taking before the crisis. The other explanation suggests that banks with more short-term investor holdings performed weaker during the crisis, as short-term investors may have sold their shares frantically during the crisis due to poor expectations, which has contributed to lower stock prices. Garel and Petit-Romec (2017) agree with previous studies with the conclusion that higher pre-crisis capital helps banks to cope better with a crisis, but they specify the importance of the source of capital.

Cohen and Scatigna (2016) mainly identify four different strategies by which a bank can seek a higher risk-weighted capital ratio. If the capital is sought to be raised through retained earnings, the bank may cut dividends or, alternatively, seek to increase profits, for example through wider interest rate spread or increases in fees for advisory and other services. Another, less attractive strategy, is to issue new equity, for instance through a rights issue to existing shareholders. This, however, tends to lower the share price. A bank may also use a strategy of making changes to the assets side of the balance sheet. Through a reduction in lending, a bank can accumulate retained earnings. A bank can also sell funds and use the income of loan cuts and asset sales to pay off debts. The fourth strategy concerns a reduction of risk-weighted assets by reducing high-risk loans and replacing them by safer loans. (Cohen & Scatigna, 2016.)

Empirical findings in Cohen and Scatigna (2016) shed light on the arrangements that banks worldwide have sought to achieve higher capital ratios in the aftermath of the crisis, over the period of 2009-2012. Higher capital ratios have mainly been achieved through accumulated retained earnings, instead of cuts in lending or asset growth. The study also shows that well-capitalized banks grew

more than other banks and expanded lending faster after the crisis. (Cohen & Scatigna, 2016.) Yet, these findings contradict in part the evidence in Le et al. (2020), that ample increases in retained earnings limits bank lending.

3.4 Cyclicality of Capital Buffers

The purpose of countercyclical capital buffers is to raise additional capital for a bank during an economic upswing and use the buffer to ensure business continuity when a bank faces large losses. Countercyclical capital buffers reduce bank stress in crisis situations, as banks do not need to make rapid and substantial increases to their lending rate to compensate for sudden loan losses, which would also have disadvantageous consequences on the real economy (Benes & Kumhof, 2015). Using a theoretical model, Benes and Kumhof (2015) study the effects of countercyclical capital buffer of Basel III framework, particularly during shocks that raise borrower riskiness. With an ease of countercyclical capital buffer during the downturn, banks do not face excessive pressure to rebuild their capital. As a result, lending rates will not rise too much, which would burden borrowers who are already distressed. This has considerable macroeconomic effects, such as reduction of volatility in investment, output and consumption, as well as less need for volatility of policy rates. (Benes & Kumhof, 2015.)

Empirical findings in Liu and Varotto (2015) provide evidence that lending growth of small banks is less pro-cyclical compared to large banks. The study of Liu and Varotto (2015) on Eurozone banks over 2007-2015 analyzes the impact of sovereign debt on loan growth. Liu and Varotto (2015) point out that the focus of the debate on the sovereign debt crisis typically looks over big banks, that reallocate assets from the private sector to the government, which in turn strengthens pro-cyclicality and deepens the crisis. In peripheral countries in particular, the increase in the public debt of small banks does not appear to reduce their lending to the private sector, but creates a liquidity buffer that has a positive effect on bank-specific loan growth. Compared to large banks, the lending behavior of small banks is more stable between up- and downswings, thus small banks can play an important role in mitigating credit contraction during a recession, when continued lending is most needed to smooth economic cycles. (Liu & Varotto, 2015.) Liu and Varotto (2015) attach importance to the incentives inherent in banking regulation that place additional demands on larger banks.

4 VOLUNTARY BANK CAPITAL

A key issue in the regulatory debate is whether capital requirements are properly calibrated (Aikman et al., 2019). Benes and Kumhof (2015) model regulation as a system that imposes sanctions on banks if they do not meet the minimum requirements, which in turn creates incentives for banks. Within the regulatory framework in being, it is the responsibility of banks' management to determine individually how much capital is needed to permit the sustainable implementation of their own business model.

In examining the beneficial effect of capital, de Bandt et al. (2018) separate the effects between regulatory and voluntary bank capital. They find especially the voluntary capital to be exclusive for bank performance, whereas they do not find capital requirements to have any significant effects in that respect. They use a data of the largest French banks between 2007 and 2014. First, they estimate how the ratio of total accounting capital over total assets corresponds to regulatory requirements, and how capital ratio affects bank performance, which is measured using ROA. Secondly, they construct a regression that models the relationship between capital ratio and performance, but which separates the effects between regulatory capital and capital voluntarily held by a bank.

In terms of value-maximizing, banks should increase capital held as long as its marginal benefit outweighs the marginal cost, and when they are equal, the capital ratio is optimal (de Bandt et al., 2018). The benefits and costs, according to de Bandt et al. (2018), are bank-specific and dependent on several factors, and can vary over time, e.g., normal times versus crisis times. As in Mehran and Thakor (2011), the optimal level may depend on the internal characteristics of the bank, such as the bank size, as well as the prevailing market situation. De Bandt et al. (2018) argue that changes in voluntary capital reflect the fact that banks tend to adapt to different situations and strive towards their optimal level of capital, and therefore these changes should be positively related to performance.

Changes in regulatory bank capital have rather indistinct impact on bank performance, as it depends on the bank's current position in relation to its optimal capital level. If a bank holds approximately optimal amount of capital, a change in regulatory capital can adversely affect its performance. (De Bandt et al., 2018.) De Bandt et al. (2018) point out that in times of crisis, banks tend to experience a lack of capital, and stricter capital requirements are often also favorable for performance, pushing a bank closer to its optimal capital level.

Bank capital and profits have, according to Coccorese and Girardone (2021), a positive relationship, although various variables affect the intensity of this relation. Using a large bank data from 2000 to 2018 covering banks in both developed and developing countries, Coccorese and Girardone (2021) find this relation between capital level and profitability in terms of ROA to be dependent on bank size, timing, and environmental conditions. The study indicates that the relation is particularly strong in times of crisis, especially in low- and middle-income countries and for large banks, although not for G-SIBs.

Coccorese and Girardone (2021) interestingly find a stronger relation of capital and profitability for banks operating in countries with high corruption levels, in comparison to less corrupted countries. Furthermore, in countries with weaker economic freedom, more capitalized banks appear to earn higher profits compared to banks with a similar level of capital operating in countries with higher freedom on the business for firms, which Coccorese and Girardone (2021) explain likely to result from higher competition of freer economies.

Coccorese and Girardone (2021) use three measures of bank capital in their study, of which the first is the ratio of Tier 1 capital over RWA (TIER1RWA). The second measure, equity over total assets (EQAST), is a leverage ratio which represents a broader concept of capital. The third is the ratio of the capital surplus over the regulatory requirement (CAPSURPLUS), calculated as follows:

$$\text{CAPSURPLUS} = \frac{\text{Total regulatory capital ratio} - \text{Minimum capital requirement ratio}}{\text{Minimum capital requirement ratio}} * 100 \qquad (1)$$

This represents the voluntary bank capital that banks hold in order to deal with unexpected losses. Generally, the main findings mentioned above of Coccorese and Girardone (2021) hold for all the three measures of capital, but there is some divergence. An increase in capital measured as EQAST generates higher profitability in more stable countries in comparison to unstable ones, but such difference is not significant for capital changes measured as TIER1RWA or CAPSURPLUS. In addition, during the crisis times, the positive effect of capital for profitability is clear, when capital is measured as TIER1RWA or CAPSURPLUS. However, the effect is reversed for EQAST, meaning that in the transition from normal times to crisis, the positive effect of capital to profitability decreases. The study shows that the focus of banking regulation on capital requirements does not hamper banks' potential profits, but that both the Basel requirement-based and traditional capital ratios show a small positive impact on banks' ROA.

Bagntasarian and Mamatzakis (2019) use a dynamic panel analysis to study the relationship between bank capital buffer in excess of the minimum requirements, performance, and risk in EU-27 countries during the period of 2004-2013. Capital buffer is measured as total capital over risk-weighted assets less the country-specific minimum requirement. The used performance indicators are ROA, ROE, NIM and bank's cost efficiency. The study confirms that bank performance and risk exposure have an impact on the capital buffer, although Bagntasarian and Mamatzakis (2019) observe different outcomes for banks of low and high performance. In the case of banks in low performance regime, an improvement in performance has an increasing effect on capital buffer, whereas this effect is negative for better performing banks, i.e., an improvement in performance has a reducing effect on capital buffer. Moreover, Bagntasarian and Mamatzakis (2019) find a positive effect of capital buffer on bank stability and performance, and it appears to lower the risk of default. Bagntasarian and Mamatzakis (2019) state that tightened capital regulation can improve bank performance, yet the effect differs subject to performance and risk features of banks.

5 EMPIRICAL RESEARCH

5.1 Data

The unbalanced bank-level panel data is collected from Bankfocus database, and it covers 308 Eurozone banks during the period of 2005-2020. This timeframe captures the pre-crisis period, the introduction of Basel II and the financial crisis, as well as the transition to tighter Basel III banking regulation, sovereign debt crisis in Europe, the decline in interest rates to below zero. Due to deficiencies in the dataset, banks' CET1 level has not been included in the study, but instead total capital and Tier 1 ratio.

Banks are divided into three size groups based on total assets, where group 1 is the smallest, group 2 medium and group 3 the largest banks. Each year size groups are formed as percentiles of total assets of all banks' that year, i.e., one bank may belong to different size groups in different years (see, appendix 2). Banks in the group 1 can be considered to operate locally, and largest banks to operate in many countries. This division seeks to identify whether the factors affecting banks' performance are related to the scale of bank's operations. This division does not take a stand on the geographical location of banks' operations in the euro area, but on the scope of its business activities. Similarly, Berger and Bouwman (2013) run regressions separately for three bank size groups based on total assets, yet they use the same thresholds each year to delimit the groups. In their earlier study, bank liquidity creation is found to have different relationship with bank capital depending on bank size (Berger & Bouwman, 2009), hence, dividing data by bank size is justified for obtaining better reliability on results.

Certain exclusions are done for observations that appeal unlikely to fit to the data. Proxy methods typically used to prune extreme observations were not applicable for the data due to a high randomness and imbalance of extreme observations. The selection of obviated data is manually done for observations of each ratio. The boundaries for eliminated observations are presented in the appendix 1.

5.2 Bank Performance Measures

Among the research, numerous indicators are used for performance. Bank performance is defined in ECB (2010) as a bank's capacity to generate sustainable profitability. Profitability is a key measure of performance, as it signals a bank's ability to cope with daily operations, defense against losses and generate proper returns for its owners. However, performance does not solely denote profitability, and risk, efficiency, asset quality and future prospects should also be considered on bank performance measurement. (ECB, 2010.)

