The effect of capital ratios on the risk, efficiency and profitability of banks: Evidence from OECD countries[1]

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Abstract

Using a sample of 1,992 banks from 39 OECD countries during the 1999–2013 period, we examine whether the imposition of higher capital ratios is effective in reducing risk and improving the efficiency and profitability of banking institutions. We demonstrate that while risk- and non-risk based capital ratios improve bank efficiency and profitability, risk-based capital ratios fail to decrease bank risk. Our results cast doubts on the validity of the weighting methodologies used for calculating risk-based capital ratios and on the efficacy of regulatory monitoring. The ineffectiveness of risk-based capital ratios with regard to bank risk is likely to be exacerbated by the adoption of the new Basel III capital guidelines. While Basel III requires banks to hold higher liquidity ratios along with higher capital ratios, our findings suggest that imposing higher capital ratios may have a negative effect on the efficiency and profitability of highly liquid banks. Our results hold across different subsamples, alternative risk, efficiency, and profitability measures and a battery of estimation techniques.

Key Words: Bank capital, Basel capital, risk, efficiency, profitability, principal component analysis, quantile regressions.

JEL Classification: G21, G28, G29

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1. Introduction

Since the enactment of the Basel I Accord in 1989, followed by Basel II in 2004 and most recently the Basel III Accord in 2010, the definition of bank capital has evolved dramatically in an effort to improve banking system stability and fill the harmonization gap that had caused previous financial crises. The 2007-2008 financial crisis, in particular, made it clear that capital requirements alone are insufficient to prevent bank failures. For instance, many of the banks bailed out by governments held adequate capital shortly before the crisis (Demirgüç-Kunt et al., 2013). The shortcomings of earlier Basel Accords prompted the Basel Committee on Banking and Supervision (BCBS) to implement yet another set of guidelines for banking regulation. The BCBS's efforts resulted in the Basel III guidelines, which require banks to be more rigorous by redefining capital structure. In addition, in Europe, this was followed by a reform plan to create a European Systemic Risks Board (ESRB) that includes a European Banking Authority (EBA) to provide new macroeconomic policies to prevent the build-up of speculative bubbles.

The Basel III Accord aims to improve the quality and increase the size of a bank's equity base. Accordingly, the new guidelines consider three inter-related measures of capital requirements: i) the capital adequacy ratio (TCRP), which calls for a minimum ratio of 8% of capital to risk-weighted assets; ii) the Tier1 capital ratio (T1RP), which requires a minimum ratio of 6% of Tier1 capital to risk-weighted assets; and iii) Tier1 common equity (CET1), which requires a minimum ratio of 4.5% of common equity to risk-weighted assets.[2] In this paper, we compare the impact of capital on the risk, efficiency, and profitability of the banking sector. Specifically, we compare and contrast various definitions of capital (Basel risk-based and traditional, non-risk-based capital ratios) using a sample of 1,992 banks located in 39 OECD countries over the period 1999-2013.

We focus on bank capital because of the mixed literature on its effect on bank risk and performance. Capital serves as a tool to avoid future financial crises and as a security mechanism to absorb any contagion effects. Therefore, it should be of particular interest to practitioners and regulators in OECD countries because, on the one hand, holding higher capital ratios forces banks to absorb losses

[2] Basel III also requires banks to create a capital conservation buffer (CCB) that equals 2.5% of risk-weighted assets (rwa) and a countercyclical buffer (CB) that may vary between 0% and 2.5% of risk-weighted assets. While the former ensures that banks have the capacity to resist and absorb losses during stressful situations, the latter is used to provide funds to ensure the continuity of lending activities and thereby avoid economic stagnation. For more details, refer to the Basel III phase-in arrangements and the Basel III overview table available at: http://www.bis.org/bcbs/basel3.htm.

in cases of default instead of benefiting from expensive governmental bailouts. For instance, in the 2007-2008 crisis, many OECD countries had to intervene and bail out large banks who became severely undercapitalized (Eubanks, 2010). The European Union launched a bailout plan of €200 billion using taxpayers' money to save distressed banks and other financial institutions. On the other hand, higher capital can decrease leverage, a major activity of banks in OECD countries.[3] For example, banks in the United Kingdom had a financial leverage of 51.9% in 2008 (cf., Dullien et al., 2010). Thus, one might also argue that holding higher capital ratios can put constraints on bank activities, weaken economic growth, increase bank risk, and decrease efficiency and profitability. Furthermore, it has been shown that banks' capital ratios can be procyclical (Repullo and Suarez, 2012) which makes raising additional capital to maintain the minimum level of capital requirements even harder to achieve when crises occur. Thus, given that the GDP growth of OECD countries decreased from 2% in 2007 to -3.9% in 2009, the requirement to hold higher capital could have a more damaging effect in periods of economic turmoil by reducing financial institutions' ability to finance the real economy (Dullien et al., 2010).

While previous studies mainly use bank equity to assets to examine the effect of capital ratio on risk, efficiency and profitability, we use nine definitions of capital. This approach allows us to determine which kinds of capital are most effective in enhancing banking system stability and performance. We start by examining whether risk-based capital ratios are more effective in reducing bank risk and improving bank performance than traditional capital ratios, in the light of renewed debate that casts doubts over the effectiveness of risk-based estimation techniques (Blum, 2008; Cathcart et al., 2015; Dermine, 2015). Second, we investigate whether high quality capital, such as common equity and Tier 1 capital, is more effective at absorbing losses and signaling the quality of bank assets than other capital, such as Tier 2 capital (Haldane, 2012; Demirgüç-Kunt et al., 2013). By examining the effect of capital on bank risk, efficiency and profitability, our study is different from Demirgüç-Kunt et al. (2013), who examine the impact of capital on bank stock returns, and Anginer and Demirgüç-Kunt (2014), who examine the impact of capital on bank systemic risk. Our findings have important implications for regulators and policy makers and add to the ongoing debate on the regulations that require banks to comply with capital guidelines.

[3] For more details, please refer to the OECD banking sector leverage chart available at: https://data.oecd.org/corporate/banking-sector-leverage.htm .

We find that traditional, non-risk based capital measures in the form of common equity and tangible equity reduce bank inefficiency and improve profitability but require banks to hold higher loan loss reserves. Risk-based capital ratios also increase bank efficiency and profitability but do not affect loan loss reserves. In addition, we find that Tier 2 capital proxied by other capital fails to show any significant association with bank risk, but reduces efficiency and profitability. This is consistent with the BCBS's recommendations to reduce the reliance on Tier 2 capital.

Our results hold across a battery of robustness checks including when we divide the sample into small, medium, and large banks and when we consider the following subsamples: too-big-to-fail banks, highly liquid banks, and banks during the financial crisis. We find that the capital effect is more pronounced for too-big-to-fail banks whereas it is reversed for highly liquid banks. The latter result indicates that higher capital ratios reduce the efficiency and the profitability of highly liquid banks. We further demonstrate that during the crisis period, highly capitalized banks have higher loan loss reserves, higher net interest margins, and lower costs. Finally, our results remain unchanged throughout a battery of robustness tests including: the use of additional macroeconomic and institutional control variables, alternative measures of bank risk, profitability, and efficiency, a principal component analysis (PCA), quantile and three-stage least squares regressions, and a set of other estimation techniques.

Our research makes both operational and methodological contributions to the existing literature. From an operational perspective, we extend the literature that investigates the inter-relationships between risk, capital, and profitability (Altunbas et al. 2007; Tan and Floros, 2013; Lee and Hsieh, 2013) by examining the impact of the Basel capital ratios (versus the traditional capital ratios) on the risk, efficiency, and profitability of banks. This allows governments and regulators to determine which kinds of capital are more effective in enhancing banking system stability and performance. Second, the insights derived from comparing the Basel and traditional capital ratios are important for policy makers, as they address the question of whether imposing banking capital guidelines is indeed effective. Third, while the Basel III Accord proposes new liquidity guidelines along with capital requirements, our findings suggest that requiring highly liquid banks to hold higher capital might impede their efficiency and profitability. This raises questions about the financial impact of simultaneously imposing the Basel III capital and liquidity requirements on the banking system. Finally, Basel and traditional capital ratios appear to have a more pronounced effect on too-big-to-fail banks than on other banks. From a methodological perspective, we add to the empirical literature and apply a Principal Component

Analysis (PCA), which shows that our results hold when we use different components of bank capital. Moreover, a conditional quantile regression shows that capital has a more pronounced effect on more efficient and profitable banks with higher loan loss reserves. Finally, we address possible inter-relationships between risk, efficiency and profitability using three-stage least squares regressions and show that our results are not affected by simultaneous bias.

The remainder of this paper is structured as follows. Section 2 establishes the theoretical framework used to analyze the impact of regulatory capital on the risk, efficiency, and profitability of banks and presents the hypotheses. Section 3 describes our sample and introduces the different measures of risk, efficiency, and profitability. It also defines the capital ratios and the control variables employed in our models. Section 4 outlines the results of our baseline regression. Section 5 presents our robustness tests and additional estimation techniques. Section 6 concludes.

2. Hypotheses development

The question of how capital affects bank risk, efficiency and profitability is still far from being resolved. In this section we develop a set of testable hypotheses to futher clarify these associations. While the literature often examines the traditional equity to assets ratio to proxy for bank capital, in this study we use Basel risk-based capital ratios and compare their effect with that of traditional, non-risk based capital ratios.

2.1. Risk and bank capital

Economic theories provide different predictions regarding the impact of capital on bank stability and risk taking. Anginer and Demirgüç-Kunt (2014) explain that banks aim to have high capital ratios to resist earnings shocks and to ensure their capacity to honor deposit withdrawals and other engagements. They also explain that higher capital buffers make bank owners more prudent and wiser in their investment choices. Accordingly, a *"more skin in the game"* policy improves bank risk monitoring and screening, given that higher capital ratios reduce bank liability and expectations for public bailouts (Demirgüç-Kunt et al., 2013). A number of empirical studies support this view. Jacques and Nigro (1997) find that higher risk-based capital measures may decrease bank risk. Similarly, Aggarwal and Jacques (1998) use data from 2,552 FDIC-insured commercial banks from 1990 to 1993 and show that banks tend to hold capital ratios above the minimum capital requirement as a way of preventing failure in stress situations. Editz et al. (1998) further examine the relationship between

regulation and banking stability. Studying a sample of British commercial banks, they show that a minimum capital requirement is positively correlated with the safety and soundness of banks and does not distort their lending activities. Moreover, Berger and Bouwman (2013) find that capital has a positive impact on the probability of survival for small banks. Finally, Tan and Floros (2013) and Anginer and Demirgüç-Kunt (2014) find a significant negative relationship between several measures of capital and bank risk using samples of banks from China (in the former article) and 48 countries (in the latter). Ultimately, more prudent management can play a key role in aligning the interests of shareholders and depositors and in reducing agency problems, thus suggesting a negative association between capital and risk. This leads to the following hypothesis:

Hypothesis 1a: Higher risk and non-risk based capital ratios are associated with lower bank risk.

An alternative set of theories posits that unregulated banks tend to take excessive risks to maximize shareholder value at the expense of depositors. In fact, bank managers can benefit from deposit insurance schemes to engage in riskier activities because the depositors' money is guaranteed should investments not pay off. To prevent this moral hazard problem, Kim and Santomero (1988) propose a risk-based capital plan whereby banks are forced to internalize their losses and increase their capital ratios commensurably with the amount of risk taken. The same pattern applies to systemic banks because the idea of being too-big-to-fail produces moral hazard behavior that leads to excessive risk taking underlying both deposit insurance and government bailouts. For this reason, the *"regulatory hypothesis"* requires banks to hold a minimum amount of capital to bank risk, suggesting a positive association between capital and risk. Empirically, Koehn and Santomero (1980) show that higher capital ratios increase the variance of total risk for the banking sector. By the same token, Avery and Berger (1991) find that a risk-based capital concept may have a destabilizing effect on the financial system. Furthermore, Blum (1999) uses a dynamic framework and demonstrates that raising capital may eventually lead to increased risk. He explains that if it is too costly for a bank to increase its capital level to meet capital in the future, then the only solution for the bank in the present day is to increase the riskiness of its portfolio. Similarly, Iannotta et al. (2007) find a significant positive connection between capital and loan loss provisions when examining a sample of the largest European banks from 1999 to 2004. Accordingly, we pose the following competing hypothesis:

Hypothesis 1b: Higher risk and non-risk based capital ratios are associated with higher bank risk.

More recently, there have been several studies that explore the effectiveness of risk-based capital ratios. Most of them show that risk-based capital ratios have no significant impact on bank risk. For instance, Blum (2008) finds that if banks are free to determine their own risk exposure, they will be incentivized to understate their risk in an effort to avoid higher capital requirements. These untruthful assessments could lead to higher investments in riskier activities. Dermine (2015) also demonstrates that the only way to prevent any untruthful reporting and the associated increase in banks' risk exposure is to create a complementary non-risk-based leverage ratio that serves as a back-up to the regulatory capital ratio. In the same context, Cathcart et al. (2015) report that the top 25 banks in the United States and Europe had Tier 1 capital ratios of 8.3% and 8.1% prior to the onset of the financial crisis, which are much higher than the requirement of 4% regulatory Tier 1 capital ratio by the BCBS. However, despite these high solvency ratios, these banks were not able to absorb their risk exposure and prevent systemic risk. Cathcart et al.'s (2015) study is in line with Haldane's (2012) work, which shows no conclusive evidence that regulatory capital ratios reduce banks' probability of default. Under this perspective, we hypothesize the following:

Hypothesis 1c: There is no association between risk-based capital ratios and bank risk.

2.2. Efficiency, profitability, and bank capital

Lee and Hsieh (2013) argue that the relationship between capital and risk should be extended to examine bank efficiency and profitability. The literature mainly shows a positive association between capital and efficiency. For instance, Barth et al. (2013) find that capital stringency and the equity to asset ratio are positively associated with bank efficiency. Examining an unbalanced panel of 5,227 bank-year observations in 22 European Union countries, Chortareasa et al. (2012) find that capital has a positive effect on efficiency and a negative outcome on bank costs. Their results suggest that higher capitalization alleviates agency problems between managers and shareholders. Hence, shareholders will have a greater incentive to monitor management performance and ensure that the bank is efficient. Staub et al. (2010) find that when banks hold more capital, they are more cautious in terms of risk behavior, which can be channeled into higher efficiency scores. Likewise, Banker et al. (2010) show that the capital ratio is positively correlated with aggregate efficiency, technical efficiency, and allocative efficiency when investigating the efficiency of 14 Korean banks. Pasiouras (2008) also finds that technical efficiency increases with bank capitalization. Finally, Carvallo and Kasman (2005) and Ariff

and Can (2008) report that more efficient banks hold more capital buffers as retained earnings. Therefore, we propose the following hypothesis:

Hypothesis 2: Higher risk and non-risk based capital ratios are associated with greater bank efficiency.

There is also an abundant literature surrounding the relationship between capital and profitability. Recently, Tan (2016) finds that more capitalized banks are more profitable because they have higher creditworthiness, engage more in prudent lending, and borrow less, which reduces their costs and increases their profitability. Demirgüç-Kunt et al. (2013) find that capital ratios, especially Tier 1 capital, had a positive influence on the stock returns of larger banks during the 2007–2008 financial crisis. In addition, Iannotta et al. (2007) find that banks with higher capital ratios are more profitable. They argue that more capitalized banks have better management quality and thus higher income and lower costs. Berger (1995) uses a Granger causality test to examine the causal relationship between capital and earnings and concludes that highly capitalized banks are likely to have lower bankruptcy costs, which in turn reduces funding costs, thus generating higher profits. Berger's results and explanations are on a par with those of Demirgüç-Kunt and Huizinga (2000), who also find a positive correlation between the equity to assets ratio and bank profits when examining a sample of 44 developed and developing countries. Finally, Tan and Floros (2013) and Tan (2016) find a weak positive association between capital and profitability (and between capital and bank efficiency) using a sample of Chinese banks. Consequently, we hypothesize the following:

Hypothesis 3: Higher risk and non-risk based capital ratios are associated with greater bank profitability

Table 1 provides a summary of the main empirical studies that examine the links between capital, risk, efficiency, and profitability.

[Insert Table 1 around here]

3. Data and methodology

3.1. Sample construction and empirical approach

We use Bankscope as a primary source of data for this study. For each bank, we retrieve annual data from 1999 to 2013. Our sample is unbalanced and includes 1,992 banks from 39 OECD and six partner countries.[4] A bank is excluded from the sample if it does not have at least three continuous observations. In addition, we remove countries that have data for less than four banks. Macroeconomic data are obtained from the World Bank's World Development Indicators database, whereas institutional environment data are collected from the World Bank's Banking Regulation and Supervision database and the World Governance Indicators database. Finally, we use the Heritage Foundation database to control for a country's economic and financial development.

To examine the impact of different definitions of bank capital on risk, efficiency and profitability, we follow Beck et al. (2013), Berger and Bowman (2013), and Anginer et al. (2014) and use the following baseline OLS regression model:

$$\mathrm{f(risk, efficiency, profitability)_{ijt}} = \alpha + \beta \times \mathrm{Capital\_structure_{ijt-1}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{\mathrm{j=1}}^{\mathrm{N}} \delta_j \times \mathrm{Country_j} + \sum_{\mathrm{t=1}}^{\mathrm{T}} \mu_t \times \mathrm{Time_t} + \varepsilon_{\mathrm{ijt}} \quad (1)$$

where the dependent variables on the left-hand side refer to bank i's risk indicators (LLRTAP, LLRGLP and LLRIMP), efficiency indicators (CIRP, NONIEGRP, and COSTAP), and profitability indicators (NIMP, EARTAP, and OTHOIAA) in country j in year t, as defined in Section 3.2. Capital_structure and Bank_control, respectively, represent different definitions of capital and bank control variables, as identified in Section 3.3. All independent variables are lagged by one year because regulatory changes can be slow and may require time to take effect. Country and Time represent country and year fixed-effect dummy variables and are included to mitigate any effect of potentially omitted variables related to country and year specifications (Anginer and Demirgüç-Kunt, 2014). Finally, we use additional estimation techniques such as principal component analysis, quantile regressions, a three-stage least squares regression based on seemingly unrelated least squares estimation, and a propensity score matching technique to further check the robustness of the results.

[4] We exclude the United States to avoid any biases that may result from an overrepresentation of American banks in the sample. In addition, this separates our paper from the plethora of studies that focus exclusively on the U.S.

3.2 Measures of risk, efficiency, and profitability

We measure risk using the ratio of loan loss reserves to total assets (LLRTAP). This ratio measures loan quality (Altunbas et al., 2007; Lee and Hsieh, 2013; Abedifar et al., 2013) with higher values can be explained as a precautionary reserve policy but at the same time as an anticipation of high non-performing revenue (Anginer et al., 2014). Abedifar et al. (2013) explain that this ratio takes the past and future performance of a bank's loan portfolio into consideration. However, as prior studies have argued, this measure partially reflects banks' loan portfolios because variations between banks may be related to different banking policies regarding non-performing loans, reserves, and write-offs. Therefore, to ensure the robustness of our results, we also employ the ratio of loan loss reserves to gross loans (LLRGLP) and of loan loss reserves to impaired loans (LLRIMP), both proxies for bank loan quality and credit default risk.[5]

Our second variable measures bank efficiency or, more precisely, cost efficiency as proxied by the cost to income ratio (CIRP). Cost mainly includes bank overheads, in which salaries play a predominant role. This ratio is used to measure cross-bank differences in terms of efficiency where higher values indicate lower efficiency. Chortareas et al. (2012) explain that higher costs reflect managerial inadequacy, which could be negatively related to efficient bank intermediation. For robustness, we also employ the ratio of non-interest expenses to gross revenues (NONIEGRP) and the ratio of non-operating items and taxes to average assets (COSTAP), where higher values indicate higher costs.[6]

Finally, we use the net interest margin to capture bank profitability (NIMP). This ratio is computed as the bank's [interest income – interest expenses] divided by total earning assets. In other words, the net interest margin is the difference between what a bank agrees to receive from borrowers and what it

[5] We focus on credit risk for several reasons: First, credit risk is considered one of the most important risks a bank can face. It also constitutes, along with operational risk and market risk, the first pillar of Basel II. Second, we did not include market-based indicators such as the distance to default or other complex risk measures because we focus on a broad sample of listed and unlisted conventional banks, rather than only on publicly listed banks. Finally, stability indicators such as the Z-score cannot be used as a dependent variable because the Z-score includes a capital measure, our key independent variable.