Ratios based on returns are probably the most common indicators of bank performance used in the research. Perspective on returns varies subject to what is used as a divisor. In this study two return ratios are used ROAA and RoRWA. ROAA uses assets as the denominator in the formula, while in RoRWA the assets are adjusted on their comprised risk. ROAA reflects the ability to generate profits from a bank's assets, which demonstrates the efficiency of asset management. ROA is used as an indicator of bank performance in de Bandt et al. (2018), Le et al. (2020) and Bagntasarian and Mamatzakis (2019), among others. RoRWA measures how well a bank manages its balance sheet and risk-taking, i.e., the risk taken to achieve the returns. If total assets and returns remain the same, and the risk exposure increases, ROAA is unaltered, but RoRWA decreases. RoRWA is useful when comparing the performance between different banks, as the ratio reflects the level of risk associated with a bank's own business. The inclusion of both of these performance measures in the study will help to make observations as to whether the impact of a variable on returns differs significantly when the risk level of a bank is taken into account.

The calculation used in this study for the return measures is the following:

$$\text{ROAA} = \frac{\text{Net income}}{\text{Average total assets}} * 100 \qquad (2)$$

where denominator is the average of total assets in the beginning and in the ending of financial year;

$$\text{RoRWA} = \frac{\text{Net income}}{\text{Risk weighted assets}} * 100 \qquad (3)$$

Financial performance is very often measured by ROE, but in this study, it can be considered as an unsatisfactory performance indicator due to the large size and heterogeneity of the bank data. The data includes cooperative banks for which, due to the nature of their business and their ownership structure, equity is not as relevant as for other banks. The purpose of the selected indicators is to reflect the returns of all banks in the data in the most comparable way possible. The advantage of ROA over ROE as a measure of performance is, as argued by De Bandt et al. (2018), that leverage has a smaller effect on ROA. Moreover, De Bandt et al. (2018) point out that some positive effects that increase equity convey as lower ROE, indicating weaker performance.

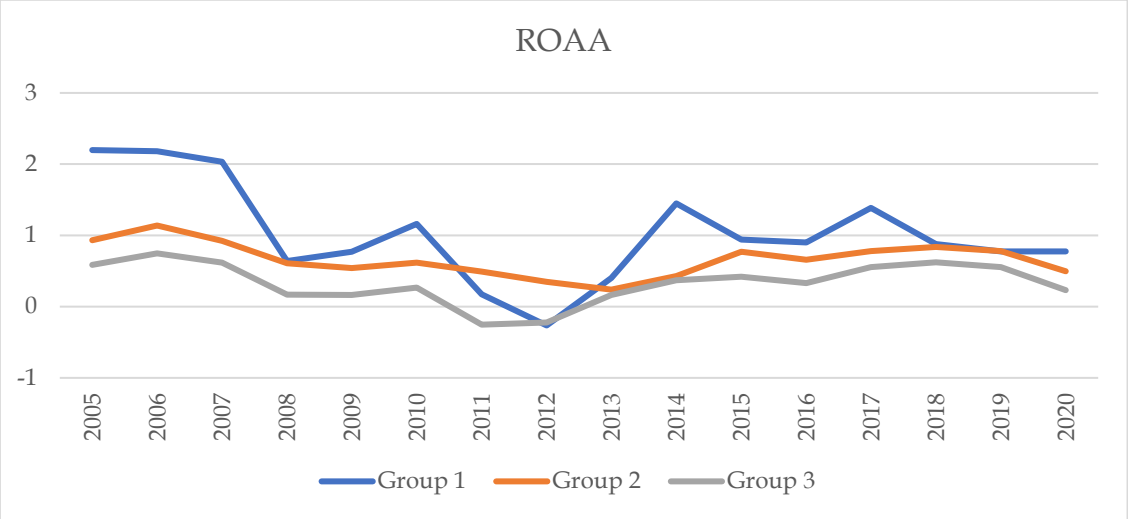

Figure 2. Annual averages of Return on Average Assets (ROAA, %) by bank size group[1].

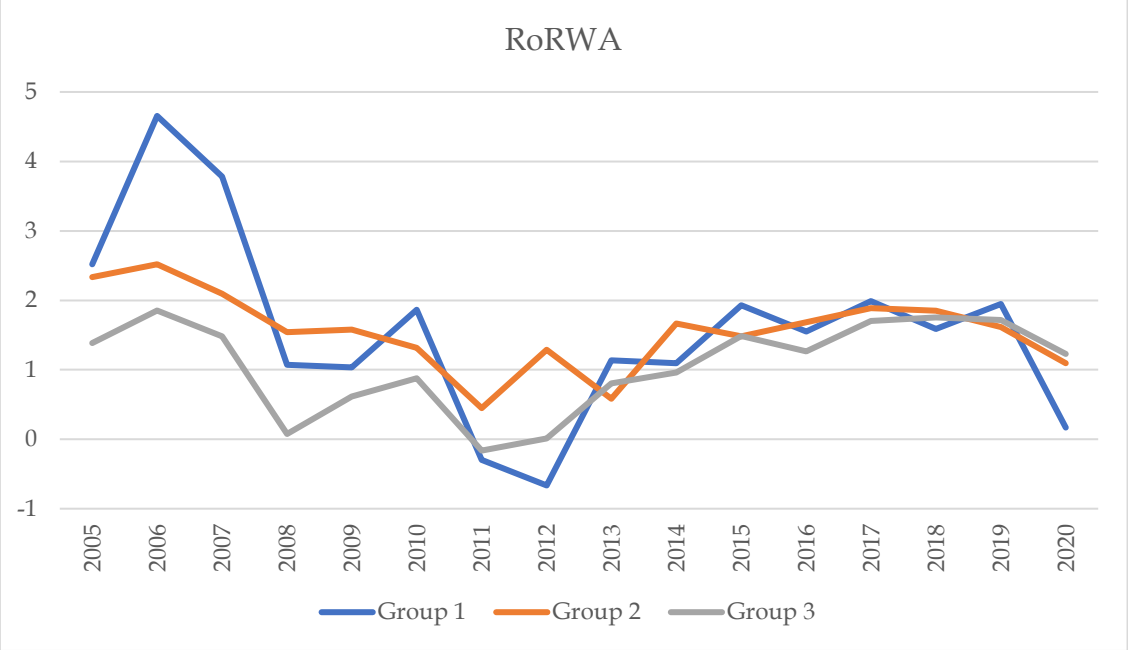

Figure 3. Annual averages of Return on Risk-Weighted Assets (RoRWA, %) by bank size group.

5.3 Bank Capital

This study aims to examine the relation of capital level and bank performance, and whether the relation stems from voluntary capital held, or from changes in regulatory requirements. Thus, the empirical model must be able to separate the effects of regulatory and voluntary capital.

Bank capital is measured as total capital to risk-weighted assets. The development of capital levels of different bank size groups, as presented in the

[1] Group 1 = small banks, group 2 = medium-sized banks, group 3 = large banks.

figure 4, has been upward trending during the study period. Capital levels of large banks have been the lowest but almost converged with medium banks since 2013. The relative increase from 2005 to 2020 has also been the largest for large banks. Capital levels of small banks have been by far the highest, although fallen since 2017. Berger and Bouwman (2013) suggest that bank size itself creates a better economical position for a bank, and due to that, small banks are endangered at all times, and not just during economic downturns. This may explain at least partially the higher capital ratios of small banks.

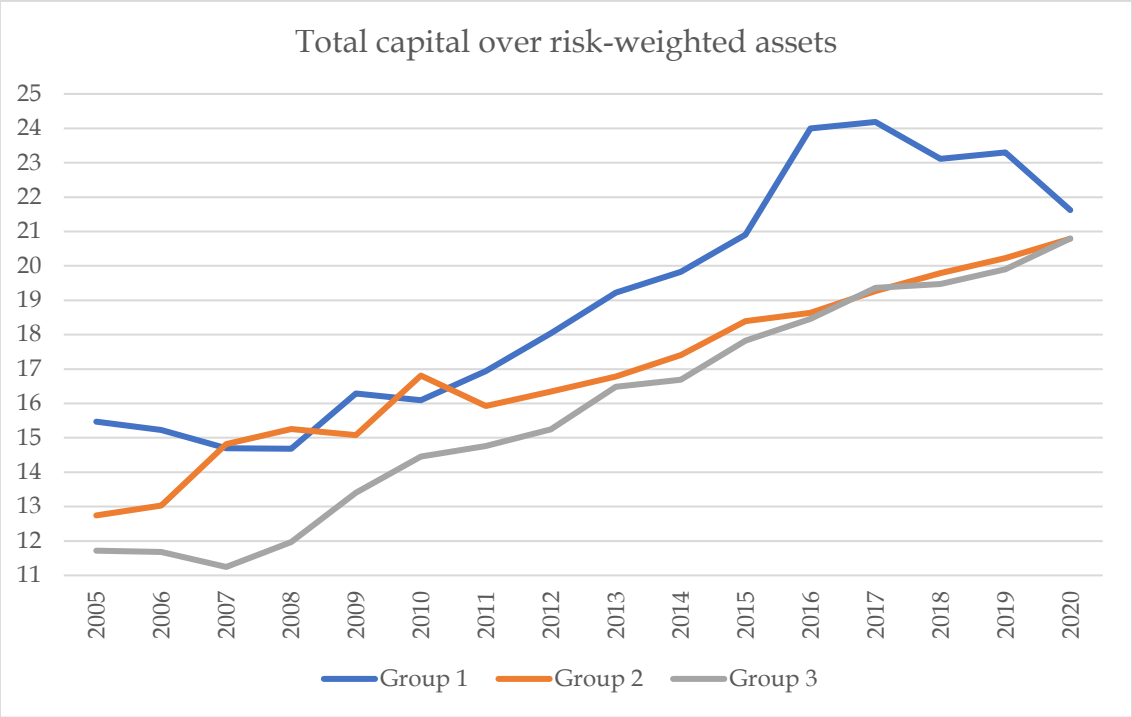

Figure 4. Annual averages of total capital over risk-weighted assets ratio (%) for each bank size group.

Total capital ratio is then divided into a bank-specific minimum requirement, and the residue of total capital and the requirement. The Basel framework (BIS, 2021a) acts as a basis for national authorities for setting the bank-specific capital requirement, and for most banks the Basel requirements are adopted as such. Besides the 8% capital requirement, Basel III adds the countercyclical buffer to the minimum requirement. If the Basel Committee defines a bank as G-SIB, it is required to fulfill the additional buffer for G-SIBs. In addition, the local supervisory authority may designate a bank as a domestic systemically important bank (D-SIB) and impose an additional capital requirement on such a bank, even if the bank is not a G-SIB. A bank may be subject to additional capital requirements as both D-SIB and G-SIB, or only one of them, depending on the practice of the national authority. A smaller subsidiary of a G-SIB operating in a different country is also subject to the G-SIB requirements, so the possibility of arbitration does not arise from placing subsidiaries under a different authority. (BIS, 2021a.) The data

of bank-specific minimum capital requirements[2] is based on Financial Stability Board (2022), European Banking Authority (2022) and European Systemic Risk Board (2022).