[6] We focus on accounting ratios instead of efficiency scores for several reasons. First, parametric and non-parametric approaches compute efficiency scores relative to a common frontier and tend to give an advantage to banks operating in developed countries as they are far more developed than banks operating in less developed countries. Because our sample includes banks in OECD countries composed of developed and developing markets, the use of efficiency scores may bias our results. Second, the literature often uses total equity as an input to control for bank risk (cf., Johnes et al., 2009, Johnes et al., 2014; Ayadi et al., 2016). Efficiency scores are not an appropriate dependent variable because they include bank equity in their inputs. Third, accounting based measures are easy to find and interpret, especially for comparison studies. Finally, although accounting based efficiency measures are exposed to measurement errors, we try to mitigate this problem and make sure the results remain robust by using three different measures of efficiency.

offers to depositors. This measure of profitability is mainly related to traditional lending and borrowing activities and is consistent with the classical definition of a bank as an intermediary between lenders and borrowers. In addition, we employ the ratio of net income to total assets (EARTAP) and the ratio of other operating income to three-year average assets (OTHOIAA) to ensure the robustness of our results. The latter ratio is particularly important as it measures the proportion of fees and other operating income as a percentage of a bank's average assets.

3.3. Measures of capital and control variables

We follow Demirgüç-Kunt et al. (2013) and Anginer and Demirgüç-Kunt (2014) and use several definitions for capital ratios. In a first step, we calculate the capital ratios according to the Basel guidelines using risk-weighted assets (rwa). Secondly, we compute the same ratios but using total assets (ta) instead. Thus, in the first step, we employ the following capital ratios: Tier1 divided by risk-weighted assets (Tier 1/rwa), Tier1 plus Tier2 divided by risk-weighted assets (Total capital/rwa), common equity to risk-weighted assets (Common equity/rwa), and other capital to risk-weighted assets (Other capital/rwa). Tier 1 capital represents the sum of shareholders' funds and perpetual, non-cumulative preferred shares. Total capital serves as the numerator in the capital adequacy ratio and contains a proportion of Tier 2 capital in addition to Tier 1 capital. Tier 2 includes subordinated debt and some hybrid capital. Under Basel II guidelines, the total capital ratio must be maintained at a level of least 8%. Bank common equity includes common shares, retained earnings, reserves for general banking risks, and statutory reserves. Because data on Tier 2 capital are rare, we decided to compute a proxy called "other capital" defined as the difference between total capital and common equity. Other capital mainly includes subordinated debt and hybrid capital. Finally, we consider the tangible equity ratio, which represents a bank's tangible equity divided by total assets (Tangible equity/ta). Tangible equity removes goodwill and any other intangible assets from a bank's equity base.

We further employ a series of bank-level control variables to account for differences in bank characteristics. First, we include the ratio of net loans to total assets (Net loans/ta) because the literature shows that banks that possess a meaningful loan portfolio are less exposed to risk than banks that prefer to invest in derivatives, other types of securities, and non-traditional activities. In addition, traditional loan activities are less expensive to monitor than financial derivatives, which could decrease bank costs and improve profitability. Second, we use the growth rate of total assets (Growth assets) to control for the expansion of a bank's balance sheet during the current year (compared to the previous year).

Abedifar et al. (2013) employ this ratio as a proxy for bank growth and development strategies. As they expand and develop, banks are expected to attract more skilled employees and be less exposed to information asymmetry. In addition, they are likely to have better capacity to improve their credit risk management, which should decrease their risk while at the same time increasing their efficiency and profitability as a result of better screening and monitoring of investments. Third, we control for diversification using a measure of income diversity (Income diversity). This ratio captures the degree to which banks diversify between lending and non-lending activities. There are different views regarding the effect of income diversity on bank risk and returns. Abedifar et al. (2013) argue that by expanding their activities, banks can collect different information on clients' businesses, which can be used to better manage lending decisions and to better screen clients' risk profile. Demirgüç-Kunt and Huizinga (2010) find that non-interest income is linked to more volatile returns, while Abedifar et al. (2013) find that non-interest income is negatively associated with bank interest margins. Their findings are similar to those of Stiroh (2004, 2006), who finds that a reliance on non-interest income does not increase bank profits. We follow Laeven and Levine (2007) and compute income diversity as 1 – [(Net interest income – other operating income)/(operating income)]. The higher the value, the more a bank's activities are diversified. Fourth, we use the natural logarithm of total assets to control for bank size (Size). The literature shows that larger banks can benefit from economies of scale and portfolio diversification, which should improve their efficiency and decrease their risk exposure (Pasiouras, 2008; Chorterareas et al., 2012; Abedifar et al., 2013; Barth et al., 2013; Tan and Floros, 2013). Finally, to control for risk and efficiency, we use the cost to income ratio in the risk model and loan loss reserves to total assets in the efficiency and profitability models.[7] All variables are winsorized at the 1 and 99 percent levels to mitigate the effect of outliers. Variable definitions and data sources are provided in Appendix A.

3.4. Descriptive statistics

Table 2 (Panels A.1 and A.2) presents summary statistics for bank- and country-level control variables. The number of observations varies between risk-based measures and non-risk based measures. For instance, the ratio of Tier1 capital to risk-weighted assets (Tier 1/rwa) has 10,050 observations with a median of 11.1% – well above the minimum 6% requirement proposed by the

[7] Please refer to the literature review as well as Footnote 4 and Section 4.6 for detailed discussions and empirical findings of the inter-relationships between risk, capital, efficiency, and profitability.

BCBS. However, non-risk based measures have almost three times as many observations. For example, the ratio of tangible common equity to total assets has a total of 29,852 observations with a median value of 9.85%. The number of missing observations in the former category can be explained by the fact that most banks started reporting information pertaining to their capital ratios in 2007 (i.e. the official date for mandatory adoption of Basel II in the European Union). Some banks also prefer not to provide information about their capital adequacy ratios; rather, they provide information about their traditional capital ratios. These banks might still be operating under the Basel I Accord or might prefer not to disclose information about their risk weighting and thus their assets' risk exposure. Table 2, Panel B reports the Pearson correlation matrix between independent variables. All correlation coefficients are below 0.5, with the exception of the correlation between different definitions of capital ratio. Therefore, in the next section we run nine regression models, one for each of the nine capital ratios, to avoid multicollinearity.

[Insert Table 2 around here]

4. Main results

We use the following OLS regression model to examine the relationship between capital ratios, risk, efficiency and profitability:

$$\mathrm{f(LLRTAP, CIRP, NIMP)_{ijt}} = \alpha + \beta \times \mathrm{Capital\_structure_{ijt-1}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{j=1}^{N} \delta_j \times \mathrm{Country_j} + \sum_{t=1}^{T} \mu_t \times \mathrm{Time_t} + \varepsilon_{ijt} \quad (2)$$

The dependent variables are bank *i*'s LLRTAP, CIRP, and NIMP in country *j* in year *t*, measured by loan loss reserves to total assets, cost to income, and net interest margin, as defined in the previous section. Capital_structure represents the capital ratios described in the previous section. Bank_control incorporates bank size, bank loan engagement, the growth of total assets, the income diversity ratio and bank cost or risk, depending on the equation.

The results of Eq. (2) are presented in Table 3 and show a significant positive relationship between the traditional measures of capital and bank loan loss reserves (columns 5, 6, 7, and 9) and an insignificant relationship when risk-weighted assets are employed to define capital (columns 1 to 4), thus supporting hypothesis 1a when traditional capital ratios are used and 1c for Basel capital ratios. In

other words, banks with higher traditional capital ratios have higher loan reserves, suggesting a higher precautionary reserve policy to protect against any potential credit default risk.[8] Our results are similar to those of Altunbas et al. (2007) who document a positive relationship between capital and loan loss reserves ratio in a European context. In contrast, the capital ratios that use risk-weighted assets in their definitions have aninsignificant influence on bank loan loss reserves. Blum (2008) and Haldane (2012) contend that the ability to achieve targets imposed by banking regulators is closely associated with the degree of complexity of banking regulations. For instance, more complex capital ratio measures allow banks to manipulate their risk-weighted assets and thus increase their capital adequacy in a way that does not reflect their real risk exposure (Haldane, 2012; Cathcart et al., 2015; Dermine, 2015). As the banking sector is moving forward in its implementation of the Basel III capital guidelines, these results raise concerns about appropriate risk-weighted assets. Finally, we notice that both ratios of "other capital" (columns 4 and 8) have an insignificant association with bank risk, which we attribute to the following factors. First, as mentioned above, the risk-based measure of other capital includes risk-weighted assets that can be manipulated by banks and thus no longer reflect their real risk exposure. Second, unlike Tier 1 (common equity and tangible equity), other capital or Tier 2 capital reflects complex debt type elements in the capital definition. These elements are different from capital of good quality and cannot be used to absorb bank losses related to credit risk exposure proxied by loan loss reserves.

[Insert Table 3 around here]

Table 4 provides the results for the efficiency model. We find that higher capital ratios improve bank efficiency (in all columns except for columns 4 and 8), thus confirming hypothesis 2. The results are similar to those of Pasiouras (2008), Chorterareas et al. (2012), and Barth et al. (2013) who suggest that higher capital ratios ameliorate supervision and monitoring in response to the aforementioned *"more skin in the game"* policy. Specifically, holding higher capital buffers makes bank owners and managers more prudent regarding their investment choices. Higher capital ratios can also align the interests of bank shareholders and depositors, which reduces agency problems and can ultimately decrease costs and thus improve bank efficiency. In contrast, the results show the opposite effect in

[8] Note that the mechanism by which the loan loss reserves ratio is calculated differs across bank categories. For instance, business lines vary substantially between commercial and investment banks. Accordingly, loan-based financial intermediaries, e.g. commercial banks, will necessarily have larger amounts of risk under the loan reserve measure than investment banks. Thus, variations in the loan loss reserves ratio might depend on a bank's business model rather than its actual credit risk exposure. However, in our study, this is not the case because we only use a sample of commercial banks.

columns (4) and (8), where we use other capital. In other words, when we exclude common equity or capital of good quality from the capital definition, we find that other capital decreases bank efficiency, which does not support hypothesis 2. Other capital includes, for example, hybrid capital, which combines certain characteristics of capital and debt, thus offering complex combinations of different instruments. It also includes subordinated debt instruments that have several weaknesses in terms of their fixed maturities and inability to absorb losses except in cases of liquidation. Our results suggest that the composition of other capital may be the reason behind the ineffectiveness of capital ratios in absorbing losses, especially given what was witnessed during the subprime crisis. The fact that other capital, or Tier 2 capital, is less reliable than Tier 1 capital is also reported in other studies (Anginer et al., 2013; Demirgüç-Kunt et al., 2013). Furthermore, the components of other capital (hybrid capital and subordinated debt) are more difficult and expensive to monitor, which could also explain the positive effect on bank costs. Our findings support the Basel III recommendation that banks should increase their Tier 1 capital to 6% and maintain Tier 2 capital below 2%.

[Insert Table 4 around here]

Lastly, Table 5 shows a positive and significant impact of different capital ratios on banks' profitability (columns 1 to 9 except columns 4 and 8). Our results confirm hypothesis 3 and concur with the regulatory hypothesis and the extended literature, suggesting a positive relationship between capital ratios and bank profits (Berger, 1995; Jacques and Nigro, 1997; Demirgüç-Kunt and Huizinga, 2000; Rime, 2001; Iannotta et al., 2007; Lee and Hsieh, 2013; Tan, 2016). Similar to Table 4, we find that capital other than common equity is negatively related with bank profits. This coincides with the BCBS' recommendations to reduce the reliance on capital that is of poor quality in the capital ratio.

[Insert Table 5 around here]

With respect to our control variables, we find in all columns that banks with business models focused on lending activities are more efficient and more profitable but they tend to hold higher reserves to protect against any potential credit default. In addition, traditional banking activities, which reduce bank costs and improve profitability, require less monitoring compared to securities and other financial derivatives. We also find that asset growth is negatively associated with bank reserves for loan loss and positively associated with bank efficiency and profitability. This suggests that a bank can benefit from expanding its strategy by investing more in risk management, attracting competent and skilled

managers, and enhancing monitoring and screening of potential projects, which can be reflected in lower expectations of credit default, and improved efficiency and profitability. Moreover, the income diversity ratio is negatively associated with bank loan loss reserves (columns 1 to 9). Accordingly, a higher income diversity ratio decreases bank expectation of credit default (Berger et al., 2014) because, unlike loans to assets, a higher ratio means a diversification towards non-traditional activities and therefore a lesser need for loan loss reserves. However, a higher ratio increases bank costs and reduces profitability because banks are required to improve their risk management, supervision, and monitoring as they face risks that can emerge from accessing new markets, information asymmetries, and morally hazardous behavior compared to traditional loan activities. As for bank size, we find evidence of a positive association with bank efficiency, suggesting that larger banks benefit from economies of scale (Altunbas et al., 2007; Abedifar et al., 2013) as well as better and more sophisticated risk management (Pasiouras, 2008; Chorterareas et al., 2012; Barth et al., 2013). Finally, we find that a higher loan loss reserves ratio is positively associated with bank costs and bank profits. Thus, although traditional banking activities are less expensive than non-traditional activities, there is a positive association between loan loss reserves and bank costs. This is logical given that higher reserves mean higher costs of monitoring and supervision for riskier credits and therefore higher interest margins, as riskier activities may generate higher profits.

5. Robustness checks

5.1. Robustness tests: Bank size, too-big-to-fail banks, liquidity, and financial crisis

In this section, we follow Anginer and Demirgüç-Kunt (2014) and examine the cross sectional heterogeneity regarding the impact of capital ratios on risk, efficiency, and profitability. More precisely, we investigate whether the association between capital, risk, efficiency, and profitability differs for small, medium, and large banks, too-big-to-fail banks, highly liquid banks, and banks during the subprime crisis.

First, we split our sample according to bank asset size. [9] Table 6 illustrates the results for our three subsamples. We find that although the Basel capital measure has either an insignificant or a marginally significant negative effect on reserves for loan loss, traditional capital ratios continue to show an

[9] Based on the lower (Q25) and the upper quantile (Q75), banks are classified as small banks when LnTA≤11.719, medium banks when 11.719<LnTA<15.405 and large banks when LnTA≥15.405.

overwhelmingly positive effect. We further demonstrate that small banks are less capable of manipulating their risk-weighted assets, which is unsurprising given that they quantify their risk based on the standardized approach or the internal rating-based approach, whereas large banks are allowed to follow a more advanced and complex internal rating-based approach to quantify their risk exposure. We also find that medium and large banks with higher capital ratios have higher loan loss reserves (but only for traditional measures of capital ratio), are more efficient, and have higher net interest margins, thus again confirming hypotheses 1a, 1c, 2, and 3. Larger banks benefit from economies of scale and have higher retained earnings than smaller banks. This could explain why the results are less significant for smaller banks. In addition, larger banks can afford to hold more reserves to protect against riskbecause they are more efficient and more profitable (Fiordelisi et al., 2011). They are also more capable of reporting untruthful assessments of their risk exposure, therefore avoiding higher capital ratio requirements. This could explain why risk-based capital ratios fail to report a negative impact on bank risk while the traditional capital ratios exhibit a positive and significant association with loan loss reserves, indicating a precautionary policy to protect against any credit default.

[Insert Table 6 around here]

To examine whether our results hold for too-big-to-fail banks, we interact our capital ratios with a dummy variable (TBTFA) that takes on a value of one if a bank's share of a country's total assets exceeds 30%. The results are presented in Table 7, Panel A, and further validate hypotheses 1a and 2, namely that higher capital ratios are associated with higher loan loss reserves as a precautionary policy to protect against credit default and higher efficiency. The positive association with profitability is also maintained, albeit with lower significance.

Because the Basel III Accord requires banks to maintain a certain level of highly liquid assets, we control for bank liquidity and interact capital ratios with a dummy variable (h_liquid) that takes on a value of one if a bank's liquidity is higher than the upper quantile of its liquidity ratio[10] proxied by the ratio of liquid assets to deposits and short term funding (also called the maturity match ratio (Beck et al., 2013)). This ratio explains the risk arising from different maturity profiles of liabilities and assets in financial institutions. Our results, reported in Table 7, Panel B, suggest that capital ratios are less effective in reducing costs for highly liquid banks. In addition, we find that higher capital ratios reduce

[10] Based on their median value, commercial banks are classified as highly liquid banks when the ratio of liquid assets to deposits and short term funding, LADSTFP, exceeds 68.293, i.e., h_liquid = 1 if LADSTFP>68.293, and 0 otherwise.

the profitability of highly liquid banks. Finally, we find no significant impact of capital ratios on risk for highly liquid banks. Our results clearly show that higher capital, in combination with higher liquidity, penalizes bank activities and reduces bank efficiency and profitability. Horváth et al. (2014) note that there is a trade-off between higher capital ratios and liquidity creation. They argue that the Basel solution of requiring banks to hold stronger capital buffers might harm banks' liquidity creation and vice versa. Their results are in line with Berger and Bouwman (2012) who find that capital is negatively associated with bank liquidity creation in the short term. These results raise significant questions about Basel III's main contribution as it requires banks to hold higher liquidity buffers measured by – in addition to new and more complex capital requirements – two explicit liquidity ratios, i.e. the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR).

[Insert Table 7 around here]

We also follow Abedifar et al. (2013) and Beck et al. (2013) and consider 2008–2009 as the crisis period. Accordingly, we use a crisis dummy that takes on a value of 1 in 2008–2009 and 0 otherwise. As with bank liquidity, we include an interaction term between capital ratios and the crisis dummy. The results presented in Table 7, Panel C confirm hypotheses 1a, 2, and 3, and show that banks with higher capital ratios have higher loan loss reserves (even for risk-based capital ratios), lower costs, and higher profitability during the crisis period. However, the results hold for three out of nine capital ratios for the profitability model, seven out of nine capital ratios for the efficiency model, and six out of nine ratios for the risk model.

5.2. Robustness tests: Macroeconomic and institutional variables as controls

In this section, we address any concerns related to possibly omitted variables. Specifically, in addition to bank-level control variables[11], we now include a series of macroeconomic and macro-institutional indices in each of our three estimated models to examine the robustness of our main results.

First, we consider deposit insurance, a dummy variable that takes on a value of 1 if a country has an explicit deposit insurance scheme and 0 otherwise. Regulators and policymakers encourage deposit insurance because it reduces the risk of bank runs (Pasiouras et al., 2008). Barth et al. (2004) explain that if bank depositors withdraw their money from the banking system, illiquid but solvent banks may

[11] In this section, we do not use country and year fixed effects to avoid possible multicollinearity problems with country-level control variables.

be forced into insolvency. Therefore, the existence of a deposit insurance scheme in addition to powerful supervisory authorities may play a key role in improving bank profits and decreasing bank risk. However, a growing body of research shows that deposit insurance intensifies the moral hazard behavior of bank managers because depositors know that their money is insured and are thus less interested in monitoring bank activities (Pasiouras, 2008; Barth et al., 2013). Simultaneously, bank managers have more incentive to take on risk because neither shareholders nor depositors will bear losses. This could result in higher risk as well as lower efficiency and profitability (Anginer and Demirgüç-Kunt, 2014). In addition, we use the GDP growth rate to control for economic development.

We complement these variables with several other macroeconomic and institutional variables from the risk and performance literature. From the risk literature, we use the Herfindahl-Hirschman index (HHID), calculated as the sum of the squared market share in terms of deposits for banks in each country[12] with higher HHID indicating greater market power. In addition, we include certified audit requirements to measure whether an external audit by licensed auditors can influence bank risk and performance (Barth et al., 2013). Finally, we employ two complementary measures of political and institutional quality to check the robustness of our results. These indicators are the world governance index, computed as the average of six governance dimensions (i.e., voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption), and an index of economic freedom computed as the average of ten quantitative and qualitative factors that capture four categories of economic freedom (i.e., the rule of law, limited governance, regulatory efficiency, and open markets). The respective data are obtained from the World Bank website for the former and the Heritage Foundation website for the latter.

[Insert Table 8 around here]

We further draw on the efficiency and profitability literature and include an index of capital stringency calculated based on eight questions about the overall compliance of a country's banking system with the Basel capital guidelines. The index takes on values between 0 and 8, with higher values indicating greater capital stringency. In addition, we employ a proxy for market discipline using an indicator that varies between 0 and 8 with higher values indicating a higher number of mandatory policies on information transparency and disclosure. Finally, we employ two complementary measures

[12] We also compute the HHI using total assets, equity, and loans and obtain similar results.

to control for the capacity of bank supervisory authorities. We use supervisory power, an index that takes on values between 0 and 14, where higher values suggest that supervisory authorities are more capable of taking specific actions against bank management, shareholders, and auditors. In addition, we use entry requirements, a variable that takes on values between 0 and 8 with higher values indicating greater entry restrictions in terms of obtaining a banking license. Pasiouras (2008) argues that entering a market should be encouraged because it enhances competition between banks, improves efficiency, and reduces bank costs.