The figure 5 shows that bank-specific capital requirements have stayed at 8% over 2005-2010 on average, but since then have risen yearly until 2019. Requirements are the lowest for small banks and the highest for large banks.

Voluntary capital demonstrates the share of capital that a bank holds as a voluntary buffer. The share of large banks has been the lowest on average throughout the study period, and since the presence of negative interest rates, the voluntary capital of medium-sized banks has been very close to that of large banks. For small banks, the gap with the other two size groups has been large in the 2010s, although by 2020 the gap has diminished on average to around one per cent. It is of interest in terms of results, how the rather significant share of voluntary capital of small banks has affected their returns.

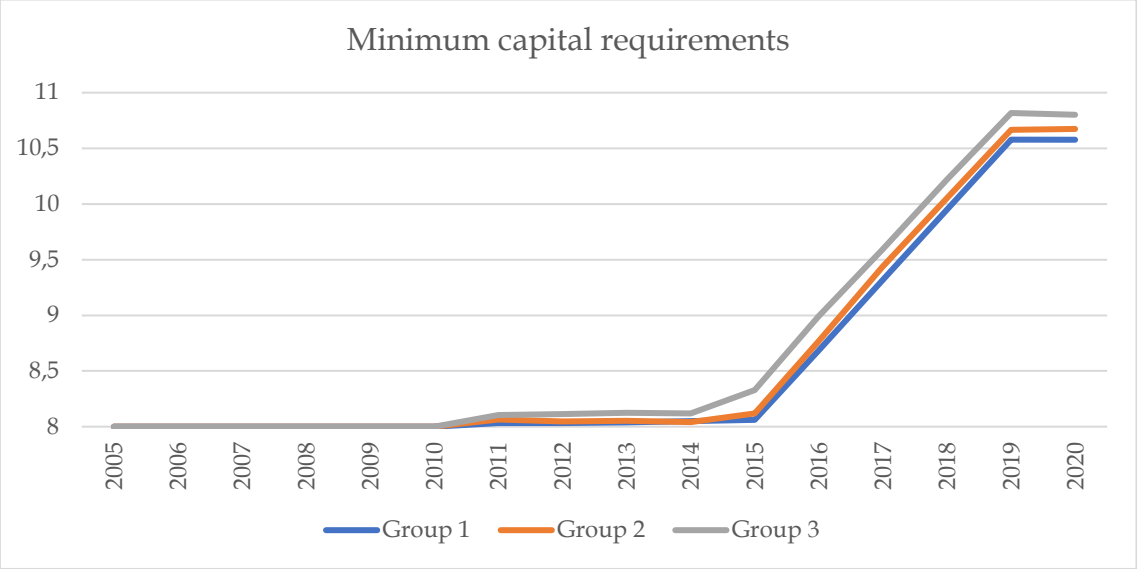

Figure 5. Annual averages of bank-specific regulatory requirements of total capital over risk-weighted assets (%) for each bank size group.

[2] The bank-specific requirements as calculated based on the defined sources are confirmed by Juhani Raatikainen.

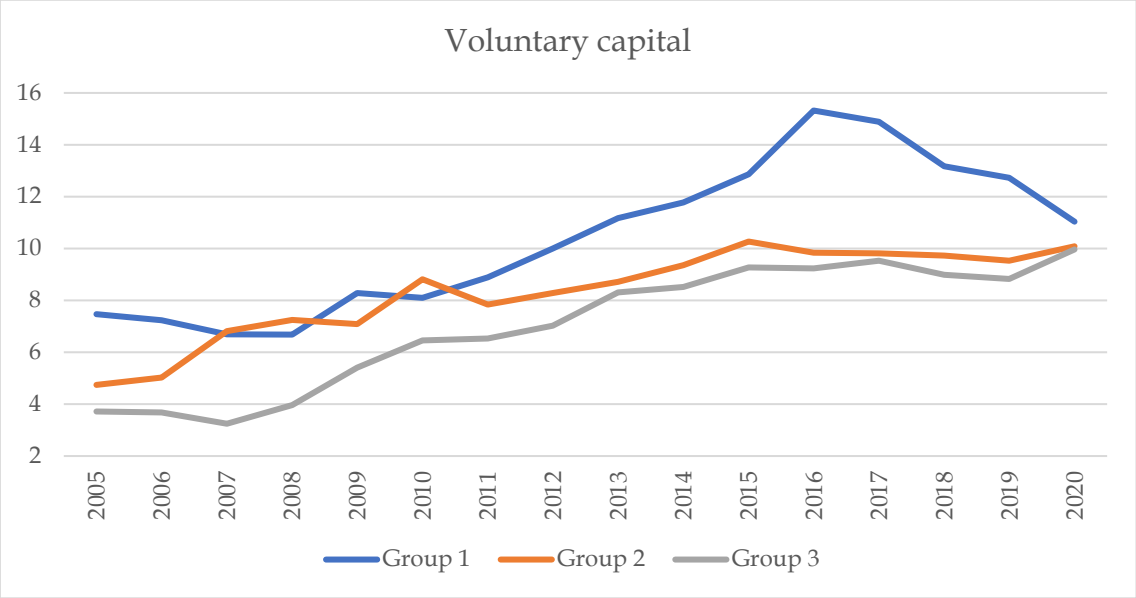

Figure 6. Annual averages of voluntary capital over risk-weighted assets (%) for each bank size group.

5.4 Method

Following the approach used by de Bandt et al. (2018), the regression below estimates the relationship of return rate and total capital level, with various factors controlled:

$$\text{return rate}_{i,t} = \alpha_0 + \beta_0 * \text{CapRatio}_{i,t} + X_{i,t}\,\gamma_0 + \eta_{0,i} + \varepsilon_{0,i,t} \qquad (4)$$

where

i = bank
t = time
β_0 = coefficient of interest
CapRatio = total capital to risk-weighted assets
X = a vector of control variables
η = bank fixed effect (in the fixed effects model)
ε = an idiosyncratic error term assumed to be i.i.d. and normally distributed

On the second stage of the empirical part, $\text{CapRatio}_{i,t}$ is replaced with $\text{CapReq}_{i,t}$ and $\text{VolCap}_{i,t}$ to separate the effects of bank-specific capital requirements and voluntary capital. $\text{VolCap}_{i,t}$ is the residual of $\text{CapRatio}_{i,t}$ - $\text{CapReq}_{i,t}$. The resulting regression below represents the relationship of return rate, bank-specific capital requirement, and voluntary capital held:

$$\text{return rate}_{i,t} = \alpha_1 + \beta_1 * \text{CapReq}_{i,t} + \beta_2 * \text{VolCap}_{i,t} + X_{i,t}\,\gamma_1 + \eta_{1,i} + \varepsilon_{1,i,t} \qquad (5)$$

5.5 Control Variables

Following the tradition in empirical banking research, for example de Bandt et al. (2018) and Francis & Osborne (2012), the regressions include several control variables that serve as proxies for internal and external effects. These variables cover bank lending activities, size, strategy, macroeconomic conditions, and monetary policy. Bank-specific variables are collected from Bankfocus database, and other variables are from Refinitiv Datastream.

LoansAssets: Bank lending in relation to total assets, the LoansAssets variable, tells how large share of a bank's business is in lending. Lending is among the core activities for banks, thus capturing the weight of loans in the asset portfolio is an essential proxy. Furthermore, the ability of a bank to maintain the level of lending is considered one of the indicators of how well a bank copes with crisis times (Košak et al., 2015; Jordà et al., 2021). The impact of changes in capital level on bank performance is also examined by changes in lending in some studies, such as Deli and Hasan (2017) and Gambacorta and Shin (2018).

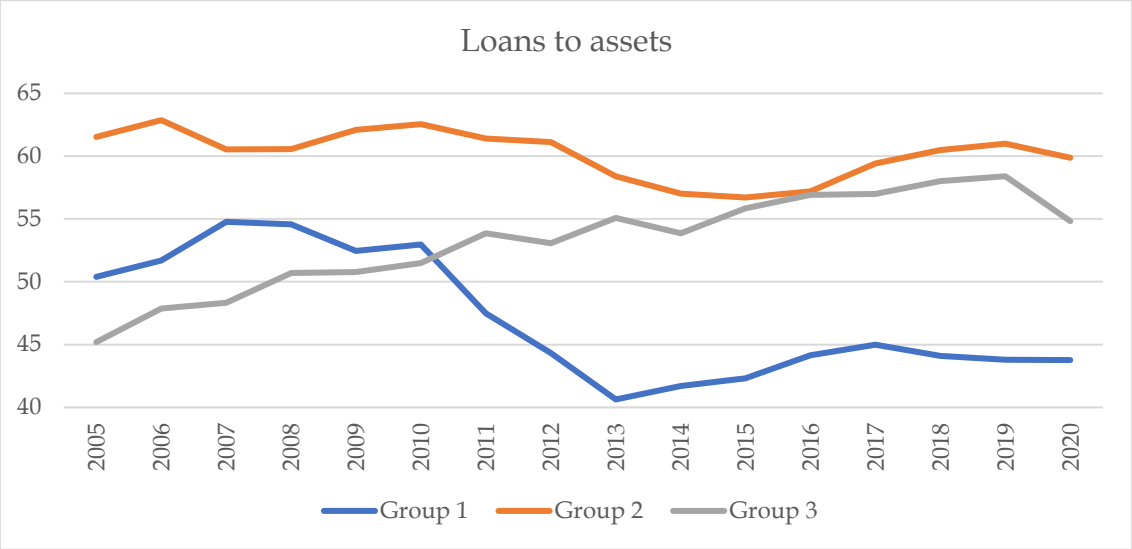

Figure 7. Annual averages of loans to total assets (%) for each bank size group.

NPL: Non-performing loans divided by total assets. Non-performing loans are bank credit that the borrower has defaulted on and has not made scheduled payments for a specified period, generally considered to be 90 days. The relation with bank performance is assumed to be negative, as a bank's returns decrease, and overall lending capacity will deteriorate if bank has a large amount of non-performing loans. The effects will be reflected in the entire financial system.

LLR: The rate of loan loss reserves to gross customer loans and advances. Loan loss reserves cover a pre-determined amount of expected loan losses, and are part of voluntary reserves. Banks can use loan loss reserves in the event of borrower's default in order to mitigate the losses incurred. For example, if a bank has loans worth of € 20,000,000 that are included in the bank's assets in the

balance sheet, and the bank estimates that 1% of the loan repayments will not be realized, the corresponding value of € 200,000 is entered to assets as negative. As can be seen from the figure 9, small banks have held loan loss reserves clearly more than the other two size groups.

Both NPL and LLR control the effect of riskiness involved in bank lending activities. Tighter capital requirements might tighten bank lending and drive banks to increase the risk level of their loan portfolios (Aikman et al., 2019).