Tables 8, 9, and 10 report the results for our risk, efficiency and profitability models. The capital ratios (except risk-based capital ratios) are positively associated with bank loan loss reserves (Table 8, columns 5 to 9), efficiency (Table 9, all columns except columns 4 and 8), and profitability (Table 10, all columns except columns 4 and 8), thus confirming our baseline findings with regard to hypotheses 1a, 1c, 2, and 3.

[Insert Table 9 around here]

With respect to our country control variables, we find that deposit insurance has a positive effect on bank loan loss reserves (Table 8, all columns except column 2) and costs (Table 9, all columns except column 4), and a negative effect on profitability (Table 10, columns 1 to 9). Therefore, the existence of explicit deposit insurance encourages moral hazard behavior and reduces monitoring and supervision, which results in higher loan loss reserves used to protect against default. This can be also translated into higher costs and lower profitability. We also find that GDP growth is negatively correlated with bank loan loss reserves but positively correlated with bank efficiency and profit. Thus, banks in countries with higher GDP growth are more efficient and more profitable, but they tend to hold smaller loan loss reserves reflecting favorable economic conditions and thus a lower expectation of credit default. Pasiouras (2008) argues that favorable economic conditions will improve bank efficiency and minimize costs. Similar results are found by Lee and Hsieh (2013) who examine the impact of bank capital on risk and profitability in the Asian context and Barth et al. (2013) who study the effect of banking regulation on efficiency using international data.

With respect to other country control variables in the risk model, we find that HHID has a positive impact on bank loan loss reserves ratio (Table 8, columns 1 to 9), suggesting that a higher concentration or market power causes financial instability because banks in concentrated markets are more likely to

be considered too-big-to-fail (Schaeck and Cihák, 2013). Certified audit requirements, the world governance index, and economic freedom are negatively associated with bank reserves for loan loss. Thus, the existence of an external monitoring mechanism, a better institutional environment (in terms of laws, governance and regulations), and higher economic freedom (in the sense of allowing labor, capital, and goods to move freely) reduces the risk of bank credit defaults.

[Insert Table 10 around here]

Finally, we find that capital stringency, supervisory power, and entry requirements are positively associated with bank efficiency and profitability. This suggests that the existence of powerful regulatory authorities encourages banks to improve risk management. It also incentivizes bank shareholders to monitor bank activities more closely. As for market discipline and private monitoring, our results suggest the opposite: we show an unexpectedly positive impact on bank costs and a negative impact on bank profitability. Chortareas et al. (2012) argue that increasing transparency and disclosure at the bank level facilitates external monitoring by regulatory authorities, which may have an indirect effect on bank efficiency and thus profit. This effect depends on a number of factors, including the credibility of the information released and whether the information only circulates between regulatory agencies or is shared with the broader public. At the same time, the requirement for banks to release transparent and credible information depends on good discipline and information sharing by bank management, which increases banks' additional supervision costs, thus reducing their returns.

5.3. Robustness tests: Principal component analysis and quantile regression approach

In this section, we perform principal component analysis (PCA)[13] and create a new set of variables called "components" that represent our measures of capital. We use PCA to combine different capital ratios and shed light on which capital ratios are related to each other (and which are not). Doing so creates new summarized components that represent all of the information of the capital variables initially introduced. These components are then used to examine which combination of capital ratios

[13] To perform PCA, several criteria need to be met (Canbas et al., 2005; Shih et al., 2007). First, the capital ratios need to be highly correlated. Second, if a variable's measure of sampling adequacy (MSA) is lower than 0.5, then this variable is unacceptable and should be removed from the PCA (higher MSA, e.g. > 0.7, means that the variable is important and should be included in the PCA). Third, all financial ratios are standardized with a mean of 0 and a standard deviation of 1. Fourth, the choice of latent variables depends on the eigenvalues and the percentage of total variance explained by the component. Therefore, we only consider components with eigenvalues greater than 1 and explained variance measures above 10%. Some details of our analysis (i.e., the eigenvalues of the components, the KMO measures of sampling adequacy, and the component loadings) are not included here but are available from the authors upon request.

most strongly affects bank risk, efficiency, and profitability (Klomp and de Haan, 2012, 2014; Bitar et al. 2016).

We first run a PCA using all nine capital ratios. Component 1 (PC1_basel2_rwa) represents 68.71% (eigenvalue=6.2) of the total variance of capital measures. This component, hereafter referred to as "overall capital", combines the risk- and non-risk weighted capital ratios except other capital. Component 2 (PC2_basel2_other) represents 20.73% (eigenvalue=1.2) of the total variance of the capital measures. This component, also called "other capital ratios", is highly correlated with other risk- and non-risk based capital ratios. For verification purposes, we run another PCA but this time we exclude "other capital" measures from the vector of capital ratios because other capital ratios have a lower measure of sampling adequacy (MSA) (KMO=0.62 for other capital/rwa and KMO=0.58 for other capital/ta). We call the new principal component PC3_basel2_rwa, which represents 85.8% (eigenvalue=6.0) of the total variance of the capital measures. We also run a final PCA using all capital ratios excluding risk-based capital ratios and other capital ratios. We call the resulting principal component the "traditional non-risk based capital measure" (PC4_trad_capital), which represents 95.53% (eigenvalue=3.8) of the total variance. We now use our four extracted components in a regression analysis using the following regression model:

$$\mathrm{BANK_{ijt}} = \alpha + \beta \times \mathrm{PCA\_capital\_ratios_{ijt-1}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{\mathrm{j=1}}^{\mathrm{N}} \delta_j \times \mathrm{Country_j} + \sum_{\mathrm{t=1}}^{\mathrm{T}} \mu_t \times \mathrm{Time_t} + \varepsilon_{\mathrm{ijt}} \quad (3)$$

In Eq. (3), $\mathrm{BANK_{ijt}}$ represents bank *i*'s risk, efficiency, and profitability in country *j* in year *t*, while $\mathrm{PCA\_capital\_ratios_{ijt-1}}$ are the components extracted from the PCA as explained above. The results, which are presented in Table 11, provide additional support to hypotheses 1a, 1c, 2, and 3. We find that PC1_basel2_rwa, PC3_basel2_rwa, and PC4_trad_capital are negatively associated with the efficiency metric and positively associated with bank profitability (while PC2_basel2_other in columns 6 and 10 shows no significant effect). As for the risk model, we find that only PC4_trad_capital shows a significant, positive association with bank loan loss reserves (column 4). We also find similar results to those observed using our main OLS regression models for our bank- and country-level control variables.

[Insert Table 11 around here]

Thus far, we find that the impact of capital ratios on bank risk, efficiency, and profitability is sometimes insignificant, which might be due to heterogeneous effects of capital ratios in different countries (cf., Beck et al., 2013). Next, we examine whether the effect of capital ratios differs between countries by interacting capital ratios (Tier 1 to risk-weighted assets from the Basel capital ratios group and common equity to total assets from the traditional capital ratios group, in addition to components 1 and 4 from the PCA) with dummies for all 39 countries of our sample (Le Leslé and Avramova, 2012). We use Eq. (4) to develop our model.

$$\mathrm{BANK_{ijt}} = \alpha + \sum_{j=1}^{N} \beta \times \mathrm{PCA\_capital\_ratios_{ijt-1}} \times \mathrm{Country_j} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{j=1}^{N} \delta_j \times \mathrm{Country_j} + \sum_{t=1}^{T} \mu_t \times \mathrm{Time_t} + \varepsilon_{ijt} \quad (4)$$

The results, presented in Table 12, exhibit cross-country variations. For instance, the capital-risk model shows that capital measures in China, Greece, and Indonesia are negatively associated with the bank loan loss reserves ratio. Similar exceptions are found for our cost and profitability models. For example, capital ratios increase bank costs in Australia, China, New Zealand, and South Africa, and decrease bank profitability in China and Ireland. Nevertheless, with the exception of the risk model, our findings show general consistency. In other words, capital ratios are negatively associated with bank cost in Austria, Brazil, Estonia, France, Germany, Hungary, India, Israel, Poland, Russia, Slovenia, Sweden, Switzerland, and Turkey. Further, capital ratios show a positive and significant association with profitability in Australia, Brazil, Canada, Germany, Hungary, Iceland, Israel, Italy, South Korea, Slovenia, South Africa, and Turkey. Consequently, we can conclude that: i) there is evidence that higher capital ratios have a positive impact on bank profitability (hypothesis 3) and a negative impact on bank cost (hypothesis 2) while the results for the risk model are mixed; ii) there is general consistency between risk- (i.e. T1RP and PC1) and non-risk (CETAP and PC4) based capital indicators even though the results are sometimes insignificant[14]; iii) the general consistency of our results across OECD

[14] We find some contradictory results between each type (risk-based versus non-risk based) of capital ratio measure. See, for example, the results for the Czech Republic, Slovakia, and the United Kingdom for the risk model, the Czech Republic for the efficiency model, and Estonia and Switzerland for the profitability model. One potential explanations for these contradictory results is the manipulation of risk-weighted assets.

countries might be related to factors such as the mandatory application of Basel II in all 25 European Union (EU) countries (a sizeable proportion of our sample) and a common accounting framework based on the International Financial Reporting Standards (IFRS) implemented in 2005 in all EU countries as well as in Canada, Australia, Brazil, and South Korea.

[Insert Table 12 around here]

Further, we use Eq. (3) to perform quantile regressions and highlight whether capital component solutions are different across quantiles of the dependent variables. Thus, our main purpose for using quantile regressions[15] is that they allow for heterogeneous solutions to the PCA capital components by conditioning on bank loan loss reserves (less risky vs. highly risky), efficiency (less efficient vs. highly efficient), and profitability (less profitable vs. highly profitable). Table 13 shows the coefficients for the twenty-fifth (Q25), fiftieth (Q50), and seventy-fifth (Q75) quantiles of the distribution of our PCA components. In addition, Figures 1, 2, and 3 illustrate the quantile and OLS regression estimates for all components specified in the risk, efficiency, and profitability models. For each covariate, we plot the quantile regression estimates for capital components as a function of quantiles ranging from 0.05 to 0.95. The shaded grey band illustrates the conventional 90% confidence interval, estimated by bootstrapping. The long dashed line is the OLS estimate and the two dotted lines characterize the confidence band.

Table 13, Panel A, shows that banks with higher capital components have higher loan loss reserves (but only in terms of the traditional capital ratios, columns 10 to 12) and that this effect becomes stronger for banks holding higher reserves. The results become clearer when depicted graphically. Figure 1.D shows that the coefficients of the fourth capital component increase in magnitude as bank ratio of loan loss reserves increases from the lower toward the upper quantiles. As for PC1_basel2_rwa (Panel A, columns 1 to 3 and Figure 1.A) and PC3_basel2_rwa (Panel A, columns 7 to 9 and Figure 1.C), we find no significant effect of capital ratios on risk for any of the quantiles. Finally, although PC2_basel2_other is marginally positively linked with bank loan loss reserves in the lower quantile (Panel A, column 4), Figure 1.B shows that, in general, there is an inconclusive relationship between other types of capital and bank risk. Thus, quantile regressions confirm our OLS results in the baseline regression model.

[15] Quantile regression results are also robust for outliers and distributions with heavy tails. In addition, quantile regressions avoid the restrictive assumption that the error terms are identically distributed at all points of the conditional distribution.

Table 13, Panel B, shows that banks with higher capital components have lower costs (higher efficiency). More importantly, we find that more efficient banks are more responsive to capital components than their less efficient counterparts. The absolute value of the capital ratio coefficients is lowest for the 75th quantile. Our results are in line with our OLS estimates and suggest that PC1_basel2_rwa, PC3_basel2_rwa, and PC4_trad_capital are positively associated with bank cost efficiency, in particular for efficient banks (the 25th quantile). This is logical because higher capital ratios play a crucial role in aligning incentives between bank owners, depositors, and other creditors, which results in more careful lending activities and thus better bank performance, as Fiordelisi et al. (2011) demonstrate. This also corroborates Demirgüç-Kunt et al. (2013) who provide evidence that capitalized banks are in a better position to withstand shocks, which translates into better stock returns. Figures 2.A, 2.C, and 2.D confirm our results.

Table 13, Panel C, shows that banks with higher capital components have higher net interest margins. The impact of capital components on profitability is stronger for more profitable banks (the 75th quantile). The results are similar to the results of our efficiency model. In addition to aligning the interests of bank owners and depositors, we argue that capital ratios increase bank owners' incentives to control managers – in response to the 'more skin in the game' policy[16] – which in turn decreases the probability of bankruptcy, improves information availability, and ultimately ameliorates bank performance (Chortareasa et al., 2012). The results can also be explained by the fact that these banks hold more capital buffers as retained earnings (Carvallo and Kasman, 2005; Ariff and Can, 2008). Figures 3.A, 3.C, and 3.D also show this increasing pattern. As for Figure 3.B, we find an opposite relationship. We find that capital other than common equity has a destabilizing effect on bank profitability.

[Insert Table 13, Figures 1A to 1D, 2A to 2D, and 3A to 3D around here]

In aggregate, we observe that: i) higher traditional capital ratios indicate protection against poorer loan quality, thus confirming hypothesis 1a; ii) banks with higher capital ratios are more cost efficient and more profitable, especially banks that are already highly profitable and efficient, thus confirming hypotheses 2 and 3; and iii) in support of hypothesis 1c, risk-based capital components do not appear to reflect actual bank risk.

[16] For more details, see Anginer and Demirgüç-Kunt (2014).

5.4. Robustness tests: Excluding non-OECD countries and merged banks and using alternative risk, efficiency and profitability indicators

We now report the results for our baseline regression model after excluding 6 non-OECD countries from our sample. These countries are Brazil, China, India, Indonesia, Russia and South Africa. We initially included these countries as they have partnerships[17] with OECD countries; however, with their high economic growth rates and their frequent classification as emerging economies, they have a banking environment that is structurally different from the fully developed economies of most OECD countries. Our results without these countries' banks are shown in Table 14, Panel A.1, and highlight no significant differences. Banks with higher capital ratios have higher reserves, are more efficient and more profitable. We also exclude merged banks from our sample as they might affect the robustness of our results. Berger and Bouwman (2013) argue that banks engaging in mergers have different growth strategies and that capital could affect the market share of small and large banks during crisis periods. These results are reported in Table 14, Panel A.2, and show that our baseline findings hold when excluding merged banks.

The descriptive statistics demonstrate that banks tend to report more information about traditional capital ratios than about the Basel capital ratios. Thus, although our findings may reflect real differences between the effect of risk-weighted assets (rwa) and total assets (ta) on bank risk, they could also arise due to differences between the samples.[18] To further validate our findings and neutralize any potential effects resulting from differences between the samples, we employ the propensity score matching (PSM) technique proposed by Rosenbaum and Rubin (1983). We first construct a dummy variable that takes the value of one if bank capital – represented by Tier1 capital from the group of risk-based capital ratios and the ratio of common equity to assets from the group of traditional capital ratios – is greater than or equal to the median, and zero otherwise. Second, we estimate a logit model in which we regress the capital ratio dummies on all control variables used in the baseline model and the country and year fixed effects. We use the scores estimated to match each observation with a dummy that equals one for highly capitalized banks and zero for less capitalized banks. To ensure the robustness of our results, we follow Bitar et al. (2016) and employ two different matching methods: a match that uses the K-nearest

[17] These countries (except for Russia) are considered to be key partners according to the OECD website.
[18] We thank an anonymous reviewer for pointing out that the results for the effect of capital on bank risk could be influenced by differences between our samples. We address this issue by performing a robustness test in which we employ a propensity score matching technique using the same number of observations for the treated and control groups based on highly and less capitalized banks.

neighbors (with the number of nearest neighbors set at n=2, n=5, and n=10) and Gaussian Kernel matching.

The results of our matched samples are reported in Table 14, Panel B.1 using the Tier 1 capital ratio and Panel B.2 using the common equity capital ratio. The findings suggest that highly capitalized banks are more efficient and more profitable than less capitalized banks. The findings also suggest that highly capitalized banks have higher loan loss reserves when using the common equity ratio but lower loan loss reserves when using the Tier 1 capital ratio. Compared to our baseline results, risk-based capital ratios are more sensitive to risk and thus negatively associated with loan loss reserves. Thus, sample size does not have a significant influence on the results except for the association between Basel capital and bank loan loss reserves, which is now significantly negative. We report T statistics for the differences between the treated, highly capitalized group and the less capitalized control group for each of the methods. For the Tier 1 capital ratio, the differences between the treated and control group vary between 0.13 and 0.20% for the loan loss reserves ratio, between 6.08 and 7.24% for the cost inefficiency ratio, and between 0.40 and 0.53% for the net interest margin ratio. These differences are statistically significant at the 1% and 10% level, depending on the models.

[Insert Table 14 around here]

We also replace our dependent variables with three alternative measures of risk, efficiency and profitability including a bank's loan loss reserves to gross loans (LLRGLP), the bank's non-interest expenses to gross revenues (NONIEGRP), and the bank's earnings computed as net income to assets (EARTAP). The corresponding results are presented in Table 15, Panel A (A.1 for our baseline regression and A.2 for PCA). We also use three other indicators, including loan loss reserves to impaired loans (LLRIMP), the ratio of non-operating items and taxes to average assets (COSTAP), and the ratio of other operating income to average assets (OTHOIAA). The results for these substitutions are presented in Table 15, Panel B (B.1 for our baseline regression and B.2 for PCA).

We find that banks with higher capital ratios have higher reserves for loan losses, lower cost inefficiency and higher net interest margins. These findings persist when we use a PCA approach. Yet, with one exception, the ratios of capital to risk-weighted assets show no significant impact on bank risk, providing additional evidence that risk-based capital measures may not be computed soundly. This raises questions about the benefits and costs of being compliant with the Basel III capital requirements

(Demirgüç-Kunt and Detragiache, 2011; Haldane, 2012; Ayadi et al., 2016). Therefore, regulators have three possible solutions: i) simplify the risk-weighted assets formula to prevent any future manipulations, ii) improve monitoring and supervision policies to prevent any information asymmetries and false risk disclosures, and iii) require banks to hold a minimum risk-free leverage ratio, in addition to the risk-based capital ratios, to signal banks' real risk exposure.

[Insert Table 15 around here]

5.5. Robustness tests: Three-stage least square regressions and other estimation techniques

The literature shows that inter-relationships exist between bank risk, capital, efficiency, and profitability, which could create a simultaneity bias (Altunbas et al. 2007; Fiordelisi et al., 2011; Tan and Floros, 2013). According to Lee and Hsieh (2013), troubled banks may find that raising capital is very costly and that inducing these banks to diminish their leverage ratios due to higher capital ratios might reduce their expected returns. As a consequence, bank owners may tend to choose a higher point on the efficiency frontier to improve their profits, leading to investments in riskier portfolios (Fiordelisi et al., 2011). This behavior can also be explained by the *"cost skimping hypothesis"*, under which banks tend to improve their profits by devoting more resources to riskier activities (Peura and Keppo, 2006; Fiordelisi et al., 2011). Thus, increased capital ratios are compensated by greater risk-taking behavior. In a similar context, Berger and De Young (1997) as well as Williams (2004) refer to the *"bad management"* hypothesis, whereby inefficient banks engage in riskier activities – compared to efficient banks – to increase their returns in order to cover for any managerial inadequacies or inefficient control of operating expenses, and to compensate bank shareholders and debt holders for the amount of risk taken.

To eliminate any potential problems related to endogeneity and cross correlation between the error terms resulting from a simultaneity bias, we use three-stage least squares (3SLS) estimation by formulating the following regressions Eq. (5)–Eq. (7):

$$\mathrm{LLRTAP_{ijt}} = \alpha + \beta \times \mathrm{CAPITAL_{ijt-1}} + \beta_2 \times \mathrm{CIRP_{ijt}/NIMP_{ijt}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{\mathrm{j=1}}^{\mathrm{N}} \delta_{\mathrm{j}} \times \mathrm{Country_j} + \sum_{t=1}^{T} \mu_t \times \mathrm{Time_t} + \varepsilon_{\mathrm{ijt}} \qquad (5)$$

$$\mathrm{CAPITAL_{ijt}} = \alpha + \beta \times \mathrm{LLRTAP_{ijt}} + \beta_2 \times \mathrm{CIRP_{ijt}/NIMP_{ijt}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{j=1}^{N} \delta_j \times \mathrm{Country_j} + \sum_{t=1}^{T} \mu_t \times \mathrm{Time_t} + \varepsilon_{ijt} \quad (6)$$

$$\mathrm{CIRP_{ijt}/NIMP_{ijt}} = \alpha + \beta \times \mathrm{LLRTAP_{ijt-1}} + \beta_2 \times \mathrm{CAPITAL_{ijt-1}} + \gamma \times \mathrm{Bank\_control_{ijt-1}} + \sum_{j=1}^{N} \delta_j \times \mathrm{Country_j} + \sum_{t=1}^{T} \mu_t \times \mathrm{Time_t} + \varepsilon_{ijt} \quad (7)$$

All variables incorporated in the three equations are described in the data and methodology section and in Appendix A.