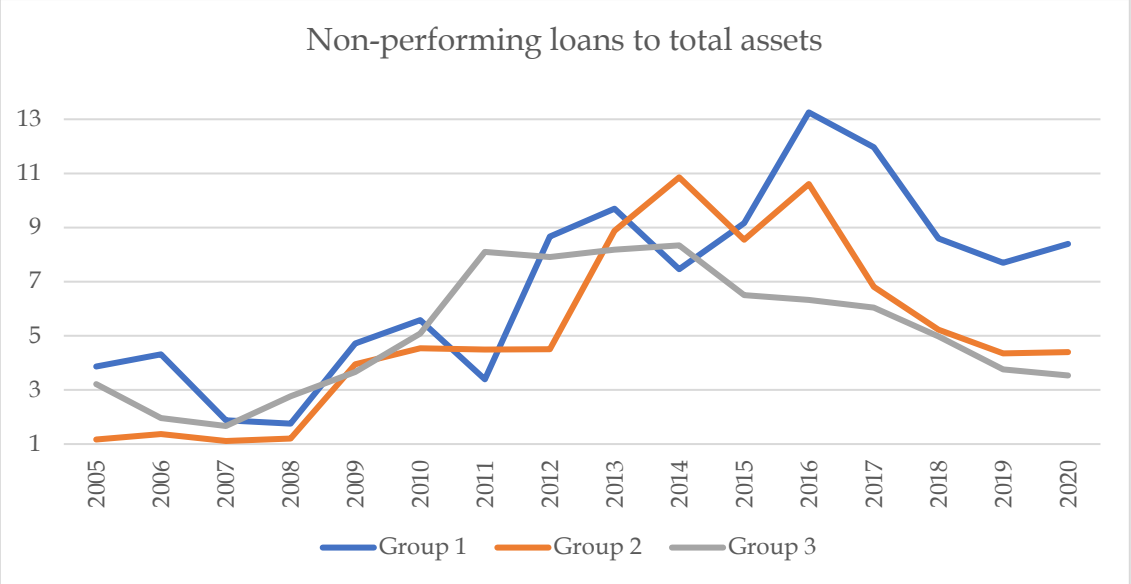

Figure 8. Annual averages of non-performing loans to total assets (%) for each bank size group.

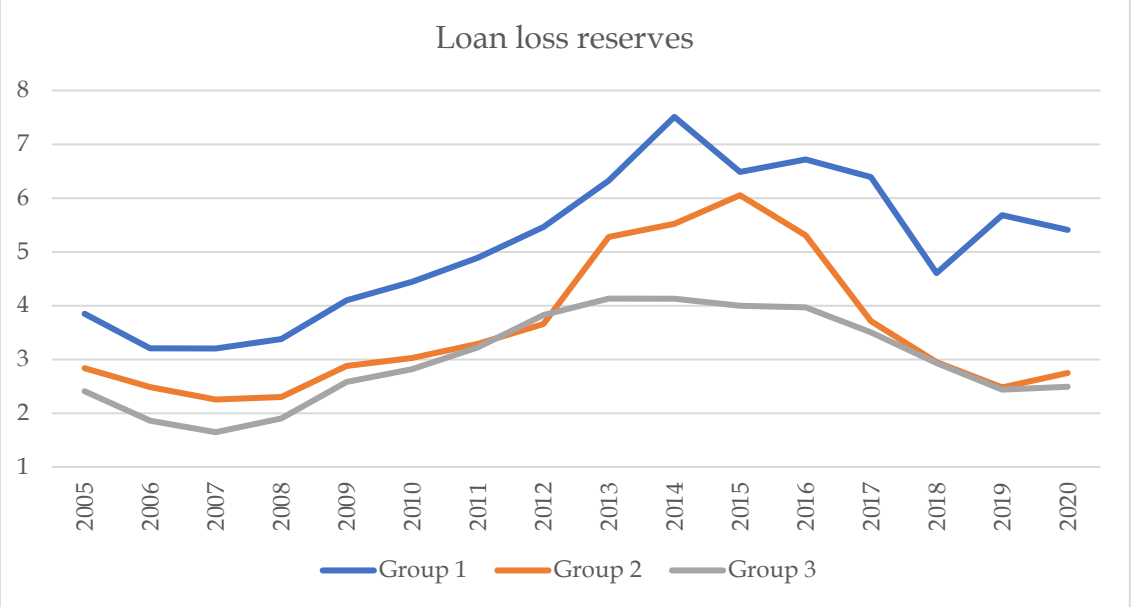

Figure 9. Annual averages of loan loss reserves to gross customer loans and advances (%) for each bank size group.

lnSize: Natural logarithm of total assets. Even though the regressions are run separately for bank size groups, there is still a large heterogeneity inside of

each size group. Similarly, in Berger and Bouwman (2013) bank size is controlled by both dividing the data to three size groups and using a natural logarithm of gross total assets as a control variable. This variable can capture the many benefits of larger size, such as better risk diversification and higher market power, as in de Bandt et al. (2018). Size is controlled by the same variable also in Le et al. (2020).

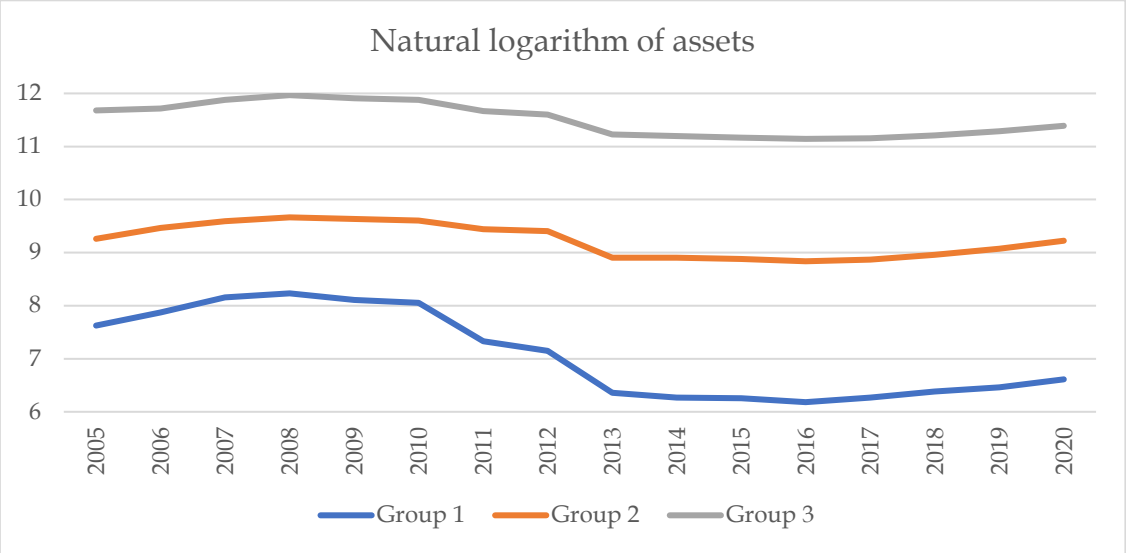

Figure 10. Annual averages of natural logarithm of total assets (in million euros) for each bank size group.

ShareDeposits: The ratio of deposits over debt reflects the importance of deposit-based fundraising for a bank's strategy. De Bandt et al. (2018) control deposit-based financing with the same variable, and Berger and Bouwman (2013) by using core deposits over gross total assets. This variable is particularly interesting during this study period, which includes a large change in interest rates. Figure 11 shows that each bank has increased deposits in relation to debt during the study period. The size of the bank seems to have a clear association on how much a bank has deposits as a source of funding, as the larger the bank, the smaller the share of deposits over debt.

LNIIOperating: The ratio of net interest income to operating revenues measures how much of the revenues of a bank's primary business activities are interest income. It is desired to observe how the interest income in year t affects the bank income for year t+1, and therefore the variable is lagged by one year. Together with ShareDeposits, LNIIOperating includes the effects of bank business strategies to the model. Banks' non-interest-based operating revenues include different kinds of fees, for example, those of service, securitization and financial management. Thus, LNIIOperating reflects the importance of interest income in a bank's business strategy. The lower the interest income, the more a bank has non-traditional banking activities, such as investment banking, issuance and investment of own funds.

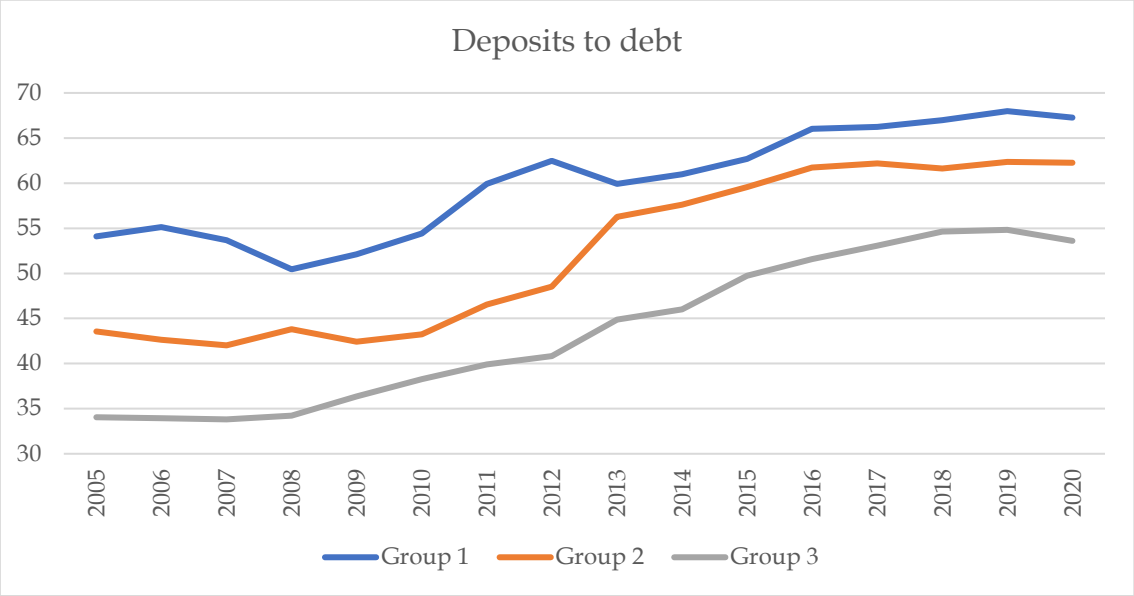

Figure 11. Annual averages of deposits to debt (%) for each bank size group.

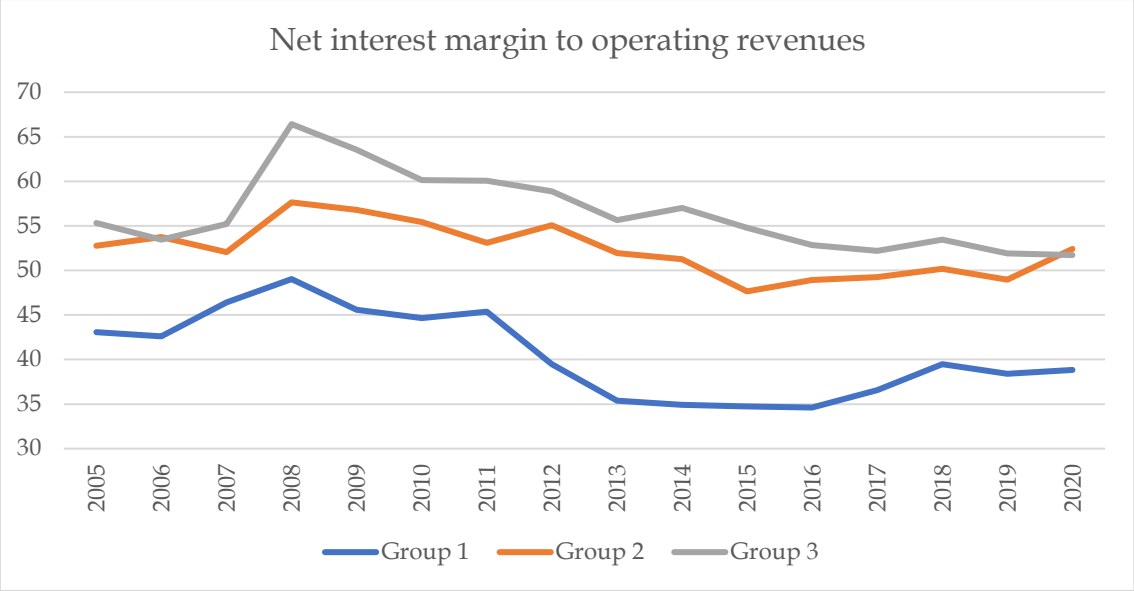

Figure 12. Annual averages of net interest margin to operating revenues (%) for each bank size group.

The control variables DGDP, DCPI and EURORISK included in the model describe the macroeconomic conditions and overall riskiness in the banking environment in the euro area.

DGDP: The annual change in the euro area real GDP, the variable examines the relation of general economic developments and banks' performance. The relation of annual change in GDP and performance is expected to be positive, as economic developments typically boost businesses. During the data period, sharp declines in the euro area GDP have been caused by the financial crisis, following the European sovereign debt crisis and later the corona virus crisis.

DCPI: The control variable of eurozone inflation is the yearly change of harmonized eurozone consumer price index. Inflation and GDP growth are

universal and widely used macroeconomic control variables in banking research, for instance, in Francis and Osborne (2012), Le et al. (2020) and Jordà et al. (2021). Inflation was at the highest level in 2007, after which it sharply fell, going back up in 2011, followed by 3 years of decline. In 2014, inflation in the euro area even fell below zero, after which it has remained well below the 2% annual target set by the European Central Bank.

EURORISK: The yield spread between Italian government bond of 10-year maturity and German government bond of the same maturity. The same yield spread measure is also used by Rogers, Scotti and Wright (2014), and later followed by Haitsma, Unalmis and de Haan (2016) to capture the unconventional monetary policy surprises within the eurozone. Both Germany and Italy are large and important euro area countries, and the market for their government bonds is large and liquid. As justified in Rogers et al. (2014), monetary policy actions that reduced yield spreads within stressed eurozone countries, also resulted in increasing German sovereign bond yields, hence, the mere use of German bond rates as a measure of monetary policy surprises would not provide a sufficient view. Furthermore, Italian government bond rate quickly reflects the situational changes of the stressed euro area countries. As in Haitsma et al. (2016), the trend of this variable demonstrates the intention of ECB's unconventional monetary policy to decrease the eurozone government bond spreads.

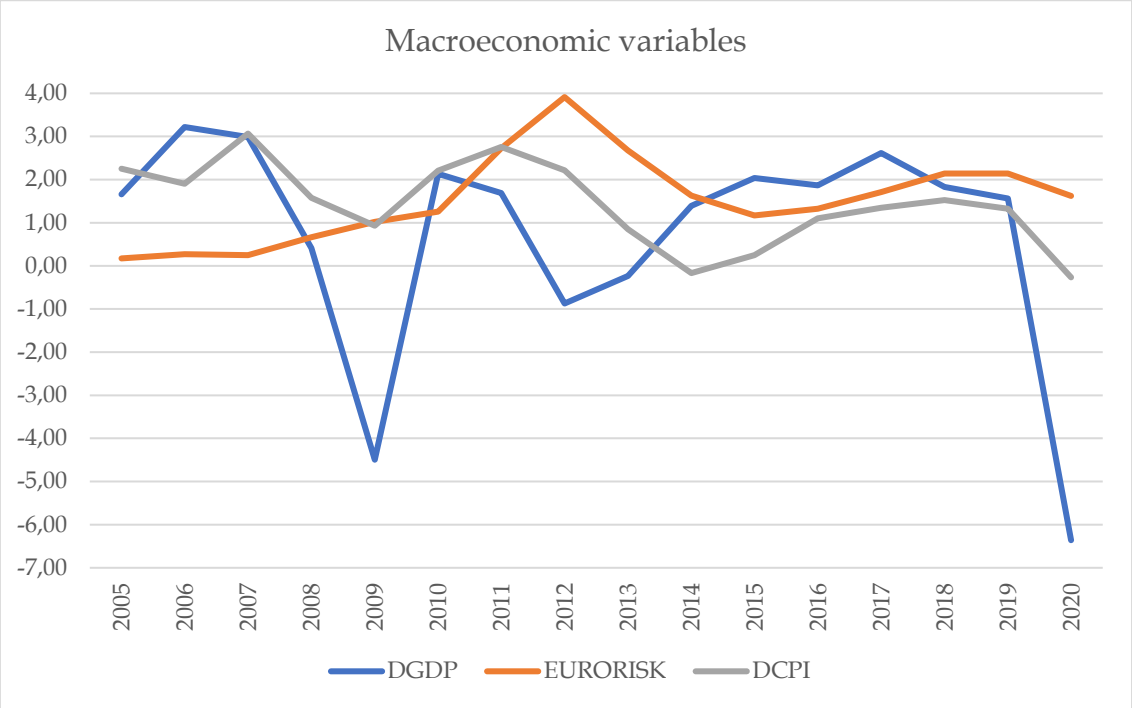

Figure 13. Annual change of eurozone real gross domestic product (DGDP, %), Italian government 10-year-bond less German government 10-year-bond (EURORISK, %), annual change of harmonized eurozone consumer price index i.e., eurozone inflation (DCPI, %).

The control variables of ShadowRate and Euribor3 include to the model the monetary policy implemented by the ECB. The data period involves a sharp decline in interest rates and an exceptionally long period of negative interest rates,

and a strong increase in expansionary monetary policy. Together with the variables DGDP, DCPI and EURORISK, these variables control the macroeconomic changes occurred during the data period.

Euribor3: The 3-month Euribor is the interest rate on interbank lending and measures the conventional monetary policy in the model. The variable represents the main eurozone loan and deposit reference rate for banks.

ShadowRate: The annual average of euro shadow rate, as estimated by Wu and Xia (2020). Shadow rate describes the notional policy rate when the decline of nominal ECB policy rates has stopped around zero, and its purpose is to present all the impacts and effectiveness of monetary policy computationally on the same scale with the policy rate. When nominal interest rates are above zero, the shadow rate is also very close to the nominal rate. Since 2014, when interest rates in Europe fell to a negative level, monetary policy has been much lighter than might be inferred from the policy rate. The negative shadow rate therefore represents a loosen monetary policy. The government bond purchase program launched by the ECB in 2015 is one example of a quantitative easing that is not reflected in policy interest rates but is reflected in the shadow rate (ECB, 2015). Policy rates alone would not be sufficient to describe the pursued monetary policy in the euro area during the study period.

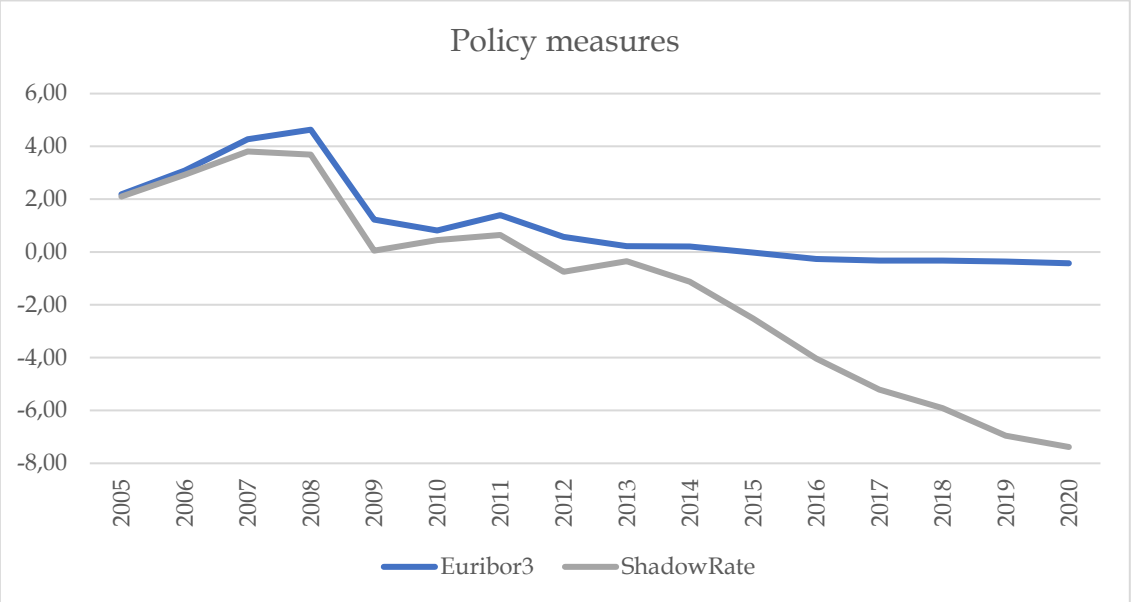

Figure 14. Annual averages of Euro shadow rate (%) and 3-months Euribor rate (%).

Table 7. Description of variables.

Variable name	Explanation
Performance – dependent variables	
ROAA	Return on average assets
RoRWA	Return on risk-weighted assets
Bank capital – independent variables of main interest	
CapRatio	Total capital / RWA
CapReq	Bank-specific capital requirement
VolCap	Voluntary capital, CapRatio - CapReq
Control variables	
Lending and riskiness in lending activities	
LoansAssets	Loans / Assets
NPL	Non-performing Loans /Assets
LLR	Loan loss reserves / Gross customer loans & advances
Bank size	
lnSize	Natural logarithm of assets (M€)
Bank strategy	
ShareDeposits	Deposits /(Assets - Equity)
NIIOperating	Net interest income / Operating revenues
Riskiness in banking environment	
DGDP	Annual change in the euro area real GDP
DCPI	Annual percentage change in the euro area harmonized consumer price index (inflation)
EURORISK	Italian Government bond yield - German government bond yield of 10-year maturity
Monetary policy	
Euribor3	Euribor 3-months interest rate
ShadowRate	Annual average of the euro area shadow rate

6 RESULTS AND ANALYSIS

6.1 Regression results

The regression results are presented in separate tables for equations 4 and 5 for ROAA and RoRWA. To select the appropriate regression model between within and random effect models, a Hausman test has been performed for each regression.