The results presented in Table 16, Panels A and B, suggest the following: (i) In contrast to some of our earlier findings, risk-based capital ratios exhibit a negative and significant effect on bank ratio of loan loss reserves, thus coinciding with the results obtained through the PSM technique, while traditional capital ratios exhibit a positive effect on the same ratio, albeit only in Panel A; (ii) consistent with our earlier findings, banks with higher capital ratios are more cost efficient (Panel A) and more profitable (Panel B); (iii) risk, efficiency and profitability are important determinants of bank capital ratios; and (iv) coinciding with Fiordelisi et al. (2011), banks that tend to hold higher reserves for loan loss are more profitable but less cost efficient. Overall, the 3SLS estimation shows that after controlling for any potential endogeneity problems resulting from the simultaneity bias, the effect of bank capital on bank risk, efficiency, and profitability remains highly similar to the main results presented in Tables 3 to 5 and thus supports Hypotheses 1a, 1c, 2, and 3.

[Insert Table 16 around here]

We now examine the robustness of our results using three alternative estimation methods. First, we bootstrap our standard errors with 100 replications (Petersen, 2009). Ghosh (2016) argues that this technique runs the regression several times and employs the variability in the slope coefficients as an estimate of their standard deviation. The bootstrapped results presented in Table 17, Panel A, remain in line with our main findings. Second, we use the Fama and MacBeth (1973) estimation technique to provide corrected cross-sectional standard errors. Table 17, Panel B, shows that the results are even more robust. Finally, we use the White estimation methodology to correct for the heteroscedasticity of standards errors as well as Newey-West adjusted standard errors to correct for the autocorrelation of the residuals. The results are tabulated in Table 17, Panel C, and show no difference with our main results.

[Insert Table 17 around here]

6. Conclusions

This study explores the effect of capital ratios on the risk, efficiency, and profitability of banking institutions. We contribute to the existing literature by employing several definitions of capital (risk and non-risk based). We argue that risk-based capital ratios can be ineffective due to untruthful assessment of bank real risk exposure (Cathcart et al. 2015; Dermine, 2015), especially when regulatory and supervisory authorities are not able to detect these untruthful disclosures (Haldane, 2012). This was evident during the subprime crisis when banks that were considered adequately capitalized went bankrupt. We study the effect of capital ratios on the risk, efficiency, and profitability of banks to address prior studies' concerns that any explorations of the relation between capital and risk should be extended to efficiency and profitability. We find that risk-based capital ratios have no impact on bank risk while non-risk based capital ratios increase bank reserves to protect against loan deafult. We also demonstrate that higher capital ratios increase bank efficiency and profitability. Finally, we find that capital (other than common equity) has a destabilizing effect on bank efficiency and profitability, reflecting the importance of higher quality capital (common equity) in reducing risk and improving efficiency and profitability.

We perform a battery of robustness tests and find similar results. The effect of capital is more pronounced for larger and too-big-to-fail banks while the opposite occurs for highly liquid banks. Specifically, higher capital ratios reduce the efficiency and the profitability of highly liquid banks; thus, imposing higher capital ratios on highly liquid banks might have a penalizing effect. As for the crisis period, we find that highly capitalized banks have higher loan loss reserves, higher net interest margins and lower cost. Our results remain unchanged when we use additional macroeconomic control variables and replace our capital ratios with metrics derived from principal component analysis. Additional results obtained from quantile regressions show that higher capital has a more significant impact on highly cost efficient, and profitable banks with higher loan loss reserves. Finally, our results hold when excluding non-OECD countries and merged banks, when using alternative risk, efficiency, and profitability measures, and when employing three-stage least squares regressions and other estimation techniques.

Our findings have important implications for regulators and policymakers, particularly in OECD countries. First, while risk-based and traditional capital ratios show a pronounced effect on bank

efficiency and profitability, our results suggest that risk-based capital ratios fail to decrease bank risk, thus casting doubt on the Basel risk-weighting methodology. Second, banks in OECD countries are still less capable of dealing with capital-like ratios than with ratios based on good quality capital. On the one hand, our findings are in line with emerging research that raises questions about the effectiveness of a more complex capital regulatory framework in reducing bank risk (Haldane, 2012; Cathcart et al. 2015; Dermine, 2015). On the other hand, we provide evidence that capital of good quality is more effective in reducing bank risk and improving efficiency and profitability than other types of capital, thus supporting Basel III recommendations to impose constraints on supplementary capital. Consequently, future research on bank risk should further investigate and compare the effect of the Basel-prescribed versus traditional capital ratios on bank risk.

It is worth noting that the overall significance and interpretation of our results depend largely on the validity of the accounting measures used to proxy for bank risk, efficiency, and profitability. We attempt to overcome potential limitations related to measurement errors using a large variety of proxies and econometric techniques; however, not all of these robustness checks confirm our main results. For instance, risk-based capital ratios show a negative and significant effect on bank reserves for loan loss in some of the alternative estimation techniques (PSM, 3SLS). Consequently, more research is needed to draw definitive conclusions about which type(s) and combinations of capital ratio measures banks should use. Furthermore, this study focuses only on capital guidelines. Future studies should also account for the flexibility shown by supervisory agencies in implementing Basel III as well as for the other regulatory standards imposed by the accord. Liquidity and leverage requirements along with the implementation of appropriate frameworks for risk management and corporate governance are also important factors to consider when investigating the effectiveness of Basel III.

References

Abedifar, P., Molyneux, P., Tarazi, A. (2013) Risk in Islamic banking. Review of Finance 17(6): 2035–2096.

Aggarwal, R.K., Jacques, K. (1998) Assessing the impact of prompt corrective action on bank capital and risk. Economic Policy Review 4(3): 23–32.

Altunbas, Y., Carbo, S., Gardner, E., Molyneux, P. (2007) Examining the relationship between capital, risk and efficiency in European banking. European Financial Management 13(1): 49–70.

Anginer, D., Demirgüç-Kunt, A. (2014) Bank capital and systemic stability. Policy Research Working Paper No. 6948, The World Bank, Washington, DC.

Anginer, D., Demirgüç-Kunt, A., Zhu, M. (2014) How does bank competition affect systemic stability? Journal of Financial Intermediation 23(1): 1–26.

Ariff, M., Can, L. (2008) Cost and profit efficiency of Chinese banks: A non-parametric analysis. China Economic Review 19(2): 260–273.

Avery, R.B., Berger, A.B. (1991) Risk-based capital and deposit insurance reform. Journal of Banking & Finance 15(4–5): 847–874.

Ayadi, R., Ben Naceur, S., Casu, B., Quinn, B. (2016) Does Basel compliance matter for bank performance? Journal of Financial Stability 23(4): 15–32.

Banker, R.D., Chang, H., Lee, S. (2010) Differential impact of Korean banking system reforms on bank productivity. Journal of Banking & Finance 34(7): 1450–1460.

Barth, J., Lin, C., Ma, Y., Seade, J., Song, F. (2013) Do bank regulation, supervision and monitoring enhance or impede bank efficiency? Journal of Banking & Finance 37(8): 2879–2892.

Beck, T., Demirgüç-Kunt, A., Merrouche, O. (2013) Islamic vs. conventional banking: Business model, efficiency and stability. Journal of Banking & Finance 37(2): 433–447.

Berger, A.N., (1995) The relationship between capital and earnings in banking. Journal of Money, Credit and Banking 27(2): 432–456.

Berger, A.N., Bouwman, C., Kick, T., Schaeck, K. (2014) Bank risk taking and liquidity creation following regulatory interventions and capital support. Working paper, University of South Carolina.

Berger, A.N., Bouwman, C.H.S. (2012) Bank liquidity creation, monetary policy, and financial crises. Working paper, University of South Carolina.

Berger, A.N., Bouwman, C.H.S. (2013) How does capital affect bank performance during financial crises? Journal of Financial Economics 109(1): 146–176.

Berger, A.N., De Young, R. (1997) Problem loans and cost efficiency in commercial banking. Journal of Banking & Finance 21(6): 849–870.

Bitar, M., Hassan, M.K., Walker, T., (2016) Political systems and the financial soundness of Islamic banks. Working paper, John Molson School of Business, Concordia University.

Blum, J. (1999) Do capital adequacy requirements reduce risks in banking? Journal of Banking & Finance 23(5): 755–771.

Blum, J. (2008) Why Basel II may need a leverage ratio restriction. Journal of Banking & Finance 32(8): 1699–1707.

Canbas, S., Cabuk, A., Kilic, S.B. (2005) Prediction of commercial bank failure via multivariate statistical analysis of financial structures: The Turkish case. European Journal of Operational Research 166(2): 528–546.

Carvallo, O., Kasman, A. (2005) Cost efficiency in the Latin American and Caribbean banking systems. International Financial Markets, Institutions and Money 15(1): 55−72.

Cathcart, L., El-Jahel, L., Jabbour, R. (2015) Can regulators allow banks to set their own capital ratios? Journal of Banking & Finance 53(4): 112–123.

Chortareasa, G.E., Girardoneb, C., Ventouric, A. (2012) Bank supervision, regulation, and efficiency: Evidence from the European Union. Journal of Financial Stability 8(4): 292–302.

Demirgüç-Kunt, A., Detragiache, E. (2011) Basel core principles and bank soundness: Does compliance matter? Journal of Financial Stability 7(4): 179–190.

Demirgüç-Kunt, A., Detragiache, E., Merrouche, O. (2013) Bank capital: Lessons from the financial crisis. Journal of Money, Credit and Banking 45(6): 1147–1164.

Demirgüç-Kunt, A., Huizinga, H. (2000) Financial structure and bank profitability. World Bank Policy Research Working Paper No. 2430.

Demirgüç-Kunt, A., Huizinga, H. (2010) Bank activity and funding strategies: The impact on risk and returns. Journal of Financial Economics 98(3): 626–650.

Dermine, J. (2015) Basel III leverage ratio requirement and the probability of bank runs. Journal of Banking & Finance 53(4): 266–277.

Dullien, S., Kotte, D.J., Márquez, A., Priewe, J. (2010) The financial and economic crisis of 2008-2009 and developing countries. United Nations Conference on Trade and Development. University of Applied Sciences, Berlin.

Eubanks, W.W. (2010) The European Union's Response to the 2007-2009 Financial Crisis. Congressional Research Service. Report for Congress, 7-5700.

Fiordelisi, F., Marques-Ibanez, D., Molyneux, P. (2011) Efficiency and risk in European banking. Journal of Banking & Finance 35(5): 1315−1326.

Ghosh, S. (2016) Political transition and bank performance: How important was the Arab Spring? Journal of Comparative Economics 44(2): 372–382.

Haldane, A.G. (2012) The dog and the Frisbee, Bank of England, United Kingdom.

Horváth, R., Seidler, J., Weill, L. (2014) Bank capital and liquidity creation: Granger causality evidence. Journal of Financial Services Research 45(3): 341−361

Houston, J.F., Lin, C., Lin, P., Ma, Y. (2010) Creditor rights, information sharing, and bank risk taking. Journal of Financial Economics 96(3): 485–512.

Iannotta, G., Nocera, G., Sironi, A. (2007) Ownership structure, risk and performance in the European banking industry. Journal of Banking & Finance 31(7): 2127–2149.

Jacques, K., Nigro, P. (1997) Risk-based capital, portfolio risk and bank capital: A simultaneous equations approach. Journal of Economics and Business 49(6), 533–547.

Johnes, J., Izzeldin, M., Pappas, V. (2009) Efficiency in Islamic and conventional banks: A comparison based on financial ratios and data envelopment analysis, Working Paper, Lancaster University Management School.

Johnes, J., Izzeldin, M., Pappas, V. (2013) A comparison of performance of Islamic and conventional banks 2004 to 2009. Journal of Economic Behavior & Organization 103S(7): 93–107.

Kahane, Y. (1977) Capital adequacy and the regulation of financial intermediaries, Journal of Banking & Finance 1(2): 207–218.

Kim, D., Santomero, A.M. (1988) Risk in banking and capital regulation. The Journal of Finance 43(5): 1219–1233.

Klomp, J., de Haan, J. (2012) Banking risk and regulation: Does one solution fit all? Journal of Banking & Finance 36(12): 3197–3212.

Klomp, J., de Haan, J. (2014) Bank regulation, the quality of institutions, and banking risk in emerging and developing countries: An empirical analysis. Emerging Market Finance & Trade 50(6): 19–40.

Koehn, M., Santomero, A.M. (1980) Regulation of bank capital and portfolio risk. The Journal of Finance 35(5): 1235–1244.

Laeven, L., Levine, R. (2007) Is there a diversification discount in financial conglomerates? Journal of Financial Economics 85(2): 331–367.

Laeven, L., Valencia, F. (2008) Systemic banking crises: A new database. IMF Working Paper No. 08/224.

Laeven, L., Valencia, F. (2012) Systemic banking crisis database: An update. IMF Working Paper No. 12/163.

Le Leslé, V., Avramova, D. (2012) Revising risk-weighted assets. IMF Working Paper No. 12/90.

Lee, C., Hsieh, M. (2013) The impact of capital on profitability and risk in Asian banking. Journal of International Money and Finance 32: 251–281.

Pasiouras, F. (2008) International evidence on the impact of regulations and supervision on banks' technical efficiency: An application of two-stage data envelopment analysis. Review of Quantitative Finance and Accounting 30(2): 187–223.

Petersen, M. (2009) Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies 22(1): 435–480.

Repullo, R., Suarez, J. (2012) The procyclical effect of bank capital regulation. The Review of Financial Studies 26(2): 452–490.

Rime, B. (2001) Capital requirements and bank behavior: Empirical evidence for Switzerland. Journal of Banking & Finance 25(4): 789–805.

Schaeck, K., Cihák, M. (2012) Banking competition and capital ratios. European Financial Management 18(5): 863–866.

Schaeck, K., Cihák, M. (2013) Competition, efficiency and stability in banking. Financial Management 43(1): 215–241.

Shih, V., Zhang, Q., Liu, M. (2007) Comparing the performance of Chinese banks: A principal component analysis. China Economic Review 18(1): 15–34.

Staub, R.B., Da Silva e Souza, G., Tabak, B.M. (2010) Evolution of bank efficiency in Brazil: A DEA approach. European Journal of Operational Research 202(1): 204–213.

Stiroh, K. (2004) Diversification in banking: Is non-interest income the answer? Journal of Money, Credit and Banking 36(5): 853–882.

Stiroh, K. (2006) A portfolio view of banking with interest and noninterest activities. Journal of Money, Credit and Banking 38(5): 1351-1361.

Sufian, F. (2010) The impact of risk on technical and scale efficiency: Empirical evidence from the China banking sector. International Journal of Business Performance Management 12(1): 37–71.

Tan, Y. (2016) The impact of risk and competition on bank profitability in China. International Financial Markets, Institutions, and Money 40: 85–110.

Tan, Y. Floros, F. (2013) Risk, capital and efficiency in Chinese banking. International Financial Markets, Institutions, and Money 26: 378–393.

Williams, J. (2004) Determining management behaviour in European banking. Journal of Banking & Finance 28(10): 2427–2460.

Tables

Table 1: Overview of the main literature on banking regulations and bank risk

Authors (year)	Period under study	Countries	Methodology	Main empirical evidence
Panel A: Capital and risk				
Peltzman (1970)	1963–1965	United States	A theoretical model developed by Peltzman (1965) and regression analysis	Uncertainty about the effectiveness of the capital risk relationship.
Rime (2001)	1989–1995	Switzerland	Simultaneous equations	No significant relationship between capital and risk in Swiss commercial banks.
Mayne (1972)	1961–1968	United States	Ordinary Least Squares (OLS) regressions	A more standardized formula for capital requirements may lead to better bank compliance regarding any capital increase.
Barrios and Blanco (2004)	1985–1991	76 Spanish commercial banks	Disequilibrium estimation and partial adjustment equations	The pressure of market is the key determinant of capital requirements.
Kahane (1977)	---	---	Theoretical paper; Portfolio model	Imposing constraints on both sides of a bank's balance sheet is the only way to construct a feasible capital measure that diminishes the probability of bank default.
Demirgüç-Kunt and Detragiache (2011)	1999–2006	86 countries	Ordinary Least Squares (OLS) regressions	Compliance with Basel core principles does not enhance banks' Z-scores.
Haldane (2012)	Different periods	Different samples	Multiple regression techniques	No conclusive evidence that complex capital ratios impede banks' probability of default.
Blum (2008)	---	---	Theoretical paper and model	Regulators need to implement a non-risk based leverage ratio to alleviate the inefficiencies of the Basel II risk based capital requirements.
a. Positive association between capital and risk				
Koehn and Santomero (1980)	---	---	Theoretical paper; Quadratic programming of Merton	Capital requirements may have an effect that is opposite to that intended by regulators.
Avery and Berger (1991)	1982–1989	United States	Regression analysis	Higher capital requirements increase the capital ratio of banks. Yet, they do not affect the business risk faced by banks.
Kim and Santomero (1988)	---	---	Theoretical paper; Mean-variance approach	Restrictions on bank assets may shift the position of the optimal portfolio choice for banks.
Blum (1999)	---	---	Theoretical paper; Dynamic framework	Increasing capital guidelines tomorrow will increase banks' risk today.
Shrieves and Dahl (1992)	1983–1987	United States commercial banks	Simultaneous equations	There is a positive relationship between capital and risk
Iannotta et al. (2007)	1999–2004	15 European countries	Regression analysis	The equity-to-assets ratio is positively associated with the bank loan loss provision ratio.
b. Negative association between capital and risk				
Aggarwal and Jacques (1998)	1990–1993	United States commercial banks	Simultaneous equations	Regulatory capital requirements reduce bank portfolio risk.
Brewer and Lee (1986)	1987–1984	United States	Multi-index market panel data model	Bank risk increases if bank loans and funds increase and decreases when the capital-to-assets ratio increases.
Jacques and Nigro (1997)	1990–1991	United States commercial banks	Three stage least squares (3SLS) regressions	Capital ratios and bank risk are negatively related.
Anginer and Demirgüç-Kunt (2014)	1997–2012	48 countries	Ordinary Least Squares (OLS) regressions	Capital ratios are negatively correlated with bank risk. This relationship is more pronounced for larger banks and banks during the crisis period.
Berger and Bouwman (2012)	1993–2003	United States commercial banks	Panel data regressions	Capital improves banks' soundness. However, it reduces the liquidity creation for small banks.
Tan and Floros (2013)	2003– 2009	China	Three stage least squares (3SLS) regressions	Capital ratios are negatively associated with bank Z-scores. This relationship becomes insignificant when replacing Z-scores with the ratio of loan loss provisions to loans and the volatility of ROA and ROE.
Panel B: Capital, efficiency, and profitability				
Altnubas et al. (2007)	1992–2000	15 European countries	Seemingly unrelated regression (SUR) approach	Inefficient European banks have higher capital positions and lower risk.

Authors (year)	Period under study	Countries	Methodology	Main empirical evidence
Fiordelisi et al. (2011)	1995–2007	26 European Union countries	Generalized Method of Moments (GMM)	More efficient banks are more capitalized; higher capital ratios are positively correlated with bank efficiency.
Pettway (1976)	1971–1974	United States	Regression analysis	Capital requirements decrease the operational efficiency of the banking system.
Demirgüç-Kunt et al. (2013)	2005–2009	12 OECD countries	Regression analysis	Capital requirements have a positive influence on banks' stock returns. There is evidence that Tier1 capital is more effective than other forms of capital.
Lee and Hsieh (2013)	1994–2008	Asian banks	Dynamic panel data approach	There is a negative relationship between bank capital and risk but an inconclusive relation between bank capital and profitability.
Barth et al. (2013)	1999–2007	72 countries	DEA and regression analysis	Capital is an important determinant of bank efficiency.
Tan and Floros (2013)	2003–2009	China	Three stage least squares (3SLS) regressions	Weak positive association between capital and bank technical efficiency.
Tan (2016)	2003–2011	China	Two step GMM estimator	Positive association between capital and bank profitability proxied by ROE. However, the association becomes insignificant when using ROA and negative when using NIM and profit margin.
Chortareas et al. (2012)	2000–2008	22 European Union countries	DEA, truncated, Tobit, and GLM regressions	Capital is positively correlated with the efficiency and the net interest margin of the EU banking sector.
Banker et al. (2010)	1995–2005	Korea	DEA, OLS regressions	The capital adequacy ratio is positively correlated with bank efficiency.
Staub et al. (2010)	2000–2007	Brazil	DEA, dynamic panel data, autoregressive and Tobit regressions	Capitalization is an important determinant of Brazilian bank efficiency.
Sufian (2010)	2000–2006	China	DEA, panel data, and Tobit regressions	Capitalization is positively related with bank efficiency.
Pasiouras (2008)	2003	95 countries	DEA and Tobit regressions	Technical efficiency increases with bank capitalization.

Table 1 – (Continued)

Table 2: Summary statistics

	N	Mean	Std. Dev.	5th Pctl.	25th Pctl.	Median	75th Pctl.	95th Pctl.
Panel A.1: Bank and country level control variables								
Risk model:								
Loan loss reserves/ta	22,878	2.933	4.065	0.079	0.729	1.631	3.442	10.258
Loan loss reserves/gross loans	22,878	5.11	5.766	0.255	1.423	2.963	6.413	18.776
Loan loss reserves/impaired loans	15,974	165.99	179.98	26.01	52.77	94.27	203.03	591.92
Efficiency model:								
Cost to income	29,268	70.18	28.185	30.341	52.605	67.946	85.898	106.14
Non-interest expenses/gross revenues	29,398	69.80	28.319	29.48	52.46	67.95	85.87	106.26
Non-operating items/average assets	28,770	-0.499	0.838	-1.838	-0.755	-0.38	-0.127	0.404
Profitability model:								
Net interest margin	29,592	4.177	3.539	0.51	1.668	3.007	5.768	11.698
Earnings/ta	29,770	0.925	1.867	-1.463	0.230	0.701	1.453	4.028
Other operating income/ average assets	29,577	6.636	13.205	0.028	0.566	1.657	5.622	33.1
Main variables & control variables:								
Tier 1/rwa	10,050	14.524	11.685	5.8	8.39	11.1	15.7	35.55
Total capital/rwa	12,397	18.181	15.037	8.49	11.13	13.78	18.6	42.99
Common equity/rwa	8,528	16.772	18.945	5.008	8.513	11.711	17.052	42.82
Other capital/rwa	8,157	1.273	3.353	-3.993	-0.04	1.322	3.17	6.863
Tier 1/ta	9,672	9.48	9.02	2.629	4.574	6.638	10.735	25.742
Total capital/ta	10,096	11.09	9.693	3.509	5.75	8.222	12.536	27.861
Common equity/ta	29,850	14.956	15.262	2.787	5.809	9.734	17.404	48.1
Other capital/ta	10,094	0.801	2.28	-2.536	-0.075	0.708	1.915	4.925
Tangible equity/ta	29,852	15.156	15.497	2.68	5.84	9.85	17.78	49.12
Net loans/ta	29,478	51.701	24.158	5.968	35.028	55.969	69.659	87.558
Growth assets	26,942	17.005	35.569	-24.03	-0.46	8.63	25.42	83.97
Income diversity	29,506	0.853	0.58	0.031	0.395	0.762	1.341	1.839
Size	29,877	13.597	2.535	9.55	11.719	13.47	15.405	17.927

Panel A.2: Macroeconomic and institutional control variables:

	N	Mean	Median	Std. Dev.	Min.	Max.
Deposit insurance	585	0.84	1	0.36	0	1
GDP growth	585	3.33	3.37	3.73	-14.74	14.16
HHID	585	0.14	0.12	0.09	0.03	0.91
Certified audit	585	0.99	1	0.06	0	1
Capital stringency	585	5.78	6	1.53	2	8
Market discipline	585	5.62	5	0.89	4	9
Supervisory power	585	9.74	9	2.29	4	14
Entry requirements	585	7.5	8	0.89	0	8
World governance index	585	0.47	0.65	1.01	-1.09	2.38
Economic freedom	585	62.54	62.1	10.41	47.4	83.1

Panel B: Correlation matrix:

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(14)
Tier1/rwa	(1)													
Total capital/rwa	(2)	0.947												
Common equity/rwa	(3)	0.839	0.842											
Other capital/rwa	(4)	-0.282	-0.135	-0.402										
Tier1/ta	(5)	0.787	0.733	0.628	-0.178									
Total capital/ta	(6)	0.713	0.706	0.567	-0.029	0.944								
Common equity/ta	(7)	0.790	0.746	0.703	-0.338	0.943	0.888							
Other capital/ta	(8)	-0.269	-0.122	-0.379	0.938	-0.135	0.038	-0.300						
Tangible equity/ta	(9)	0.787	0.746	0.676	-0.261	0.943	0.890	0.975	-0.224					
Net loans/ta	(10)	-0.284	-0.279	-0.257	0.114	-0.099	-0.075	-0.107	0.112	-0.095				
Growth assets	(11)	0.123	0.101	0.095	-0.073	0.145	0.144	0.146	-0.040	0.138	-0.106			
Income diversity	(13)	0.096	0.117	0.102	-0.063	0.058	0.077	0.085	-0.029	0.071	-0.294	0.040		
Size	(14)	-0.429	-0.363	-0.366	0.2394	-0.435	-0.462	-0.443	0.184	-0.449	-0.076	-0.182	0.069	

Note: The sample covers 1,992 banks in 39 countries. Variable definitions are provided in Appendix A.

Table 3: Capital and risk model. The dependent variable is the ratio of bank loan loss reserves to total assets (LLRTAP). FE stands for 'fixed effects'. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	LLRTAP [1]	LLRTAP [2]	LLRTAP [3]	LLRTAP [4]	LLRTAP [5]	LLRTAP [6]	LLRTAP [7]	LLRTAP [8]	LLRTAP [9]
Net loans/ta	0.03***	0.03***	0.033***	0.033***	0.035***	0.035***	0.045***	0.034***	0.0451***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Growth assets	-0.011***	-0.011***	-0.012***	-0.012***	-0.01***	-0.01***	-0.011***	-0.011***	-0.011***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Income diversity	-0.361***	-0.363***	-0.432***	-0.436***	-0.458***	-0.478***	-0.529***	-0.447***	-0.522***
	(0.002)	(0.113)	(0.144)	(0.149)	(0.148)	(0.141)	(0.100)	(0.138)	(0.100)
Cost to income	0.002	0.002	0.003	0.003	0.002	0.003	0.006	0.002	0.005***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Size	-0.077**	-0.073**	-0.063	-0.057	-0.028	0.003	0.041	-0.071**	0.042
	(0.036)	(0.031)	(0.004)	(0.039)	(0.046)	(0.003)	(0.030)	(0.034)	(0.030)
Tier 1/rwa	-0.005								
	(0.006)								
Total capital/rwa		-0.001							
		(0.004)							
Common equity/rwa			-0.003						
			(0.004)						
Other capital/rwa				-0.017					
				(0.020)					
Tier 1/ta					0.027*				
					(0.015)				
Total capital/ta						0.025**			
						(0.013)			
Common equity/ta							0.036***		
							(0.007)		
Other capital/ta								0.002	
								(0.028)	
Tangible equity/ta									0.035***
									(0.007)
Constant	2.144***	2.042***	1.89**	1.856**	0.754	9.736	-1.737***	1.764**	-1.738***
	(0.764)	(0.641)	(0.883)	(0.889)	(0.959)	(0.902)	(0.569)	(0.708)	(0.569)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	7,383	8,635	6,342	6,065	7,013	7,157	17,664	7,156	17,665
R-squared	0.305	0.259	0.303	0.307	0.297	0.294	0.257	0.29	0.257

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 4: Capital and efficiency model. The dependent variable is the cost to income ratio (CIRP). Our estimations are based on OLS regressions. FE stands for 'fixed effects'. See Appendix A for variable definitions.

	CIRP [1]	CIRP [2]	CIRP [3]	CIRP [4]	CIRP [5]	CIRP [6]	CIRP [7]	CIRP [8]	CIRP [9]
Net loans/ta	-0.196***	-0.232***	-0.2168***	-0.2***	-0.179***	-0.188***	-0.113***	-0.192***	-0.115***
	(0.273)	(0.033)	(0.039)	(0.039)	(0.036)	(0.035)	(0.018)	(0.036)	(0.018)
Growth assets	-0.035*	-0.037**	-0.022	-0.016	-0.044**	-0.031	-0.044***	-0.026	-0.046***
	(0.019)	(0.016)	(0.022)	0.023)	(0.019)	(0.019)	(0.007)	(0.019)	(0.007)
Income diversity	2.972*	2.735*	1.961	1.329	3.167**	2.882*	9.707***	2.445	9.732***
	(1.522)	(1.451)	(1.961)	(1.672)	(1.613)	(1.547)	(0.810)	(1.563)	(0.808)
Loan loss reserves/ta	0.426	0.521**	0.556	0.611*	0.562*	0.581*	0.581***	0.535*	0.593***
	(0.324)	(0.263)	(0.351)	(0.369)	(0.318)	(0.313)	(0.099)	(0.310)	(0.099)
Size	-3.047***	-2.826***	-3.194***	-3.128***	-3.309***	-3.218***	-3.225***	-3.09***	-3.302***
	(0.273)	(0.256)	(0.302)	(0.295)	(0.286)	(0.276)	(0.201)	(0.275)	(0.203)
Tier 1/rwa	-0.168**								
	(0.068)								
Total capital/rwa		-0.156***							
		(0.058)							
Common equity/rwa			-0.091**						
			(0.043)						
Other capital/rwa				0.28*					
				(0.162)					
Tier 1/ta					-0.234**				
					(0.106)				
Total capital/ta						-0.165*			
						(0.095)			
Common equity/ta							-0.179***		
							(0.032)		
Other capital/ta								0.632***	
								(0.214)	
Tangible equity/ta									-0.201***
									(0.031)
Constant	123.252***	120.977***	129.267***	127.02***	128.284**	127.316***	113.307***	122.48***	114.72***
	(6.851)	(6.172)	(7.659)	(7.632)	(6.491)	(6.399)	(4.093)	(6.192)	(4.115)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	7,329	8,582	6,337	6,062	7,004	7,149	17,569	7,149	17,569
R-squared	0.211	0.181	0.212	0.219	0.211	0.207	0.307	0.208	0.308

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 5: Capital and profitability. The dependent variable is the bank net interest margin (NIMP). Our estimations are based on OLS regressions. FE stands for 'fixed effects'. See Appendix A for variable definitions.

	NIMP [1]	NIMP [2]	NIMP [3]	NIMP [4]	NIMP [5]	NIMP [6]	NIMP [7]	NIMP [8]	NIMP [9]
Net loans/ta	0.011***	0.013***	0.01**	0.0098**	0.01***	0.009***	0.016***	0.009***	0.016***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Growth assets	0.003*	0.002	0.002	0.002	0.005***	0.005**	0.002***	0.004**	0.003***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Income diversity	-0.81***	-0.921***	-0.858***	-0.825***	-0.896***	-0.968***	-1.029***	-0.898***	-1.041***
	(0.142)	(0.132)	(0.157)	(0.163)	(0.131)	(0.139)	(0.081)	(0.143)	(0.081)
Loan loss reserves/ta	0.282***	0.263***	0.27***	0.265***	0.274***	0.272***	0.197***	0.281***	0.198***
	(0.040)	(0.034)	(0.044)	(0.045)	(0.038)	(0.038)	(0.014)	(0.038)	(0.014)
Size	-0.185***	-0.215***	-0.199***	-0.193***	-0.133***	-0.159***	-0.221***	-0.192***	-0.219***
	(0.029)	(0.029)	(0.032)	(0.033)	(0.029)	(0.030)	(0.023)	(0.028)	(0.023)
Tier 1/rwa	0.009								
	(0.006)								
Total capital/rwa		0.008*							
		(0.005)							
Common equity/rwa			0.008**						
			(0.003)						
Other capital/rwa				-0.073***					
				(0.015)					
Tier 1/ta					0.05***				
					(0.009)				
Total capital/ta						0.031***			
						(0.008)			
Common equity/ta							0.053***		
							(0.004)		
Other capital/ta								-0.084***	
								(0.024)	
Tangible equity/ta									0.052***
									(0.004)
Constant	4.706***	4.888***	5.133***	5.373***	3.735***	4.368***	4.816***	5.405***	4.814***
	(0.642)	(0.590)	(0.695)	(0.691)	(0.596)	(0.603)	(0.438)	(0.520)	(0.439)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	7,364	8,630	6,367	6,092	7,037	7,186	17,651	7,186	17,650
R-squared	0.619	0.600	0.625	0.628	0.619	0.614	0.609	0.612	0.609

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 6: Capital and bank size. The dependent variables are (1) the ratio of loan loss reserves to assets (LLRTAP), (2) the cost to income ratio (CIRP), and (3) the bank net interest margin (NIMP). We only show variables of interest and estimate our models using three sub-samples: small banks (Panel A), medium banks (Panel B), and large banks (Panel C) based on their asset size. Based on the lower (Q25) and the upper quantile (Q75), banks are classified as small banks when LnTA<11.719, medium banks when 11.719<LnTA<15.405, and large banks when LnTA>15.405. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

Panel A: Small banks

Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa	-0.086*	115	0.552	0.86**	113	0.476	-0.005	117	0.774
	(0.045)			(0.352)			(0.038)		
Total capital/rwa	-0.032	245	0.343	0.285	243	0.316	-0.015	249	0.698
	(0.022)			(0.177)			(0.015)		
Common equity/rwa	-0.034	109	0.486	0.127	108	0.413	-0.017	111	0.797
	(0.030)			(0.197)			(0.018)		
Other capital/rwa	-0.168	104	0.479	0.047	103	0.403	0.028	106	0.79
	(0.149)			(1.354)			(0.209)		
Tier 1/ta	-0.075	123	0.583	1.81***	120	0.552	-0.011	123	0.816
	(0.062)			(0.365)			(0.022)		
Total capital/ta	-0.043	142	0.494	1.39***	140	0.518	0.032	143	0.768
	(0.045)			(0.518)			(0.041)		
Common equity/ta	0.056***	4,071	0.187	-0.011	4,079	0.291	0.041***	4,092	0.455
	(0.011)			(0.032)			(0.005)		
Other capital/ta	0.053	142	0.487	2.437*	140	0.445	0.005	143	0.765
	(0.154)			(1.362)			(0.191)		
Tangible equity/ta	0.056***	4,071	0.186	-0.011	4,079	0.291	0.042***	4,091	0.456
	(0.010)			(0.031)			(0.005)		

Panel B: Medium banks

Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa	-0.004	2,780	0.313	-0.318***	2,735	0.174	0.004	2,748	0.551
	(0.007)			(0.077)			(0.008)		
Total capital/rwa	0.001	3,697	0.23	-0.277***	3,651	0.143	0.004	3,673	0.522
	(0.005)			(0.069)			(0.006)		
Common equity/rwa	-0.000	2,212	0.286	-0.204***	2,202	0.192	0.006	2,211	0.548
	(0.004)			(0.050)			(0.005)		
Other capital/rwa	0.023	2,082	0.293	0.433	2,075	0.174	-0.107***	2,084	0.554
	(0.026)			(0.279)			(0.029)		
Tier 1/ta	0.026	2,643	0.288	-0.359***	2,635	0.155	0.043***	2,646	0.562
	(0.020)			(0.125)			(0.012)		
Total capital/ta	0.031*	2,762	0.287	-0.278**	2,752	0.157	0.028**	2,767	0.551
	(0.018)			(0.119)			(0.011)		
Common equity/ta	0.031***	8,273	0.253	-0.319***	8,190	0.23	0.04***	8,238	0.526
	(0.011)			(0.064)			(0.006)		
Other capital/ta	0.053	2,762	0.281	0.898***	2,752	0.156	-0.097**	2,767	0.551
	(0.033)			(0.302)			(0.039)		
Tangible equity/ta	0.031***	8,273	0.253	-0.371***	8,190	0.235	0.038***	8,238	0.525
	(0.011)			(0.062)			(0.006)		

Panel C: Large banks

Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa	0.014	4,488	0.371	-0.272**	4,481	0.327	0.009	4,499	0.672
	(0.012)			(0.117)			(0.007)		
Total capital/rwa	0.021	4,693	0.365	-0.223**	4,688	0.322	0.004	4,708	0.655
	(0.013)			(0.111)			(0.008)		
Common equity/rwa	0.011	4,021	0.379	-0.037	4,027	19.43	0.012**	4,045	0.677
	(0.007)			(0.064)			(0.005)		
Other capital/rwa	-0.044	3,879	0.385	0.191	3,884	0.32	-0.057***	3,902	0.676
	(0.031)			(0.171)			(0.015)		
Tier 1/ta	0.142***	4,247	0.397	-0.856***	4,249	0.326	0.095***	4,268	0.674
	(0.035)			(0.213)			(0.031)		
Total capital/ta	0.067**	4,253	0.381	-0.523***	4,257	0.319	0.035*	4,276	0.661
	(0.028)			(0.161)			(0.019)		
Common equity/ta	0.06**	5,320	0.354	-0.848***	5,300	0.299	0.089***	5,321	0.654
	(0.031)			(0.124)			(0.025)		
Other capital/ta	-0.049	4,252	0.3726	0.264	4,257	0.312	-0.079***	4,276	0.661
	(0.054)			(0.273)			(0.026)		
Tangible equity/ta	0.049*	5,321	0.35	-0.991***	5,300	0.306	0.073***	5,321	0.648
	(0.029)			(0.127)			(0.022)		

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 7: Subsample tests for highly liquid banks, too-big-to-fail banks, and banks during the financial crisis. The dependent variables are (1) the ratio of loan loss reserves to assets (LLRTAP), (2) the cost to income ratio (CIRP), and (3) the bank net interest margin (NIMP). We only report results for our variables of interest and for interaction terms between capital and a too big to fail dummy (TBTFA) (Panel A), highly liquid banks (h_liquid) (Panel B), and the crisis period (Panel C). The dummy variable TBTFA takes on a value of 1 if a bank's share in a country's total assets exceeds 30%. The dummy variable h_liquid takes on a value of 1 if bank liquidity is higher than the upper quantile of its liquidity ratio, i.e. the ratio of liquid assets to deposit and short term funding. The crisis dummy takes on a value of one for the years 2008–2009 and 0 otherwise. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