Table 8. Regression results of equation 4 for return on average assets (ROAA) by bank size group.

	Small (Group 1)		Medium (Group 2)		Large (Group 3)	
Explanatory variables	Coeff.	S.Error	Coeff.	S.Error	Coeff.	S.Error
Bank capital						
CapRatio	-0,001	0,032	0,006	0,015	**0,082*** **	0,013
Lending and riskiness in lending activities						
LoansAssets	-0,992	1,084	1,677	1,101	-0,455	0,577
LLR	0,020	0,017	**-0,136*** **	0,032	**-0,072*** **	0,025
NPL	**-0,039***	0,021	-0,010	0,018	0,005	0,014
Bank size						
lnSize	-0,441	0,487	**0,927** **	0,369	0,068	0,169
Bank strategy						
ShareDeposits	**0,021** **	0,009	**0,032*** **	0,012	**0,024*** **	0,006
LNIIOperating	0,004	0,007	**0,019*** **	0,006	0,001	0,002
Riskiness in banking environment						
EURORISK	0,169	0,224	**-0,300*** **	0,113	**-0,179*** **	0,059
DCPI	-0,175	0,176	0,019	0,128	0,008	0,066
DGDP	**0,094** **	0,037	**0,062** **	0,029	**0,053*** **	0,016
Monetary policy						
Euribor3	**0,567*** **	0,161	-0,253	0,181	-0,006	0,071
ShadowRate	-0,089	0,069	**0,118** **	0,047	**0,080*** **	0,024
Method	Fixed effects		Fixed effects		Fixed effects	
R^2	0,370		0,267		0,193	
Adj. R^2	-0,186		-0,033		-0,010	
No. of observations	148		427		739	

Table 9. Regression results of equation 4 for return on risk-weighted assets (RoRWA) by bank size group.

	Small (Group 1)		Medium (Group 2)		Large (Group 3)	
Explanatory variables	Coeff.	S.Error	Coeff.	S.Error	Coeff.	S.Error
Bank capital						
CapRatio	0,058	0,060	0,056	0,044	**0,150*** **	0,026
Lending and riskiness in lending activities						
LoansAssets	2,449	2,148	0,637	2,784	**-2,884** **	1,172
LLR	0,011	0,021	**-0,199*** **	0,060	**-0,141*** **	0,045
NPL	-0,013	0,033	-0,002	0,036	0,021	0,026
Bank size						
lnSize	-0,955	0,744	-0,043	0,743	-0,098	0,324
Bank strategy						
ShareDeposits	0,022	0,017	**0,051** **	0,025	**0,057*** **	0,011
LNIIOperating	0,005	0,012	**0,047*** **	0,012	**0,022*** **	0,005
Riskiness in banking environment						
EURORISK	0,734	0,710	**-0,427** *	0,246	**-0,299*** **	0,114
DCPI	**-0,832** **	0,332	-0,141	0,288	-0,073	0,126
DGDP	**0,198** **	0,075	**0,134** **	0,062	**0,151*** **	0,029
Monetary policy						
Euribor3	**0,992** *	0,514	0,172	0,485	0,070	0,137
ShadowRate	-0,098	0,217	-0,024	0,110	**0,084** *	0,047
Method	Fixed effects		Fixed effects		Fixed effects	
R^2	0,394		0,248		0,295	
Adj. R^2	-0,396		-0,109		0,107	
No. of observations	100		336		678	

Table 10. Regression results of equation 5 for return on average assets (ROAA) by bank size group.

Explanatory variables	Small (Group 1)		Medium (Group 2)		Large (Group 3)	
	Coeff.	S.Error	Coeff.	S.Error	Coeff.	S.Error
(Intercept)	**-7,837*** **	2,451			-0,559	0,575
Bank capital						
VolCap	**0,027** **	0,013	0,006	0,015	**0,028*** **	0,008
CapReq	**0,754** **	0,301	**-0,284***	0,171	**0,171*** **	0,051
Lending and riskiness in lending activities						
LoansAssets	0,467	0,587	1,643	1,098	**0,500***	0,280
LLR	**-0,024***	0,014	**-0,142*** **	0,032	**-0,074*** **	0,021
NPL	-0,016	0,011	-0,009	0,018	-0,006	0,011
Bank size						
lnSize	0,143	0,161	**1,031*** **	0,373	-0,028	0,036
Bank strategy						
ShareDeposits	**0,015*** **	0,005	**0,032*** **	0,012	**0,004** **	0,002
LNIIOperating	0,007	0,005	**0,020*** **	0,006	-0,001	0,002
Riskiness in banking environment						
EURORISK	-0,257	0,197	**-0,254** **	0,116	**-0,228*** **	0,059
DCPI	**-0,348** **	0,151	0,020	0,128	-0,028	0,064
DGDP	**0,152*** **	0,035	**0,062** **	0,029	**0,055*** **	0,015
Monetary policy						
Euribor3	0,127	0,225	-0,041	0,219	**-0,144***	0,076
ShadowRate	0,212	0,150	-0,029	0,098	**0,100*** **	0,034
Method	Random effects		Fixed effects		Random effects	
R^2	0,355		0,275		0,208	
Adj. R^2	0,292		-0,027		0,194	
No. of observations	148		427		739	

Table 11. Regression results of equation 5 for return on risk-weighted assets (RoRWA) by bank size group.

	Small (Group 1)		Medium (Group 2)		Large (Group 3)	
Explanatory variables	Coeff.	S.Error	Coeff.	S.Error	Coeff.	S.Error
(Intercept)	-4,233	4,410				
Bank capital						
VolCap	**0,053****	0,022	0,057	0,043	**0,148*****	0,026
CapReq	-0,088	0,598	**-0,895*****	0,326	**0,309***	0,158
Lending and riskiness in lending activities						
LoansAssets	1,458	1,018	0,482	2,739	**-2,825****	1,173
LLR	-0,018	0,020	**-0,217*****	0,059	**-0,140*****	0,045
NPL	-0,025	0,020	0,004	0,035	0,021	0,026
Bank size						
lnSize	0,434	0,270	0,407	0,747	-0,017	0,334
Bank strategy						
ShareDeposits	**0,025****	0,010	**0,044***	0,025	**0,058*****	0,011
LNIIOperating	-0,001	0,008	**0,052*****	0,011	**0,023*****	0,005
Riskiness in banking environment						
EURORISK	-0,526	0,393	-0,264	0,249	**-0,323*****	0,117
DCPI	-0,336	0,315	-0,128	0,283	-0,062	0,126
DGDP	**0,206*****	0,063	**0,139****	0,061	**0,147*****	0,030
Monetary policy						
Euribor3	0,658	0,586	**0,953***	0,546	-0,034	0,171
ShadowRate	-0,266	0,321	**-0,554*****	0,211	**0,175***	0,102
Method	Random effects		Fixed effects		Fixed effects	
R^2	0,320		0,276		0,297	
Adj. R^2	0,218		-0,073		0,107	
No. of observations	100		336		678	

Note: In the tables 8 to 11, statistical significance is indicated by ***, **, * at the 1%, 5%, and 10% levels, respectively.

6.2 Interpretation of Results

In interpreting the results, it should be noted that the data is heterogeneous and includes banks from several different eurozone countries. Banks in the euro area operate largely within a reconciled framework, and banking legislation has been harmonized especially in the aftermath of the 2008 financial crisis. However, different local factors affecting banks in different countries may not have been captured in this study, and the country-specific factors might affect particularly the performance of small, nationally operating banks. The number of

observations available for different variables has been higher the larger the bank in question. Therefore, the difference in the number of observations, especially between small and large banks, is noteworthy.

6.2.1 Total Capital Ratio

There are several evidence to suggest that banks benefit from higher capital level (see, for example, Mehran & Thakor, 2011; Košak et al., 2015; Deli & Hasan, 2017). Berger and Bouwman (2013) find a positive relation between capital and performance mainly during periods of financial distress. Higher capitalization helps banks to better recover from the crises and maintain normal operations also during the crisis (Jordà et al. 2021).

Based on the results of equation 4, the contribution of total capital ratio to bank returns appears to be significantly positive for large banks as measured by both ROAA and RoRWA, by coefficients of 0,082 and 0,150, respectively. For small and medium-sized banks, the results are not statistically significant for either return ratio. The outcome of the benefit for large banks from higher capital level supports the findings in Coccorese and Girardone (2021) that ROA and capital level have a positive relation especially for large banks. Yet, Coccorese and Girardone (2021) did not find this result for G-SIBs, which are not disaggregated in the group of large banks in this study. On the other hand, Vazquez and Federico (2015) find capital buffer to be beneficial especially for small domestic banks, while the effect is very low for average and globally operating large banks, which is contrary to the obtained regression results. Nevertheless, Vazquez and Federico (2015) identify weak capital together with excess leverage to be the main source of bankruptcy for large banks, which in turn speaks in favor of the beneficial effect of higher capital for large banks.

The relation between capital level and bank performance is found to be influenced by different factors, which are not all captured in this study. Using stock returns as a performance measure, Garel and Petit-Romec (2017) find evidence that higher capital level and performance are negatively related during crisis times, when capital is provided by short-term institutional investors. Country-specific conditions, such as the level of corruption and economic freedom, affect the relationship between capital ratio and the performance measured in the ROA, as noted in Coccorese and Girardone (2021). The same study also highlights the factors of bank size and timing (crisis versus no-crisis) in the same matter, and these factors are also captured in equation 4.

6.2.2 Bank-specific Regulatory Capital Requirement and Voluntary Capital

In the second stage of the empirical part, the regression of equation 5 is performed, where the difference to equation 4 is that capital is represented as CapReq, the bank-specific capital requirement, and VolCap, total capital less capital requirement, i.e., voluntary capital. By separating total capital ratio into these two components, it can be examined whether the effect of capital level on

performance stems precisely from the capital requirement or the voluntary capital. With regard to the relevance of this phase of the study, it is particularly interesting whether the returns of small and medium-sized banks can be explained by these two variables, as the CapRatio variable did not have statistically significant results in either case. In addition, it is of interest if the relation of bank capital and performance is significantly accentuated by either of the two capital-based variables.