Panel A: Too-big-to-fail banks									
Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa × TBTFA	0.015*	7,383	0.3053	-0.348***	7,329	0.217	0.016*	7,364	0.62
	(0.009)			(0.113)			(0.009)		
Total capital/rwa × TBTFA	0.015**	8,635	0.2596	-0.191	8,582	0.183	0.007	8,630	0.6
	(0.007)			(0.122)			(0.008)		
Common equity/rwa × TBTFA	0.014**	6,342	0.304	-0.065	6,337	0.213	0.013**	6,367	0.626
	(0.007)			(0.088)			(0.006)		
Other capital/rwa × TBTFA	-0.049	6,065	0.308	-0.21	6,062	0.219	-0.007	6,092	0.628
	(0.035)			(0.289)			(0.028)		
Tier 1/ta × TBTFA	0.107***	7,013	0.313	-0.156***	7,004	0.216	0.035*	7,037	0.62
	(0.034)			(0.161)			(0.018)		
Total capital/ta × TBTFA	0.085***	7,157	0.305	-0.512***	7,149	0.213	0.016	7,186	0.614
	(0.030)			(0.147)			(0.0175)		
Common equity/ta × TBTFA	0.029	17,664	0.259	-0.62***	17,569	0.313	0.014	17,651	0.61
	(0.018)			(0.093)			(0.012)		
Other capital/ta × TBTFA	-0.092*	7,156	0.292	-0.120	7,149	0.209	-0.021	7,186	0.612
	(0.056)			(0.379)			(0.045)		
Tangible equity/ta × TBTFA	0.023	17,665	0.259	-0.68***	17,569	0.316	0.011	17,650	0.61
	(0.018)			(0.091)			(0.012)		
Panel B: Highly liquid banks									
Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa × h_liquid	0.004	7,383	0.305	0.092	7,329	0.212	-0.021**	7,364	0.621
	(0.008)			(0.123)			(0.009)		
Total capital/rwa × h_liquid	-0.001	8,635	0.259	0.238**	8,582	0.184	-0.013*	8,630	0.602
	(0.006)			(0.097)			(0.007)		
Common equity/rwa × h_liquid	-0.001	6,342	0.303	0.056	6,337	0.214	-0.01	6,367	0.627
	(0.005)			(0.082)			(0.006)		
Other capital/rwa × h_liquid	-0.046	6,065	0.308	0.605	6,062	0.22	-0.073	6,092	0.63
	(0.038)			(0.439)			(0.044)		
Tier 1/ta × h_liquid	-0.021	7,013	0.298	0.378**	7,004	0.214	-0.031**	7,037	0.621
	(0.016)			(0.172)			(0.014)		
Total capital/ta × h_liquid	-0.019	7,157	0.295	0.344**	7,149	0.21	-0.024*	7,186	0.616
	(0.015)			(0.016)			(0.012)		
Common equity/ta × h_liquid	-0.004	17,664	0.257	0.083*	17,569	0.307	-0.003	17,651	0.61
	(0.009)			(0.049)			(0.006)		
Other capital/ta × h_liquid	-0.025	7,156	0.2906	0.494	7,149	0.2087	-0.09	7,186	0.613
	(0.064)			(0.661)			(0.070)		
Tangible equity/ta × h_liquid	-0.005	17,665	0.2572	0.098**	17,569	0.3088	-0.002	17,650	0.61
	(0.009)			(0.047)			(0.006)		
Panel C: Crisis period									
Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Tier 1/rwa × crisis	0.024*	7,383	0.305	-0.428***	7,329	0.214	-0.001	7,364	0.619
	(0.012)			(0.110)			(0.009)		
Total capital/rwa × crisis	0.021***	8,635	0.259	-0.373***	8,582	0.185	-0.002	8,630	0.6
	(0.008)			(0.085)			(0.007)		
Common equity/rwa × crisis	0.018**	6,342	0.304	-0.285***	6,337	0.216	-0.002	6,367	0.625
	(0.007)			(0.079)			(0.006)		
Other capital/rwa × crisis	0.041	6,065	0.308	-0.23	6,062	0.220	0.03	6,092	0.628
	(0.032)			(0.298)			(0.019)		
Tier 1/ta × crisis	0.03	7,013	0.298	-0.815***	7,004	0.214	-0.005	7,073	0.619
	(0.023)			(0.249)			(0.014)		
Total capital/ta × crisis	0.03*	7,157	0.294	-0.681***	7,149	0.211	-0.005	7,186	0.614
	(0.016)			(0.188)			(0.012)		
Common equity/ta × crisis	0.017***	17,664	0.258	-0.09**	17,569	0.308	0.011**	17,651	0.609
	(0.008)			(0.038)			(0.005)		
Other capital/ta × crisis	0.058	7,156	0.290	-0.302	7,149	0.209	0.074**	7,186	0.613
	(0.045)			(0.403)			(0.029)		
Tangible equity/ta × crisis	0.019**	17,665	0.258	-0.086**	17,569	0.309	0.012**	17,650	0.609
	(0.008)			(0.037)			(0.005)		

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 8: Capital and risk: Controlling for macroeconomic and institutional variables. The dependent variable is the ratio of loan loss reserves to total assets (LLRTAP). FE stands for 'fixed effects'. We use several macroeconomic and institutional country level control variables. These variables are: the Herfindahl-Hirschman index (HHID), a dummy variable that denotes certified audit requirements, a dummy variable that denotes the availability of deposit insurance, the GDP growth rate, the world governance index, and the country's economic freedom. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	LLRTAP [1]	LLRTAP [2]	LLRTAP [3]	LLRTAP [4]	LLRTAP [5]	LLRTAP [6]	LLRTAP [7]	LLRTAP [8]	LLRTAP [9]
Net loans/ta	0.029***	0.028***	0.029***	0.026***	0.032***	0.03***	0.045***	0.026***	0.045***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Growth assets	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.006***	-0.011***	-0.007***	-0.011***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Income diversity	-0.1	-0.108	-0.189	-0.21	-0.188	-0.226	0.728***	-0.193	0.714***
	(0.128)	(0.115)	(0.145)	(0.153)	(0.144)	(0.141)	(0.097)	(0.139)	(0.096)
Cost to income	0.001	0.001	0.001	0.001	0.001	0.002	0.008***	0.001	0.008***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Size	-0.16***	-0.16***	-0.19***	-0.13***	-0.08*	-0.073*	-0.036	-0.165***	-0.033
	(0.036)	(0.029)	(0.039)	(0.036)	(0.044)	(0.039)	(0.026)	(0.032)	(0.027)
Tier 1/rwa	-0.004								
	(0.006)								
Total capital/rwa		0.000							
		(0.004)							
Common equity/rwa			-0.004						
			(0.004)						
Other capital/rwa				0.022					
				(0.022)					
Tier 1/ta					0.036**				
					(0.015)				
Total capital/ta						0.043***			
						(0.012)			
Common equity/ta							0.035***		
							(0.007)		
Other capital/ta								0.074**	
								(0.032)	
Tangible equity/ta									0.034***
									(0.007)
Deposit insurance	0.411**	0.25	0.956***	0.724***	0.634***	0.427**	0.874***	0.5**	0.866***
	(0.188)	(0.167)	(0.227)	(0.230)	(0.214)	(0.207)	(0.144)	(0.210)	(0.144)
GDP growth	-0.15***	-0.16***	-0.13***	-0.12***	-0.15***	-0.15***	-0.079***	-0.149***	-0.079***
	(0.016)	(0.015)	(0.017)	(0.017)	(0.016)	(0.015)	(0.008)	(0.015)	(0.008)
HHID	1.659***	1.156***	2.606***	1.866***	2.057***	1.423**	0.414	1.645***	0.443
	(0.445)	(0.434)	(0.517)	(0.539)	(0.556)	(0.566)	(0.324)	(0.589)	(0.325)
Certified audit	-0.156	-0.4***	0.005	-0.448**	-0.428	-1.007***	-0.33	-0.922***	-0.339
	(0.184)	(0.149)	(0.188)	(0.223)	(0.337)	(0.371)	(0.261)	(0.355)	(0.262)
World governance index	-1.04***		-1.19***		-1.06***		-1.08***		-1.102***
	(0.104)		(0.119)		(0.112)		(0.067)		(0.067)
Economic freedom		-0.09***		-0.1***		-0.09***		-0.096***	
		(0.008)		(0.009)		(0.009)		(0.009)	
Constant	3.568***	9.18***	2.517***	9.095***	1.995***	7.832***	-0.49	10.067***	-0.518
	(0.769)	(0.721)	(0.837)	(0.964)	(1.002)	(1.078)	(0.633)	(0.909)	(0.636)
Country FE	No	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No	No
No. of observations	7,193	8,413	6,143	5,885	6,821	6,966	17,420	6,965	17,421
R-squared	0.158	0.148	0.169	0.164	0.166	0.166	0.214	0.158	0.214

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 9: Capital and efficiency: Controlling for macroeconomic variables. The dependent variable is the bank cost to income ratio (CIRP). FE stands for 'fixed effects'. We use several macroeconomic and country level control variables. These variables are: a dummy variable that denotes the availability of deposit insurance, the GDP growth rate, capital stringency, market discipline and private monitoring, official supervisory power, and bank entry requirements. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	CIRP [1]	CIRP [2]	CIRP [3]	CIRP [4]	CIRP [5]	CIRP [6]	CIRP [7]	CIRP [8]	CIRP [9]
Net loans/ta	-0.229***	-0.213***	-2.319***	-0.215***	-0.237***	-0.206***	-2.719***	-0.196***	-0.076***
	(0.047)	(0.036)	(0.371)	(0.046)	(0.048)	(0.043)	(0.179)	(0.043)	(0.019)
Growth assets	-0.05*	-0.051***	-0.059**	-0.047	-0.07***	-0.043*	-0.04***	-0.045*	-0.046***
	(0.027)	(0.018)	(0.030)	(0.029)	(0.026)	(0.024)	(0.007)	(0.024)	(0.007)
Income diversity	0.226	0.979	-1.121	-1.094	-0.897	-0.479	10.523***	-0.877	10.587***
	(1.695)	(1.412)	(1.787)	(1.697)	(1.840)	(1.609)	(0.792)	(1.634)	(0.790)
Loan loss reserves/ta	0.132	0.327	0.063	0.37	0.23	0.419	0.638***	0.296	0.644***
	(0.331)	(0.277)	(0.354)	(0.394)	(0.349)	(0.346)	(0.104)	(0.345)	(0.105)
Size	-2.319***	-2.127***	-2.319***	-2.285***	-2.763***	-2.931***	-2.719***	-2.385***	-2.738***
	(0.332)	(0.274)	(0.371)	(0.356)	(0.363)	(0.323)	(0.179)	(0.321)	(0.180)
Tier 1/rwa	-0.278***								
	(0.077)								
Total capital/rwa		-0.226***							
		(0.069)							
Common equity/rwa			-0.165***						
			(0.048)						
Other capital/rwa				0.129					
				(0.230)					
Tier 1/ta					-0.413***				
					(0.117)				
Total capital/ta						-0.421***			
						(0.109)			
Common equity/ta							-0.15***		
							(0.030)		
Other capital/ta								0.397	
								(0.274)	
Tangible equity/ta									-0.15***
									(0.029)
Deposit insurance	10.181***	5.315**	8.545*	5.368	8.861**	7.279**	13.324***	8.273***	13.399***
	(3.808)	(2.213)	(5.121)	(3.583)	(4.457)	(2.850)	(2.546)	(2.9116)	(2.552)
GDP growth	-0.719***	-0.598***	-0.496***	-0.521***	-0.503***	-0.541***	-0.34***	-0.56***	-0.334***
	(0.129)	(0.121)	(0.134)	(0.139)	(0.130)	(0.131)	(0.051)	(0.129)	(0.051)
Capital stringency	-1.482***	-1.317***	-1.344***	-1.354***	-1.268***	-1.329***	-1.046***	-1.262***	-1.038***
	(0.458)	(0.331)	(0.486)	(0.449)	(0.486)	(0.409)	(0.373)	(0.415)	(0.373)
Market discipline	4.151***	3.507***	4.279***	3.738***	3.641***	2.904***	2.657***	3.74***	2.691***
	(0.658)	(0.541)	(0.702)	(0.639)	(0.694)	(0.639)	(0.561)	(0.622)	(0.560)
Supervisory power	-0.606*		-0.715*		-0.49		-1.116***		-1.126***
	(0.343)		(0.367)		(0.361)		(0.268)		(0.560)
Entry requirements		-0.789		-2.121**		-2.063***		-1.892***	
		(0.504)		(0.717)		(0.613)		(0.622)	
Constant	99.345***	100.749***	102.793***	110.087***	109.267***	125.946***	96.686***	104.999***	96.744***
	(10.374)	(7.880)	(11.510)	(9.429)	(11.223)	(9.270)	(6.125)	(8.322)	(6.128)
Country FE	No	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No	No
No. of observations	4,907	6,636	4,220	4,431	4,533	5,153	13,119	5,153	13,119
R-squared	0.108	0.084	0.101	0.096	0.108	0.103	0.223	0.092	0.223

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 10: Capital and profitability: Controlling for macroeconomic variables. The dependent variable is the bank net interest margin (NIMP). FE stands for 'fixed effects'. We use several macroeconomic and country-level control variables. These variables are: a dummy variable that denotes the availability of deposit insurance, the GDP growth rate, capital stringency, market discipline and private monitoring, official supervisory power, and bank entry requirements. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	NIMP [1]	NIMP [2]	NIMP [3]	NIMP [4]	NIMP [5]	NIMP [6]	NIMP [7]	NIMP [8]	NIMP [9]
Net loans/ta	0.004	-0.007	-0.002	-0.01	0.004	-0.005	0.012***	-0.008	0.012***
	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)	(0.004)	(0.002)	(0.005)	(0.002)
Growth assets	0.019***	0.012***	0.019***	0.019***	0/02***	0.017***	0.007***	0.018***	0.007***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.003)	(0.001)
Income diversity	-1.188***	-1.851***	-1.251***	-1.635***	-1.285***	-1.736***	-1.342***	-1.667***	-1.378***
	(0.188)	(0.195)	(0.211)	(0.217)	(0.168)	(0.193)	(0.104)	(0.207)	(0.104)
Loan loss reserves/ta	0.354***	0.309***	0.324***	0.328***	0.306***	0.307***	0.225***	0.333***	0.225***
	(0.044)	(0.038)	(0.046)	(0.051)	(0.045)	(0.045)	(0.015)	(0.046)	(0.015)
Size	-0.373***	-0.382***	-0.446***	-0.397***	-0.248***	-0.254***	-0.46***	-0.375***	-0.457***
	(0.040)	(0.039)	(0.045)	(0.045)	(0.040)	(0.040)	(0.025)	(0.040)	(0.026)
Tier 1/rwa	0.035***								
	(0.009)								
Total capital/rwa		0.019***							
		(0.007)							
Common equity/rwa			0.014**						
			(0.006)						
Other capital/rwa				-0.016					
				(0.023)					
Tier 1/ta					0.112***				
					(0.016)				
Total capital/ta						0.087***			
						(0.013)			
Common equity/ta							0.062***		
							(0.005)		
Other capital/ta								-0.051	
								(0.033)	
Tangible equity/ta									0.061***
									(0.004)
Deposit insurance	-2.516***	-2.217***	-2.845***	-2.12***	-1.963***	-1.692***	-2.61***	-1.883***	-2.642***
	(0.379)	(0.292)	(0.529)	(0.387)	(0.4223)	(0.289)	(0.363)	(0.304)	(0.367)
GDP growth	0.087***	0.089***	0.094***	0.11***	0.093***	0.105***	0.04***	0.109***	0.037***
	(0.012)	(0.011)	(0.014)	(0.014)	(0.023)	(0.011)	(0.006)	(0.012)	(0.006)
Capital stringency	-0.037	0.075*	0.037	-0.069	0.031	-0.025	0.166***	-0.04	0.163***
	(0.049)	(0.043)	(0.055)	(0.059)	(0.049)	(0.05)	(0.035)	(0.053)	(0.035)
Market discipline	-1.001***	-0.763***	-1.158***	-0.92***	-0.873***	-0.72***	-1.349***	-0.89***	-1.364***
	(0.089)	(0.068)	(0.096)	(0.081)	(0.090)	(0.074)	(0.085)	(0.077)	(0.085)
Supervisory power	0.317***		0.373***		0.262***		0.284***		0.288***
	(0.051)		(0.054)		(0.049)		(0.041)		(0.041)
Entry requirements		0.47***		0.315***		0.305***		0.276***	
		(0.067)		(0.074)		(0.064)		(0.065)	
Constant	13.314***	12.515***	15.532***	15.83***	9.901***	10.617***	16.145***	15.023***	16.23***
	(1.142)	(1.177)	(1.223)	(1.381)	(1.084)	(1.259)	(0.766)	(1.221)	(0.766)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	4,935	6,680	4,244	4,457	4,557	5,182	13,177	5,182	13,176
R-squared	0.524	0.430	0.542	0.497	0.561	0.505	0.516	0.478	0.517

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 11: Principal component analysis of capital ratios. The dependent variables are a bank's loan loss reserves to assets (LLRTAP), the cost to income ratio (CIRP), and the net interest margin (NIMP). Bank level represents the bank control variables employed in prior tables above. FE stands for 'fixed effects'. In this table, we employ different combinations of capital ratios based on a principal component analysis (PCA). These components are: overall capital (PC1_basel2_rwa), other capital (PC2_basel2_other), Basel II capital without other capital (PC3_basel2_rwa), and traditional measures of capital (PC4_trad_capital). We control for bank and country level (macroeconomic) variables. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	LLRTAP				CIRP				NIMP			
	X1=PC1 [1]	X2=PC2 [2]	X3=PC3 [3]	X4=PC4 [4]	X1=PC1 [5]	X2=PC2 [6]	X3=PC3 [7]	X4=PC4 [8]	X1=PC1 [9]	X2=PC2 [10]	X3=PC3 [11]	X4=PC4 [12]
PC1_basel2_rwa	0.057				-2.238***				0.259***			
	(0.043)				(0.477)				(0.059)			
PC2_basel2_other		0.025				-0.342				0.095		
		(0.047)				(0.478)				(0.054)		
PC3_basel2_rwa			0.071*				-2.231***				0.265***	
			(0.042)				(0.489)				(0.061)	
PC4_trad_capital				0.284***				-3.509***				0.526***
				(0.079)				(0.578)				(0.074)
Deposit insurance	0.876***	0.724***	0.872***	0.426**	4.923	4.675	5.133	6.487**	-2.348***	-1.97***	-2.363***	-1.647***
	(0.222)	(0.218)	(0.222)	(0.202)	(4.710)	(3.153)	(4.724)	(2.815)	(0.529)	(0.371)	(0.534)	(0.290)
GDP growth	-0.13***	-0.134***	-0.13***	-0.145***	-0.601***	-0.598***	-0.591***	-0.518***	0.095***	0.111***	0.094***	0.102***
	(0.017)	(0.017)	(0.017)	(0.015)	(0.133)	(0.138)	(0.134)	(0.126)	(0.013)	(0.013)	(0.013)	(0.011)
HHID	2.239***	1.692***	2.224***	1.265**								
	(0.502)	(0.517)	(0.504)	(0.535)								
Certified audit	-0.245	-0.659***	-0.261	-0.833**								
	(0.167)	(0.209)	(0.168)	(0.391)								
World governance index	-1.092***		-1.087***									
	(0.116)		(0.116)									
Economic freedom		-0.096***		-0.085***								
		(0.009)		(0.009)								
Capital stringency					-1.532***	-1.281***	-1.508***	-1.335***	0.043	-0.071	0.04	-0.024
					(0.519)	(0.465)	(0.519)	(0.434)	(0.058)	(0.062)	(0.058)	(0.054)
Market discipline					3.371***	3.427***	3.368***	2.35***	-1.068***	-0.887***	-1.064***	-0.691***
					(0.732)	(0.648)	(0.735)	(0.636)	(0.103)	(0.082)	(0.103)	(0.076)
Supervisory power					-0.684*		-0.681*		0.349***		0.348***	
					(0.374)		(0.375)		(0.056)		(0.056)	
Entry requirements						-1.877***		-1.727***		0.328***		0.267***
						(0.669)		(0.613)		(0.072)		(0.064)
Constant	2.312***	9.37***	2.227**	7.423***	120.854***	108.098***	119.586***	127.994***	13.23***	15.435***	13.287***	10.557***
	(0.887)	(0.922)	(0.869)	(1.087)	(11.871)	(8.928)	(11.704)	(9.025)	(1.309)	(1.393)	(1.292)	(1.217)
Bank level	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No	No	No	No	No
No. of observations	5,725	5,725	5,725	6,951	3,853	4,227	3,853	5,043	3,876	4,253	3,876	5,072
R-squared	0.169	0.172	0.169	0.169	0.126	0.096	0.126	0.117	0.571	0.509	0.572	0.518

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 12: Comparing capital component effects across countries. The dependent variables are: (1) the ratio of bank loan loss reserves to total assets (LLRTAP), (2) the cost to income ratio (CIRP), and (3) the net interest margin (NIMP). In this table, we compare risk and non-risk based capital measures and components. For capital ratios, we use Tier 1 capital (Tier 1/rwa) and common equity (Common equity/ta). For capital components, we use PC1_basel2_rwa and PC4_trad_capital. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

	LLRTAP				CIRP				NIMP			
	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Australia	0.123***	0.505***	0.024	0.828***	1.583**	4.223	1.784**	2.507	0.25***	1.108***	0.074	1.693***
	(0.040)	(0.129)	(0.033)	(0.144)	(0.727)	(0.308)	(0.853)	(3.082)	(0.040)	(0.124)	(0.075)	(0.209)
Austria	-0.027	0.374	0.13	0.791	-1.31**	-17.764***	-3.929***	-33.572***	-0.015	0.44*	0.073	0.795*
	(0.075)	(0.331)	(0.089)	(0.493)	(0.649)	(6.829)	(1.315)	(11.745)	(0.047)	(0.259)	(0.088)	(0.426)
Belgium	-0.036	-0.187	0.014	0.128	-1.159	-23.787***	-3.211	-40.393***	0.004	0.671***	0.117	1.278***
	(0.045)	(0.203)	(0.089)	(0.289)	(1.080)	(4.176)	(1.979)	(6.322)	(0.034)	(0.157)	(0.076)	(0.197)
Brazil	-0.023	-0.033	0.004	-0.001	-0.116	-1.42*	-0.294*	-1.653*	0.008	0.446***	0.075***	0.555***
	(0.018)	(0.079)	(0.009)	-0.086)	(0.156)	(0.768)	(0.156)	(0.901)	(0.028)	(0.145)	(0.021)	(0.169)
Canada	0.023	0.149*	0.048***	0.259***	-0.483	-1.279	-1.019***	-1.928	0.029	0.166*	0.126**	0.298**
	(0.022)	(0.076)	(0.017)	(0.092)	(0.294)	(1.365)	(0.258)	(1.663)	(0.021)	(0.092)	(0.022)	(0.148)
Chile	-0.004	-0.012	0.000	-0.021	-0.084	-0.327	-0.152	-0.264	0.004	0.056	0.029	0.093
	(0.007)	(0.033)	(0.009)	(0.048)	(0.149)	(0.756)	(0.252)	(1.172)	(0.013)	(0.066)	(0.022)	(0.099)
China	-0.022***	-0.109***	-0.029***	-0.127***	0.499***	2.309**	0.368	3.223**	-0.015***	-0.048	-0.023***	-0.044
	(0.005)	(0.036)	(0.006)	(0.037)	(0.168)	(1.126)	(0.228)	(1.574)	(0.005)	(0.034)	(0.007)	(0.040)
Czech Republic	-0.044**	2.309***	0.04	1.649**	0.285	-11.997**	1.311**	1.772	-0.02	-1.019*	0.016	0.008
	(0.017)	(0.705)	(0.065)	(0.729)	(0.910)	(5.200)	(0.558)	(1.843)	(0.016)	(0.549)	(0.024)	(0.159)
Denmark	-0.008	0.084	0.072	0.4	-0.142	-5.574	-1.95***	-11.727***	0.013	0.101	0.093***	0.272
	(0.021)	(0.156)	(0.045)	(0.244)	(0.371)	(3.389)	(0.702)	(4.022)	(0.015)	(0.149)	(0.025)	(0.261)
Estonia	-0.046	-0.071	0.365*	2.15**	-0.869***	-4.34***	-1.155*	-8.433***	0.042	-0.436**	0.404*	2.12**
	(0.050)	(0.069)	(0.198)	(0.962)	(0.187)	(1.239)	(0.644)	(2.657)	(0.063)	(0.169)	(0.208)	(1.068)
Finland	0.036	0.014	0.038***	-0.527*	-1.843*	2.624	0.295	4.382	0.097*	0.086	-0.000	-0.009
	(0.059)	(0.396)	(0.007)	(0.292)	(1.112)	(7.057)	(1.427)	(7.768)	(0.055)	(0.138)	(0.051)	(0.234)
France	-0.011	0.233	-0.02	1.732**	-1.488***	-7.333**	-0.604	-16.254***	-0.009	-0.021	0.017*	0.216
	(0.027)	(0.369)	(0.019)	(0.769)	(0.466)	(3.073)	(0.375)	(3.827)	(0.021)	(0.199)	(0.009)	(0.433)
Germany	-0.07	-0.32	0.037	0.167	-1.31*	-10.392***	-1.311	-12.958***	0.045*	0.289**	0.035	0.513***
	(0.042)	(0.247)	(0.055)	(0.207)	(0.694)	(3.049)	(0.968)	(2.742)	(0.026)	(0.137)	(0.024)	(0.159)
Greece	-0.186***	-0.566*	-0.206***	-0.508	-1.081***	-4.715	-0.941**	-5.044	0.025	-0.008	0.01	-0.215
	(0.041)	(0.334)	(0.045)	(0.653)	(0.314)	(3.776)	(0.468)	(5.427)	(0.018)	(0.155)	(0.020)	(0.262)
Hungary	0.099	1.196	0.131	2.203	-1.258**	-8.374**	-1.812**	-11.178***	0.305**	1.677***	0.181*	1.066
	(0.280)	(1.109)	(0.247)	(2.066)	(0.562)	(3.559)	(0.786)	(4.110)	(0.143)	(0.597)	(0.098)	(0.745)
Iceland	0.232***	1.129***	0.359***	1.399***	-1.21	-1.849	-1.731	-0.875	0.053*	0.796***	0.0157	0.99***
	(0.074)	(0.316)	(0.073)	(0.335)	(0.812)	(3.770)	(1.377)	(4.272)	(0.032)	(0.121)	(0.191)	(0.155)
India	0.013	0.353	0.046	0.28	-0.933***	-5.938***	-1.168***	-5.312***	0.027*	0.211	0.052***	0.31
	(0.027)	(0.367)	(0.035)	(0.282)	(0.251)	(1.466)	(0.177)	(1.976)	(0.015)	(0.191)	(0.018)	(0.188)
Indonesia	-0.017	-0.225*	-0.009	-0.318*	-0.437	-4.162	-1.244**	-9.199***	0.003	0.036	0.024	-0.031
	(0.011)	(0.126)	(0.014)	(0.175)	(0.431)	(2.629)	(0.496)	(1.919)	(0.016)	(0.125)	(0.019)	(0.172)
Ireland	0.559***	4.412***	0.528	8.384***	5.754***	0.745	-0.576	3.278	-0.194***	-1.195***	-0.07	-2.019***
	(0.122)	(1.161)	(0.410)	(0.703)	(1.836)	(6.011)	(0.475)	(6.739)	(0.068)	(0.299)	(0.101)	(0.386)
Israel	0.13	-0.43	0.282*	1.528	-1.231***	-21.204***	-1.504***	-10.005***	0.067***	1.278***	0.093*	0.466**
	(0.116)	(0.765)	(0.165)	(1.005)	(0.198)	(7.950)	(0.386)	(1.496)	(0.024)	(0.341)	(0.053)	(0.218)
Italy	-0.005	-0.03	0.001	0.004	-0.143	-0.422	0.15	-0.118	0.015***	0.153***	0.02**	0.162***
	(0.009)	(0.053)	(0.013)	(0.085)	(0.140)	(0.980)	(0.294)	(1.455)	(0.005)	(0.036)	(0.009)	(0.053)
Japan	0.006	-0.071	-0.003	-0.144	-0.045	-0.206	0.582	-4.778*	0.022**	0.145**	0.022	0.201
	(0.016)	(0.179)	(0.093)	(0.487)	(0.141)	(1.007)	(0.671)	(2.843)	(0.008)	(0.069)	(0.024)	(0.156)
Luxembourg	0.001	-0.344	-0.02	0.095	-0.547	4.537	-0.122	0.55	-0.003	0.042	0.008	0.48
	(0.027)	(0.235)	(0.008)	(0.256)	(0.486)	(5.552)	(0.224)	(7.256)	(0.030)	(0.140)	(0.009)	(0.535)

	LLRTAP				CIRP				NIMP			
	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4	X1=T1RP	X1=PC1	X3=CETAP	X4=PC4
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Mexico	0.015	0.358	0.078**	0.594**	0.064	0.512	0.171	-1.59	-0.014	0.077	0.063**	0.206
	(0.021)	(0.237)	(0.030)	(0.262)	(0.256)	(1.912)	(0.398)	(1.683)	(0.036)	(0.272)	(0.029)	(0.295)
Netherlands	-0.002	0.161*	0.097***	1.225*	0.56	-1.371	-0.741	-10.381	-0.000	0.218	0.054***	0.321**
	(0.022)	(0.086)	(0.030)	(0.717)	(0.842)	(3.875)	(0.758)	(7.201)	(0.023)	(0.147)	(0.019)	(0.163)
New Zealand	0.011	0.054***	0.017**	0.128***	0.158	0.904***	0.267***	0.785	-0.001	0.09***	0.007	0.107***
	(0.009)	(0.015)	(0.008)	(0.039)	(0.103)	(0.123)	(0.060)	(0.647)	(0.015)	(0.013)	(0.008)	(0.023)
Norway	-0.053	-0.113	0.214**	0.277	-0.521	-4.893	-0.555	-12.1*	0.057	0.416	0.06	1.011
	(0.053)	(0.217)	(0.089)	(0.596)	(0.891)	(3.183)	(0.721)	(6.916)	(0.046)	(0.338)	(0.083)	(0.696)
Poland	0.115*	0.303	0.107	1.156	-0.951**	-7.372***	-2.122***	-11.844***	0.092*	0.409	0.081*	0.146
	(0.064)	(0.238)	(0.094)	(0.951)	(0.412)	(1.747)	(0.487)	(2.955)	(0.055)	(0.269)	(0.046)	(0.505)
Portugal	0.731***	2.36***	0.114	2.349**	-2.326***	-9.004***	0.291	-4.013	-0.044	-0.124	0.03	-0.068
	(0.166)	(0.450)	(0.091)	(0.951)	(0.414)	(1.818)	(0.836)	(7.369)	(0.042)	(0.143)	(0.024)	(0.148)
Russia	-0.01	0.216	0.043***	-0.018	-0.246	-3.367**	-0.157***	-3.518**	0.23	0.24	0.059***	0.251*
	(0.031)	(0.225)	(0.009)	(0.210)	(0.231)	(1.374)	(0.022)	(1.487)	(0.019)	(0.167)	(0.005)	(0.136)
Slovakia	0.04	0.452***	-0.319*	-1.275**	0.197	-7.475**	-0.655	-13.551***	-0.042	-0.223	0.07*	0.595
	(0.042)	(0.134)	(0.167)	(0.507)	(0.302)	(3.516)	(0.760)	(4.508)	(0.036)	(0.327)	(0.040)	(0.542)
Slovenia	-0.031	-0.047	0.073	-0.221	-1.452***	-7.353***	-1.784***	-10.574***	0.088***	0.334***	0.009	0.602***
	(0.040)	(0.148)	(0.057)	(0.560)	(0.195)	(1.856)	(0.400)	(2.970)	(0.016)	(0.093)	(0.027)	(0.121)
South Africa	0.178	0.823	0.207	1.209	-0.464	-5.145**	-0.812	-5.885	0.198***	0.972***	0.135	1.257**
	(0.184)	(0.974)	(0.147)	(1.454)	(0.578)	(2.431)	(0.53)	(3.59)	(0.065)	(0.292)	(0.099)	(0.508)
South Korea	-0.27	-1.527	-0.212	-2.204	1.539***	10.175***	0.216	13.34***	0.175***	0.778***	0.12	1.19***
	(0.189)	(0.992)	(0.169)	(1.395)	(0.482)	(2.439)	(2.238)	(3.321)	(0.045)	(0.196)	(0.083)	(0.275)
Spain	0.001	-0.039	-0.016	-0.04	-0.111	-1.482**	0.115	-1.607	-0.001	0.034	0.045*	0.056
	(0.007)	(0.037)	(0.013)	(0.047)	(0.985)	(0.618)	(0.126)	(1.095)	(0.006)	(0.035)	(0.026)	(0.043)
Sweden	0.006	0.071	0.265**	1.497***	-1.035***	-4.931***	-0.852***	-4.629***	0.023	0.274	0.059*	0.308***
	(0.019)	(0.091)	(0.121)	(0.485)	(0.289)	(1.555)	(0.216)	(1.379)	(0.015)	(0.171)	(0.032)	(0.082)
Switzerland	0.063***	0.207**	0.037***	0.498*	-0.541***	-6.528***	-0.12	-5.555***	-0.008	-0.095*	0.05***	-0.043
	(0.014)	(0.080)	(0.009)	(0.266)	(0.165)	(1.517)	(0.106)	(1.876)	(0.009)	(0.050)	(0.008)	(0.093)
Turkey	-0.001	-0.02	0.019**	0.104***	-0.279**	-1.467	-0.472**	-2.935**	0.039***	0.221***	0.061***	0.37***
	(0.011)	(0.049)	(0.008)	(0.033)	(0.140)	(1.014)	(0.201)	(1.23)	(0.012)	(0.038)	(0.014)	(0.085)
United Kingdom	-0.027**	0.11	0.035***	0.054	-0.689*	0.899	0.14	1.245	0.015	0.484**	0.016	0.199
	(0.011)	(0.161)	(0.011)	(0.064)	(0.361)	(2.369)	(0.152)	(1.733)	(0.012)	(0.218)	(0.013)	(0.137)
Constant	3.303	0.012	-1.134	-0.172	106.386***	105.00***	105.5699***	111.98***	4.805***	3.907***	5.004***	5.376***
	(2.198)	(0.981)	(1.400)	(0.732)	(7.730)	(5.333)	(14.789)	(8.321)	(0.786)	(0.600)	(0.7124	(0.561)
Observations	7,383	5,914	17,664	7,166	7,329	5,834	17,569	7,058	7,364	5,864	17,651	7,094
R-squared	0.34	0.361	0.27	0.374	0.243	0.264	0.327	0.258	0.626	0.651	0.615	0.632

Table 12 – (Continued)

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 13: Quantile regression approach. The dependent variables are a bank's loan loss reserves to assets (LLRTAP) in Panel A, the cost to income ratio (CIRP) in Panel B, and the net interest margin (NIMP) in Panel C. In this table, we employ different combinations of capital ratios using PCA. These components are: overall capital (PC1_basel2_rwa), other capital (PC2_basel2_ other), Basel II capital without other capital (PC3_basel2_rwa), and traditional measures of capital (PC4_trad_capital). We also control for bank and country level (macroeconomic) variables but omit the respective results for brevity. We employ quantile regressions and present the lower quantile (Q25), the median quantile (Q50), and the upper quantile (Q75) of the dependent variables, respectively. See Appendix A for variable definitions.

	Q25 [1]	Q50 [2]	Q75 [3]	Q25 [4]	Q50 [5]	Q75 [6]	Q25 [7]	Q50 [8]	Q75 [9]	Q25 [10]	Q50 [11]	Q75 [12]
Panel A: Risk model (loan loss reserves to assets)												
PC1_basel2_rwa	-0.002	0.002	0.027									
	(0.009)	(0.015)	(0.051)									
PC2_basel2_other				0.029*	0.01	0.015						
				(0.016)	(0.023)	(0.031)						
PC3_basel2_rwa							0.001	0.003	0.031			
							(0.008)	(0.015)	(0.039)			
PC4_trad_capital										0.04*	0.07***	0.145***
										(0.021)	(0.022)	(0.055)
Constant	-0.048	0.383	2.183**	-0.091	0.454	2.325***	-0.095	0.379	2.172	-0.237	0.318	1.415**
	(0.291)	(0.404)	(0.926)	(0.289)	(0.382)	(0.841)	(0.284)	(0.395)	(0.937)	(0.257)	(0.356)	(0.664)
Observations	5,897	5,897	5,897	5,897	5,897	5,897	5,897	5,897	5,897	7,149	7,149	7,149
R-squared	0.2165	0.2553	0.2703	0.2185	0.2555	0.2686	0.2169	0.2553	0.2708	0.1989	0.2357	0.257
Panel B: Efficiency model (cost to income)												
PC1_basel2_rwa	-2.466***	-1.878***	-1.122***									
	(0.662)	(0.336)	(0.344)									
PC2_basel2_other				-0.613*	-0.036	0.562						
				(0.350)	(0.298)	(0.477)						
PC3_basel2_rwa							-2.742***	-1.962***	-1.025***			
							(0.406)	(0.376)	(0.333)			
PC4_trad_capital										-3.396***	-3.09***	-1.851**
										(0.42)	(0.529)	(0.861)
Constant	100.566***	126.287***	162.335***	85.092***	118.695***	156.157***	100.996***	126.803***	160.78***	89.032***	117.176***	154.364***
	(8.052)	(7.081)	(7.261)	(7.654)	(7.017)	(6.746)	(7.089)	(7.437)	(7.319)	(5.245)	(5.671)	(6.675)
Observations	5,817	5,817	5,817	5,817	5,817	5,817	5,817	5,817	5,817	7,041	7,041	7,041
R-squared	0.169	0.209	0.204	0.169	0.208	0.198	0.164	0.208	0.203	0.152	0.193	0.191
Panel C: Profitability model (net interest margin)												
PC1_basel2_rwa	0.081***	0.114***	0.192**									
	(0.013)	(0.036)	(0.081)									
PC2_basel2_other				-0.051**	-0.07***	-0.07**						
				(0.021)	(0.018)	(0.031)						
PC3_basel2_rwa							0.076***	0.103***	0.186**			
							(0.013)	(0.029)	(0.092)			
PC4_trad_capital										0.123***	0.208***	0.324***
										(0.019)	(0.041)	(0.082)
Constant	2.194***	3.098***	4.193***	2.55***	3.486***	4.889***	2.257***	3.297***	4.262***	2.337***	3.085***	4.206***
	(0.301)	(0.337)	(0.593)	(0.335)	(0.342)	(0.633)	(0.292)	(0.333)	(0.465)	(0.276)	(0.281)	(0.323)
Observations	5,847	5,847	5,847	5,847	5,847	5,847	5,847	5,847	5,847	7,077	7,077	7,077
R-squared	0.579	0.62	0.608	0.569	0.613	0.599	0.578	0.618	0.605	0.561	0.603	0.589

Standard errors are clustered at the bank level and are reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 14: Robustness test excluding banks in non-OECD countries and merged banks. The dependent variables are: (1) the ratio of bank loan loss reserves to total assets (LLRTAP), (2) the cost to income ratio (CIRP), and (3) the net interest margin (NIMP). Panel A examines the effect of capital on bank risk, efficiency, and profitability using two subsamples where we exclude non-OECD countries (Panel A.1) and merged banks (Panel A.2). The estimations in Panel A are based on OLS regressions. Panel B reports the differences in risk, efficiency, and profitability between highly capitalized and less capitalized banks, estimated using a propensity score matching routine with three different matching methods. See Appendix A for variable definitions.

Panel A: Robustness tests based on subsamples comparison									
Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Panel A.1 – Excluding banks in non-OECD countries									
Tier 1/rwa	0.004	5,149	0.328	-0.202**	5,121	0.141	0.01*	5,143	0.5105
	(0.007)			(0.079)			(0.005)		
Total capital/rwa	0.004	5,620	0.297	-0.134**	5,583	0.124	0.01**	5,609	0.496
	(0.005)			(0.064)			(0.005)		
Common equity/rwa	0.005	4,649	0.326	-0.124**	4,635	0.165	0.008**	4,657	0.523
	(0.005)			(0.049)			(0.004)		
Other capital/rwa	-0.005	4,456	0.333	0.306	4,444	0.169	-0.069***	4,466	0.531
	(0.023)			(0.198)			(0.016)		
Tier 1/ta	0.057**	5,267	0.313	-0.329**	5,249	0.154	0.056***	5,276	0.528
	(0.023)			(0.135)			(0.011)		
Total capital/ta	0.056***	5,280	0.313	-0.232*	5,262	0.157	0.044***	5,290	0.513
	(0.019)			(0.129)			(0.009)		
Common equity/ta	0.029***	8,762	0.248	-0.179**	8,695	0.134	0.046***	8,745	0.469
	(0.009)			(0.087)			(0.006)		
Other capital/ta	0.009	5,279	0.298	0.743***	5,262	0.158	-0.074***	5,290	0.502
	(0.036)			(0.281)			(0.026)		
Tangible equity/ta	0.027***	8,763	0.247	-0.256***	8,695	0.139	0.043***	8,745	0.466
	(0.009)			(0.083)			(0.006)		
Panel A.2 – Excluding merged banks									
Tier 1/rwa	-0.006	6,647	0.319	-0.116	6,609	0.217	0.01	6,643	0.62
	(0.006)			(0.074)			(0.007)		
Total capital/rwa	-0.002	7,750	0.272	-0.129**	7,702	0.189	0.006	7,748	0.601
	(0.004)			(0.061)			(0.005)		
Common equity/rwa	-0.000	5,772	0.318	-0.08*	5,770	0.214	0.008**	5,799	0.625
	(0.004)			(0.047)			(0.004)		
Other capital/rwa	-0.029	5,528	0.324	0.281	5,529	0.221	-0.077***	5,558	0.629
	(0.023)			(0.177)			(0.017)		
Tier 1/ta	0.026	6,393	0.309	-0.179	6,389	0.216	0.052***	6,420	0.621
	(0.016)			(0.112)			(0.010)		
Total capital/ta	0.024*	6,543	0.307	-0.117	6,539	0.211	0.032***	6,574	0.615
	(0.001)			(0.099)			(0.009)		
Common equity/ta	0.037***	16,162	0.258	-0.151***	16,073	0.327	0.053***	16,152	0.608
	(0.007)			(0.032)			(0.004)		
Other capital/ta	-0.009	6,542	0.303	0.699***	6,539	0.213	-0.085***	6,574	0.613
	(0.0310)			(0.2295)			(0.0275)		
Tangible equity/ta	0.036***	16,163	0.258	-0.171***	16,073	0.245	0.052***	16,151	0.608
	(0.007)			(0.031)			(0.004)		
Panel B: Propensity score matching									
	Treated/ controls	Diff.	*T* stat	Treated/ controls	Diff.	*T* stat	Treated/ controls	Diff.	*T* stat
Panel B.1 – Comparison based on using Tier1 capital ratio									
K-Nearest neighbors (Obs. = 3,595)									
n = 2	2.22			61.49			4.306		
	2.42	-0.205	-1.81*	68.73	-7.243	-6.82***	3.874	0.433	3.85***
n = 5	2.22			61.49			4.31		
	2.42	-0.2	-1.98***	67.85	-6.36	-6.69***	3.9	0.401	4.05***
n = 10	2.22			61.49			4.31		
	2.35	-0.13	-1.38	67.58	-6.09	-6.78***	3.78	0.526	5.64***
Kernel (Obs. = 3,595)	2.22			61.49			4.31		
	2.38	-0.157	-1.92**	67.569	-6.077	-7.73***	3.79	0.511	6.13***
Panel B.2 – Comparison based on using common equity capital ratio									
K-Nearest neighbors (Obs. = 8,542)									
n = 2	3.8			74.75			6.19		
	2.56	1.24	12.61***	79.92	-5.17	-6.45***	4.1	1.585	18.2***
n = 5	3.8			74.75			6.195		
	2.62	1.17	13.09***	79.89	-5.135	-6.89***	4.597	1.598	20.34***
n = 10	3.8			74.755			6.195		
	2.62	1.17	13.54***	80.023	-5.268	-7.25***	4.588	1.606	21.16***
Kernel (Obs. = 8,542)	3.8			74.755			6.195		
	2.688	1.108	14.91***	80.071	-5.316	-8.63***	4.64	1.556	23.57***

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.