The regression results on the relation between capital requirements and bank performance are diverse among banks of different sizes. The CapReq is the largest statistically significant coefficient for ROAA of small banks, the effect being positive. However, this relation disappears for RoRWA. Capital requirement variable has a statistically significant positive relation for both return measures of large banks, and the effect almost doubles for RoRWA, yet the statistical significance is higher for ROAA. Finally, for medium banks, the relation is negative in the case of both return ratios, and this result is emphasized on RoRWA.

In previous studies on the impact of minimum capital requirements on bank performance, the requirements are found to have both strengthened and weakened bank performance. According to Benes and Kumhof (2015), the countercyclical buffer introduced by Basel III regulation has helped banks to better cope with times of financial distress. Coccorese and Girardone (2021) find Basel III-based capital requirements to have a small positive impact on ROA. Then again, Le et al. (2020) find higher capital requirements of Basel III to have a negative effect on bank ROA based on a study of the largest UK and Australian banks during 2000-2019. Various studies regarding the bank survival and performance during the last financial crisis find the reforms of Basel III needed (see, for example, Francis & Osborne, 2012).

In the figure 6, yearly averages of eurozone banks during 2005-2020 show that banks of all sizes hold far more capital than what is required. Although capital requirements have only risen since 2010, the trend of voluntary capital has been upwarding already before that.

Voluntary capital has either a positive effect or no effect at all on bank returns, while negative relations are not found. The coefficients of VolCap are statistically significant and positive for both ROAA and RoRWA of large and small banks. Voluntary capital does not appear to have an impact on return ratios of medium-sized banks.

The positive relation of voluntary capital and performance for small and large banks is emphasized in RoRWA. For ROAA, the coefficients result around 0,028 for both small and large banks. In the case of RoRWA, instead, the effect almost doubles for small banks, and for large banks, the coefficient is more than fivefold compared to that for ROAA. This suggests that voluntary capital may improve bank risk profile.

The question arises on why small banks have maintained a significantly larger excess capital buffer in recent years compared to larger banks if the benefit for small banks is even slightly lower than that for large banks. Small banks are

potentially more vigilant, as Berger and Bouwman (2013) find that small banks are at risk at all times, whereas larger ones only in the times of crisis.

Findings in Bagntasarian and Mamatzakis (2019) resemble these results regarding voluntary capital at least partially. Bagntasarian and Mamatzakis (2019) find that the capital excess of required minimum improves bank performance measured by ROA, as well as by ROE and NIM, although the effect varies depending on the current performance level and some risk factors. If a bank is in a higher performance regime, the positive effect of capital on performance found in Bagntasarian and Mamatzakis (2019) is relatively smaller to the banks belonging to a lower performance regime. This effect is not considered in this study, yet some remarks can be made in regard. Based on the yearly averages of the two return ratios presented in figures 2 and 3, medium banks have higher ROAA and RoRWA on average compared to large banks, in which case the positive effect of voluntary capital is emphasized. However, the average annual observations of the two return ratios are not clearly higher for medium-sized banks compared to small banks.

The results of equation 5 add to de Bandt et al. (2018), and expand the sample from theirs, which only covers French banks. De Bandt et al. (2018) emphasize the importance of voluntary capital as an improving factor of ROA, whereas the impact of capital requirements is considered negligible in their study. The results obtained in this study provide evidence that voluntary capital and minimum capital requirements are both significant components of capital behind the relation of capital level and performance. Furthermore, subject to bank size, voluntary capital may also be irrelevant, as in the case of medium-sized bank group. Another extended view in this study to supplement de Bandt et al. (2018), is that in comparison to ROA, voluntary capital seems to be more pronouncedly related to risk-adjusted returns.

When the results of equation 5 are compared with those of equation 4, the explanatory role of capital on performance is affirmed for each bank size group. Where the total capital ratio of small and medium-sized banks does not appear to affect bank performance at any statistically significant level, the capital variables obtain statistically significant results for both bank size groups when capital is divided into required minimum capital and voluntary capital. Medium-sized banks seem to suffer from rising capital requirements, while voluntary capital has no relation to their performance.

The negative effect of capital requirements to medium-sized banks might be explained by the relation of minimum requirements and optimal capital levels, which is emphasized in some studies (Berger et al., 1995; de Bandt et al., 2018). The effect of changes in capital requirements on a bank's performance depends on the bank's optimal level of capital and the extent to which the change in regulation is to each bank's own optimum (de Bandt et al., 2018). If the compliance with the requirements takes a bank further from the optimal level, the effect on performance will be negative. However, this study does not provide a direct answer as to why the optimal level of capital for medium-sized banks is more inconsistent with capital requirements compared to smaller or larger banks.

Answering this question would probably require a more detailed definition of the characteristics of the banks in the medium group, as this group is probably more heterogeneous than the other two.

For large banks, an increase in capital requirements is associated with higher performance as measured by both return ratios. Measured by RoRWA, the coefficients for all three capital variables used are higher than those measured by ROAA. This indicates that higher capital is to improve the risk tolerance of large banks' asset portfolio. The relation of the bank-specific capital requirement and performance is higher than that for voluntary capital, but statistical significance for voluntary capital is at 1% level for both return measures of large banks. For RoRWA, the CapReq coefficient of 0.309 is statistically significant at the 10% level, and the VolCap of 0.148 is at the 1% level.

6.2.3 Lending and the Riskiness Involved in Lending Activities

At a theoretical level, Aikman et al. (2019) argue that achieving higher capital level may lead banks to move towards riskier credit customers to gain higher lending rates, and lower lending supply. Such activities might potentially increase the risk associated with a bank's business, which can be expected to be reflected in RoRWA. However, some studies prove that this has not been the case in reality, for instance, Cohen and Scatigna (2016) do not find evidence that after the financial crisis of 2008 banks would have achieved higher capital levels by reducing lending. Furthermore, Francis and Osborne (2012) do not either find proof, based on UK banks during 1996-2007, that the adoption of tighter capital requirements would have been done by changes in lending. Deli and Hasan (2017) find evidence for only slight negative effects of tighter capital requirements on bank lending growth.

For RoRWA of large banks, the LoansAssets variable has negative, statistically significant, and remarkably high coefficients. The result does not differ much whether voluntary capital is included in the model or not, resulting -2,884 and -2,825 for equations 4 and 5, respectively. In the regression results of equation 4, the LoansAssets variable does not obtain a statistically significant coefficient for ROAA of large banks, but when the capital requirement and voluntary capital are included in the model, the coefficient is 0,50, although the significance level is only 10%. These results suggest that increased lending by large banks has greatly weakened banks' level of risk. This may be due to the above-mentioned phenomenon, where banks respond to tightening of capital requirements by putting more weight on higher-risk credit customers. Low and negative interest rates might have also pushed banks to move towards riskier lending behavior. The overall return generation of large banks does not seem to be affected by lending activities, or returns have even slightly improved. However, increases in lending have increased the overall risk taken by large banks and the increased risk-taking has not been compensated in terms of net income.

Statistically significant coefficients of LoansAssets are not found for small or medium banks for any regression results. The strategy in lending of small and medium-sized banks seems to be different from that of large banks. Changes in

the level of lending have been reflected in the risk taken by small and medium banks, and the changes have not affected the efficiency of return generation.

The only statistically significant outcome found for NPL variable is for ROAA of small banks, resulting as a coefficient of -0,013 on the significance level of 10%, i.e., rather modest finding. These results are surprising, as the impact on bank performance would be expected to be negative, but based on these results, NPL does not appear to influence banks' return generation within the eurozone banks.

LLR has statistically significant, negative coefficients for ROAA and RoRWA of medium and large banks, and in the case of both ratios, higher values for medium-sized banks. In addition, for both of the size groups, the effect is emphasized for RoRWA. Results do not remarkably differ between equations 4 and 5. A statistically significant at 10% level, slightly negative effect also appears for small banks in the case of equation 5 for ROAA.

It seems that although the LLR itself reduces assets by which returns are distributed, the effect of these reserves on the return measures is still negative. The LLR reflects a bank's perception of the stability of its loan portfolio, but banks decide on the size of the reserve themselves, so the comparison of loan loss provisions between banks is not straightforward. Low rate of loan loss reserves over total customer loans may reflect either the low risk of a bank's loan portfolio or a higher risk taken by a bank in its approach for losses.

6.2.4 Bank Size

The lnSize variable results statistically significant, positive coefficient for ROAA of medium banks, with strengthening effect in the case of equation 5. Interestingly, this is the largest statistically significant coefficient for ROAA of medium banks, while there is no evidence of relation between lnSize and performance of small or large banks. The effect on medium banks disappears for RoRWA, hence the beneficial effect does not appear to improve the risk structure of assets.

Bank size itself can create economic strength, as argued in Berger and Bouwman (2013). The growth of medium-sized banks seems clearly beneficial for performance. The reason why this effect is so significant and occurs only in the case of medium-sized banks, may be due to the heterogeneity of the size group. It can include both smaller, nationally operating banks and relatively large banks operating in a wider geographical area. It is possible that the increase in the size of a bank in terms of total assets will exceed a certain threshold within this size group, above which the bank will benefit from a larger market share and wider opportunities for risk diversification, among other things.

These results add to De Bandt et al. (2018), as they find some slight, positive relation between natural logarithm of total assets and ROA, and some stronger effect on bank risk-adjusted return on capital, whereas this study targets the positive effect dependency on the size group of a bank. Using US bank data of earlier period, Berger and Bouwman (2013) find size-variable to have a positive effect on small banks only.

6.2.5 Bank Strategy Measures

The coefficient of LNIIOperating is statistically significant for ROAA of medium size banks, and for RoRWA of medium and large banks, with positive values. LNIIOperating does not appear to have a significant impact on the performance of small banks. For large and especially for medium-sized banks, an increase in LNIIOperating has a positive, yet small effect on bank performance. The effect for medium banks is larger for RoRWA, and for large banks only appears for that ratio. This indicates that an increase in the share of NII in relation to operating revenues reduces the risk associated with banks' operations.

ShareDeposits has a significant, although small positive relation with ROAA for all size of banks, and with RoRWA of medium and large banks. Fundraising in the form of deposits has thus slightly increased banks' earnings in the euro area. Although the coefficients are small, the results are statistically highly significant. This result differs from de Bandt et al. (2018) as they report from neutral to slighty negative effects on ROA. Both this study and de Bandt et al. (2018) find only very small variability on effects around zero. Berger and Bouwman (2013) find a strong positive effect on bank surveillance for small and medium banks, whereas an increase in core deposits to assets decreases the market share of small banks.

6.2.6 Risk Measures

The research literature in banking sector has provided strong evidence that GDP growth improves bank performance (see, for example, Francis & Osborne, 2012; de Bandt et al., 2018). Statistically significant positive coefficients between DGDP and both return measures are found for each bank size group, as expected, and the relation is emphasized for RoRWA. The impact is accentuated for small banks, yet the coefficients for large banks result all statistically significant on 1% level.

In the case of large banks, EURORISK variable results negative and statistically significant on 1% level for both return measures. The negative relation is larger for RoRWA, and when capital requirements and voluntary capital are included. An increase in the relation for RoRWA is expected, as the increase in risk spread indicates an increase in risks in the business environment of the euro area banks. Large banks operate presumably within a large geographical area and in many euro area countries, and regional expansion of banks diversifies their operating environment and exposes them to a wider range of risks. For medium banks, the negative effect for ROAA is even higher, but weakens in statistical significance for RoRWA. Bank performance of small banks does not seem to be vulnerable to the euro area risk spread growth. The results indicate that the larger the bank in question, the more clearly eurozone risk spread and bank returns are related.

Higher inflation transfers to higher costs of capital, leading expectedly to weaker bank performance (Le et al., 2020). The control variable of eurozone inflation, DCPI, provides evidence of a statistically significant relation between

inflation and bank performance only for the small banks, in which case the relation is negative for both return ratios, for ROAA in equation 5 and similar coefficient in equation 4 for RoRWA. No effect is observed for larger banks. The impact of inflation on bank performance may depend on their geographical location, as proved in Le at al. (2020), and this study does not take a stand on that, yet it adds that the difference in effects may also depend on the size of the bank.

6.2.7 Policy Measures

Interest rates and bank profitability have traditionally been seen to be in a positive relation due to the interest margin as the core of bank business. Borio, Gambacorta and Hofmann (2017) find evidence of a weakening effect of persistent period of low interest rates on bank profitability. Overall, the impact of Euribor3 on bank performance varies greatly between different bank size groups. Positive, relatively high coefficients for Euribor3 are found for small banks' both return rates in the case of equation 4, as statistically significant on 1% and 10% level for ROAA and RoRWA, respectively. When adding voluntary capital and capital requirements to the model, these effects disappear. Especially in the case of ROAA, CapReq seems to replace Euribor3 as the main positive explanatory variable for small banks. A negative effect is found for ROAA of large banks from equation 4, and a positive effect for medium banks for ROAA from equation 5. Yet, in both cases, the statistical significance is only at the 10% level. The impact of interest rates on banks' returns is therefore surprisingly inconsistent and inconspicuous.

Altunbas, Gambacorta and Marques-Ibanez (2010) evidence the relatively loose monetary policy to increase bank risk among European and US banks during 1998-2008. More recently, based on European banks over the period 2000-2015, Brana, Campmas and Lapteacru (2019) find similar results. They capture monetary policy with policy interest rate, deposit facility rate, shadow interest rate and natural logarithm of central banks' total assets. Their results indicate that unconventional monetary policy increases bank risk-taking, and this effect is stronger when interest rates are low or negative. Therefore, the impact of monetary policy is expected to be emphasized in RoRWA.

A declining shadow rate indicates loosen monetary policy. Hence, a positive coefficient means that the tighter monetary policy has a positive effect on bank returns, whereas unconventional policy acts are harmful. In terms of ROAA, unconventional monetary policy is found damaging for medium and large banks, but this effect disappears for medium banks when voluntary capital and capital requirements are included in the model. For large banks, coefficients for RoRWA are slightly emphasized, yet, surprisingly, with weaker statistical significance. Results obtained on large banks resemble findings in Mamatzakis and Bermpei (2016), where unconventional monetary policy is measured by the central bank's assets and excess reserves. Their study on the effects of the Federal Reserve's unconventional monetary policy on the US bank sector over the period 2007-2013 provides evidence of negative impact on bank performance. However, the impact on bank risk is not as clear in these results as expected based on Altunbas et

al. (2010) and Brana et al. (2019). Moreover, the effect on RoRWA for medium banks turns reverse in the presence of CapReq and VolCap, indicating that loosen monetary policy is increasing RoRWA. For small banks, no statistically significant coefficients are obtained.

The impact of monetary policy, both in terms of Euribor rate alone and measured by the shadow rate, has varying effects among bank size groups. Bank-specific qualities, such as low dependence on deposits as funding and higher asset diversification, which can decrease the negative effects on performance as argued by Mamatzakis and Bermpei (2016), are controlled in this study.

7 CONCLUSIONS

The purpose of this thesis is to study the impact of capital structure on bank performance in the euro area. The research data consists of 308 euro area banks from 2005 to 2020. This study period enables to review of the tightening of capital regulation, as it encompasses the transition from Basel I to Basel II and to the prevailing Basel III framework. Furthermore, the period captures the global financial crisis, the sovereign debt crisis and, most recently, the COVID19 -crisis, as well as an exceptionally long period of low and negative interest rates and low inflation. ROAA and RORWA are chosen as the variables describing bank performance. These two variables can be used to compare the effect of capital on performance depending on whether a bank's level of risk is considered. Banks are divided into three groups based on total assets to identify differences stemming from bank size. In the first stage of the empirical study, capital is represented as total capital ratio, and in the second part, capital is divided into a bank-specific capital requirement and the excess part, voluntary capital. This study is the first of regarding the voluntary bank capital with such a broad euro area-wide data. In addition, a broad set of control variables are included to capture both internal and external factors.

The impact of tightened capital requirements on banks has been thoroughly studied in the banking literature and evidence is provided for positive as well as for negative effects. Higher capital is found to both help banks to survive through times of financial distress and faster the recovery from crises (Jordà et al., 2021) and enhance returns (De Bandt et al., 2018, Coccorese & Girardone, 2021). On the contrary, Le et al. (2020) find accumulating more capital to limit banks' efficiency, by hindering lending and expanding of business. Yet, Deli and Hasan (2017) argue that the negative effects of capital on lending remain modest and transient, and capital is even evidenced to boost lending (Gambacorta & Shin, 2018).

The results of the empirical study on total capital level suggest that large banks benefit from higher capital, and it lowers the bank risk. Instead, total capital level has no observed effect on the performance of small and medium-sized banks. The results of the second stage of the study, in which total capital is divided into bank-specific minimum requirement and voluntary capital, differ greatly between bank size groups. Increase in the minimum capital requirements enhances returns of large banks. These results are more pronounced for RoRWA compared to ROAA, which suggests a strengthening effect on the risk profile of large banks. For small banks, the effect is also positive for ROAA, but disappears in the case of RoRWA. For medium-sized banks, the impact of capital requirement is negative, and notably emphasized for RoRWA. Thus, the effect seems to be contrary as for large banks.

Finally, voluntary capital has either a positive or neutral impact on performance. The effect is positive for small and large banks for both return rates, accentuated for RoRWA, indicating a mitigating effect on bank risk. Holding

capital excess of minimum requirements might be cautiously recommended, particularly for large banks to improve risk tolerance. Meanwhile, no relation is evidenced for medium banks. De Bandt et al. (2018) argue that it is the voluntary capital that boosts bank performance as measured by ROA, whereas the change in capital requirements has no observed effect on it. De Bandt et al. (2018) emphasize that the bank-specific level of optimal capital defines whether an increase in capital level is beneficial for performance, i.e., whether it pushes a bank closer or further from its optimal capital level. Based on that, the optimal capital level of different sizes of banks seems to differ, while further research is needed to study the factors creating the optimal to differ significantly between the size groups.

In addition to findings regarding bank capital structure, the control variables provide some noteworthy results. Increase of loans in asset portfolio seems to be remarkably damaging for RoRWA of large banks, while even a slight positive effect is captured for ROAA. This might indicate higher risk associated with credit growth of large banks, yet further research should be done in respect of why this is the case for large banks, while no evidence is found for small or medium-sized banks. It is also remarkable that the largest statistically significant explanatory variable for ROAA of medium-sized banks is the natural logarithm of assets. Thus, in their group of apparently heterogeneous banks, they seem to clearly benefit from being closer in size to the group of large banks.

Each bank size group is sensitive to changes in the macroeconomic environment, although the effects vary. Eurozone risk captured by the yield spread of German and Italian government bonds is harming both medium and large bank returns, meanwhile, no effect is found for small banks. This might stem from the geographically wide risk exposure of the business of medium and large banks, while small, locally operating banks are more exposed to local risk factors. Then again, inflation is unfavorable only for small banks.

Supporting earlier findings in banking research, large banks are found to suffer from unconventional monetary policy, which also increases the risk of large banks to some extent. The ROAA of medium-sized banks also reacts in a similar way, but surprisingly loosen monetary policy seems to lower the risk of medium-sized banks. Euribor interest rate appears to be an important positive driver of returns for small banks, but it has no observed effect on risk. Each size group appears to respond differently to monetary policy as measured by both indicators.

Based on the findings in this study as well as in the previous literature, it can be concluded that the impact of bank capital structure and capital requirements on bank performance is not straightforward, and bank size is among the key factors behind the differences. Variation in the effect of capital structure is of interest from a regulatory point of view. In addition to bank size, Coccorese and Girardone (2021) emphasize timing and macroeconomic factors. Research on bank capital level and capital regulation should pay wider attention to the heterogeneity of banks and the impact of time period on the role of capital, as argued by Berger and Bouwman (2013). In the light of the outcomes in this study, that

view can be shared. Bank size has a significant impact on the role of capital in a bank's performance, and in addition, banks of different sizes are exposed differently to changes in the macroeconomic environment. However, regulation of the banking sector has become significantly more complex in recent years, and a more comprehensive approach to bank heterogeneity could lead to more difficult regulation. The difficult interpretation of regulation can create challenges for both banks and its stakeholders, and complicate bank reporting. Regarding further research, it would be useful to control more specifically, for example, the geographical location of business activities when examining the differences between the euro area banks.

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APPENDIX 1

Appendix 1. Omitted values.

Variable	Omitted values	
	Lower limit (%)	Upper limit (%)
ROAA	-55,87	67,20
RoRWA	-58,94	52,28
CapRatio		70,03
LNIIOperating	-75,97	150,33
NPL		99,99
LLR		70,46
VolCap		60,19

Note: The values outside of these boundaries are omitted from the dataset. These omitted values are picked manually since typical proxy methods were not suitable due to a high randomness and skewness of the extreme observations.

APPENDIX 2

Appendix 2. Annual boundaries for bank size groups by total assets. Values in millions of euros.

Year	Medium banks	
	Lower limit (M€)	Upper limit (M€)
2005	5759,26	22081,66
2006	6870,09	25333,55
2007	8241,59	30617,43
2008	9092,89	32721,30
2009	8536,96	33441,83
2010	8434,64	32587,65
2011	5818,94	26703,42
2012	5544,72	25634,35
2013	2593,55	17383,42
2014	2639,81	16516,44
2015	2622,57	16001,02
2016	2354,01	16101,99
2017	2569,29	16641,38
2018	2940,61	17449,79
2019	3134,82	18712,83
2020	3781,02	21313,89

Note: Each year size groups are formed as percentiles of total assets of all banks. On an annual basis, banks with total assets less than lower limit belong to group 1 (small

banks), banks with total assets equal or greater than lower limit and less than upper limit belong to group 2 (medium-sized banks), banks with total assets greater than upper limit belong to group 3 (large banks).