* Statistical significance at the 10% level.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

Table 15: Alternative risk, efficiency, and profitability measures. For Panel A, the dependent variables are: (1) the ratio of loan loss reserves to gross loans (LLRGLP), (2) the ratio of non-interest expenses to gross revenues (NONIEGRP), and (3) the bank earnings computed as the ratio of net income to assets (EARTAP). For Panel B, the dependent variables are: the ratio of loan loss reserves to non-performing loans (LLRIMP), the ratio of non-operating items to average assets (COSTAP), and (3) the ratio of other operating income to average assets. In the three models, we employ capital ratios (Panel A.1 and Panel B.1) and metrics derived from PCA (Panel A.2 and B.2) to check the robustness of our results. Our estimations are based on OLS regressions. See Appendix A for variable definitions.

Variables	LLRGLP			NONIEGRP			EARTAP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Panel A – Alternative measures (I)									
Panel A.1 – OLS regressions									
Tier 1/rwa	-0.008	7,383	0.255	-0.174**	7,346	0.205	0.017***	7,365	0.197
	(0.010)			(0.068)			(0.004)		
Total capital/rwa	-0.002	8,635	0.217	-0.157***	8,609	0.176	0.014***	8,632	0.186
	(0.009)			(0.058)			(0.003)		
Common equity/rwa	-0.001	6,342	0.256	-0.084**	6,351	0.203	0.01***	6,367	0.217
	(0.007)			(0.042)			(0.003)		
Other capital/rwa	0.003	6,065	0.258	0.208	6,076	0.208	-0.038***	6,092	0.222
	(0.031)			(0.159)			(0.011)		
Tier 1/ta	0.073***	7,013	0.256	-0.216**	7,020	0.203	0.042***	7,038	0.218
	(0.027)			(0.103)			(0.007)		
Total capital/ta	0.077***	7,157	0.255	-0.149	7,167	0.199	0.029***	7,187	0.211
	(0.026)			(0.092)			(0.006)		
Common equity/ta	0.075***	17,664	0.253	-0.175***	17,614	0.306	0.027***	17,653	0.141
	(0.010)			(0.031)			(0.003)		
Other capital/ta	0.073	7,156	0.242	0.553***	7,167	0.2	-0.07***	7,187	0.205
	(0.047)			(0.209)			(0.017)		
Tangible equity/ta	0.074***	17,665	0.253	-0.195***	17,613	0.307	0.028***	17,652	0.144
	(0.010)			(0.030)			(0.003)		
Panel A.2 – PCA & OLS regressions									
PC1_basel2_rwa	0.095	5,897	0.259	-0.988**	5,843	0.214	0.207***	5,847	0.257
	(0.069)			(0.398)			(0.031)		
PC2_basel2_other	0.061	5,897	0.258	0.44	5,843	0.211	-0.088***	5,847	0.219
	(0.067)			(0.389)			(0.028)		
PC3_basel2_rwa	0.102	5,897	0.259	-0.933**	5,843	0.214	0.196***	5,847	0.251
	(0.071)			(0.409)			(0.032)		
PC4_trad_capital	9.608***	7,149	0.268	-1.755***	7,072	0.203	0.294***	7,077	0.252
	(0.150)			(0.476)			(0.038)		
Panel B – Alternative measures (II)									
Variables	LLRIMP			COSTAP			OTHOIAA		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Panel B.1 – OLS regressions									
Tier 1/rwa	1.122**	6,497	0.391	-0.006***	7,305	0.097	0.01	7,351	0.326
	(0.362)			(0.002)			(0.007)		
Total capital/rwa	0.459	7,424	0.357	-0.006***	8,545	0.094	0.002	8,618	0.314
	(0.291)			(0.002)			(0.005)		
Common equity/rwa	0.162	5,638	0.393	-0.003**	6,315	0.074	0.008*	6,353	0.325
	(0.261)			(0.001)			(0.004)		
Other capital/rwa	-0.406	5,397	0.405	0.023***	6,044	0.085	-0.066***	6,078	0.326
	(0.775)			(0.005)			(0.021)		
Tier 1/ta	1.221***	6,149	0.384	-0.014***	6,963	0.091	0.069***	7,024	0.346
	(0.436)			(0.003)			(0.019)		
Total capital/ta	0.887**	6,254	0.376	-0.01***	7,114	0.087	0.054***	7,173	0.339
	(0.361)			(0.003)			(0.016)		
Common equity/ta	0.472*	13,343	0.364	-0.009***	17,431	0.165	0.058***	17,637	0.558
	(0.263)			(0.001)			(0.140)		
Other capital/ta	-0.71	6,254	0.374	0.034***	7,114	0.088	-0.085***	7,173	0.327
	(1.064)			(0.008)			(0.031)		
Tangible equity/ta	0.417	13,343	0.364	-0.009***	17,431	0.164	0.05***	17,636	0.557
	(0.257)			(0.001)			(0.014)		
Panel B.2 – PCA & OLS regressions									
PC1_basel2_rwa	3.912	5,290	0.405	-0.055***	6,138	0.136	0.449**	6,188	0.308
	(1.912)			(0.015)			(0.222)		
PC2_basel2_other	0.565	5,290	0.404	0.008	6,138	0.119	-0.19**	6,188	0.272
	(1.872)			(0.013)			(0.081)		
PC3_basel2_rwa	3.142	5,290	0.405	-0.054***	6,138	0.135	0.426*	6,188	0.303
	(1.973)			(0.015)			(0.217)		
PC4_trad_capital	3.221	6,276	0.37	-0.072***	7,596	0.136	0.599***	7,678	0.332
	(2.011)			(0.016)			(0.207)		

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 16: Three-stage least squares estimation based on a seemingly unrelated regression for the relationship between bank risk, capital, efficiency, and profitability. Panel A examines the inter-relationships between bank risk, capital, and efficiency using the ratio of loan loss reserves to total assets (LLRTAP), capital ratios proxied using tier1 capital/rwa and common equity/ta, and the cost to income ratio (CIRP) as dependent variables. Panel B examines the inter-relationships between bank risk, capital, and profitability using the ratio of loan loss reserves to total assets (LLRTAP), capital ratios proxied using tier1 capital/rwa and common equity/ta, and the net interest margin (NIMP) as dependent variables. FE stands for 'fixed effects'. See Appendix A for variable definitions. We use F-statistics and t-statistics instead of Chi-squared and Z-statistics for comparison purposes between different tables of multivariate regressions.

Panel A. Three least squares regression (risk, capital and efficiency)						
Variables	Eq. (4) Y= LLRTAP		Eq. (5) Y= Capital		Eq. (6) Y= CIRP	
	Tier1/rwa	Common equity/ta	Tier1/rwa	Common equity/ta	Tier1/rwa	Common equity/ta
LLRTAP			0.02	0.607***	0.269**	0.558***
			(0.048)	(0.026)	(0.129)	(0.052)
CIRP	0.001	0.006***	-0.035***	-0.069***		
	(0.001)	(0.001)	(0.004)	(0.004)		
Capital ratios	-0.006*	0.048***			-0.226***	-0.235***
	(0.003)	(0.002)			(0.031)	(0.015)
Net loans/ta	0.03***	0.046***	-0.163***	-0.104***	-0.2***	-0.103***
	(0.002)	(0.001)	(0.006)	(0.004)	(0.017)	(0.009)
Growth assets	-0.012***	-0.011***	-0.016***	-0.031***	-0.031***	-0.047***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.010)	(0.005)
Income diversity	-0.326***	0.534***	-0.532*	-0.075	2.059***	10.23***
	(0.077)	(0.061)	(0.279)	(0.199)	(0.749)	(0.396)
Size	-0.091***	0.073***	-1.795***	-2.721***	-3.128***	-3.356***
	(0.017)	(0.016)	(0.055)	(0.046)	(0.156)	(0.100)
Constant	2.243***	-2.404***	53.51***	60.24***	126.4***	115.2***
	(0.405)	(0.328)	(1.312)	(0.967)	(3.586)	(1.982)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	6,798	17,085	6,798	17,085	6,798	17,085
R-squared (F-test)	0.314***	0.257***	0.35***	0.373***	0.217***	0.323**
Panel B. Three least square regression (risk, capital and profitability)						
Variables	Eq. (4) Y= LLRTAP		Eq. (5) Y= Capital		Eq. (6) Y= NIMP	
	Tier1/rwa	Common equity/ta	Tier1/rwa	Common equity/ta	Tier1/rwa	Common equity/ta
LLRTAP			-0.159***	0.099***	0.428***	0.245***
			(0.050)	(0.027)	(0.011)	(0.005)
NIMP	0.454***	0.46***	0.363***	1.204***		
	(0.013)	(0.010)	(0.051)	(0.034)		
Capital ratios	-0.017***	0.001			0.019***	0.067***
	(0.003)	(0.002)			(0.003)	(0.002)
Net loans/ta	0.021***	0.034***	-0.156***	-0.099***	0.008***	0.014***
	(0.002)	(0.001)	(0.006)	(0.004)	(0.001)	(0.001)
Growth assets	-0.013***	-0.013***	-0.02***	-0.037***	0.0041***	0.003***
	(0.001)	(0.001)	(0.004)	(0.002)	(0.001)	(0.001)
Income diversity	0.286***	1.218***	0.016	1.23***	-0.806***	-1.096***
	(0.075)	(0.059)	(0.281)	(0.197)	(0.065)	(0.041)
Size	-0.014	0.114***	-1.63***	-2.085***	-0.162***	-0.191***
	(0.016)	(0.015)	(0.055)	(0.046)	(0.014)	(0.011)
Constant	0.211	-3.168***	47.36***	43.01***	4.077***	4.294***
	(0.364)	(0.295)	(1.220)	(0.922)	(0.316)	(0.209)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of observations	6,818	17,149	6,818	17,149	6,818	17,149
R-squared (F-stat)	0.349***	0.305***	0.346***	0.387***	0.634***	0.616***

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Table 17: Alternative estimation techniques. The dependent variables are the ratio of bank loan loss reserves to assets (LLRTAP), the cost to income ratio (CIRP), and the net interest margin (NIMP). To save space, we only report the coefficients for our variables of interest. Panel A employs a bootstrap estimation technique based on 100 resampling runs. Panel B uses a Fama-MacBeth regression. Panel C uses a White test to correct for the heteroscedasticity of standard errors. See Appendix A for variable definitions.

Variables	LLRTAP			CIRP			NIMP		
	Coefficient	N	R^2	Coefficient	N	R^2	Coefficient	N	R^2
Panel A: Bootstrapped standard errors									
Tier 1/rwa	-0.005	7,383	0.305	-0.168**	7,329	0.211	0.009*	7,364	0.619
	(0.006)			(0.068)			(0.006)		
Total capital/rwa	-0.001	8,635	0.259	-0.156***	8,582	0.181	0.008*	8,632	0.6
	(0.004)			(0.058)			(0.004)		
Common equity/rwa	-0.003	6,342	0.303	-0.091**	6,337	0.212	0.008**	6,367	0.625
	(0.003)			(0.042)			(0.004)		
Other capital/rwa	-0.017	6,065	0.307	0.28	6,062	0.219	-0.073***	6,092	0.628
	(0.023)			(0.172)			(0.017)		
Tier 1/ta	0.027*	7,013	0.207	-0.234**	7,004	0.211	0.05***	7,037	0.619
	(0.015)			(0.112)			(0.009)		
Total capital/ta	0.025*	7,157	0.294	-0.165*	7,149	0.207	0.031***	7,186	0.614
	(0.013)			(0.088)			(0.008)		
Common equity/ta	0.036***	17,664	0.257	-0.179***	17,569	0.307	0.053***	17,651	0.609
	(0.007)			(0.034)			(0.004)		
Other capital/ta	0.002	7,156	0.29	0.632***	7,149	0.208	-0.084***	7,186	0.612
	(0.031)			(0.2211)			(0.028)		
Tangible equity/ta	0.035***	17,665	0.257	-0.201***	17,569	0.308	0.052***	17,650	0.609
	(0.071)			(0.031)			(0.004)		
Panel B: Fama-MacBeth regression									
Tier 1/rwa	0.005	7,383	---	-0.347***	7,329	---	0.012**	7,364	---
	(0.020)			(0.319)			(0.019)		
Total capital/rwa	0.003	8,635	---	-0.235***	8,582	---	0.01*	8,632	---
	(0.011)			(0.190)			(0.021)		
Common equity/rwa	0.000	6,342	---	-0.199***	6,337	---	0.011***	6,367	---
	(0.012)			(0.199)			(0.001)		
Other capital/rwa	-0.008	6,065	---	-0.092	6,062	---	-0.067***	6,092	---
	(0.035)			(0.864)			(0.045)		
Tier 1/ta	0.04***	7,013	---	0.054***	7,004	---	0.054***	7,037	---
	(0.031)			(0.034)			(0.034)		
Total capital/ta	0.034***	7,157	---	-0.538***	7,149	---	0.01*	7,186	---
	(0.032)			(0.594)			(0.021)		
Common equity/ta	0.031***	17,664	---	-0.234***	17,569	---	0.052***	17,651	---
	(0.021)			(0.162)			(0.013)		
Other capital/ta	0.012	7,156	---	0.014	7,149	---	-0.065**	7,186	---
	(0.043)			(1.059)			(0.081)		
Tangible equity/ta	0.031***	17,665	---	-0.268***	17,569	---	0.051***	17,650	---
	(0.019)			(0.1743)			(0.013)		
Panel C: White test for heteroscedasticity									
Tier 1/rwa	-0.005	7,383	0.305	-0.168***	7,329	0.211	0.009**	7,364	0.619
	(0.003)			(0.049)			(0.003)		
Total capital/rwa	-0.001	8,635	0.259	-0.156***	8,582	0.181	0.008***	8,632	0.6
	(0.002)			(0.040)			(0.003)		
Common equity/rwa	-0.003	6,342	0.303	-0.091***	6,337	0.212	0.008***	6,367	0.625
	(0.002)			(0.032)			(0.002)		
Other capital/rwa	-0.017	6,065	0.307	0.28**	6,062	0.219	-0.073***	6,092	0.628
	(0.013)			(0.120)			(0.009)		
Tier 1/ta	0.027***	7,013	0.207	-0.234***	7,004	0.211	0.05***	7,037	0.619
	(0.007)			(0.073)			(0.006)		
Total capital/ta	0.025***	7,157	0.294	-0.165**	7,149	0.207	0.031***	7,186	0.614
	(0.006)			(0.066)			(0.005)		
Common equity/ta	0.036***	17,664	0.257	-0.179***	17,569	0.307	0.053***	17,651	0.609
	(0.003)			(0.021)			(0.002)		
Other capital/ta	0.002	7,156	0.29	0.632***	7,149	0.208	-0.084***	7,186	0.612
	(0.019)			(0.151)			(0.011)		
Tangible equity/ta	0.035***	17,665	0.257	-0.201***	17,569	0.308	0.052***	17,650	0.609
	(0.003)			(0.020)			(0.002)		

Standard errors are clustered at the bank level and reported in parentheses below their coefficient estimates.
* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

Quantile Plots

Figure 1. Risk model

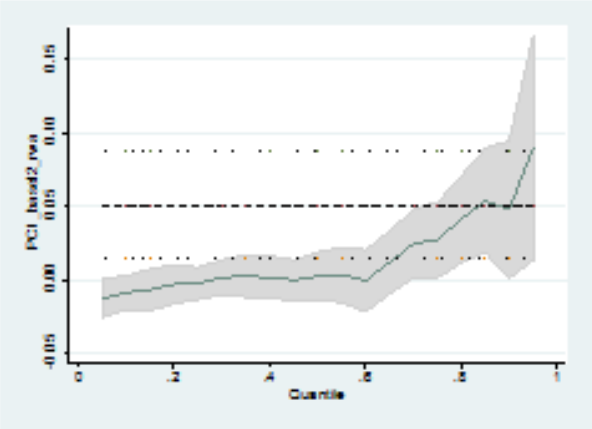

Figure 1.A. PC1_basel2_rwa

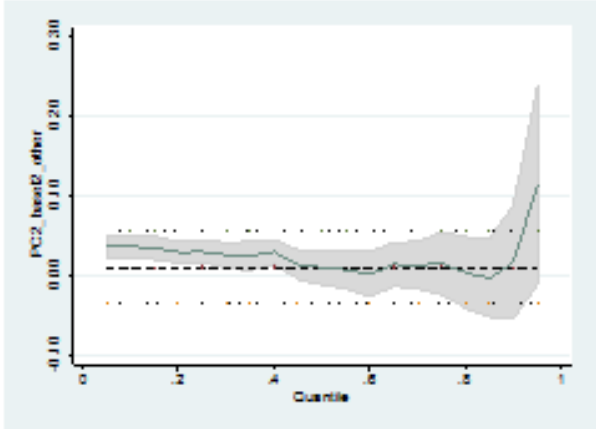

Figure 1.B. PC2_basel2_other

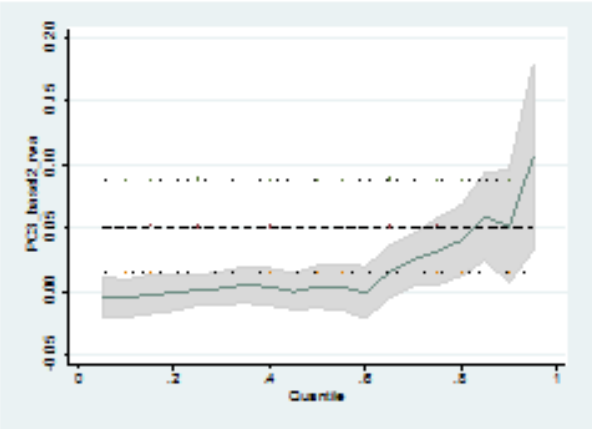

Figure 1.C. PC3_basel2_rwa

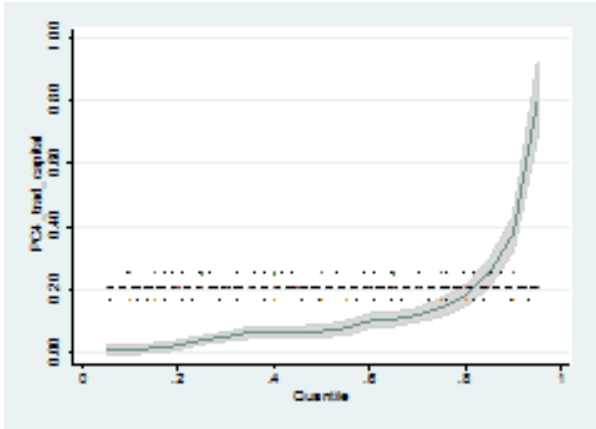

Figure 1.D. PC4_trad_capital

Figure 2. Efficiency model

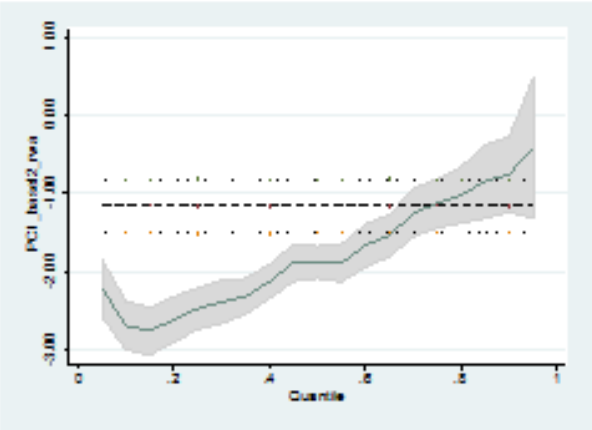

Figure 2.A. PC1_basel2_rwa

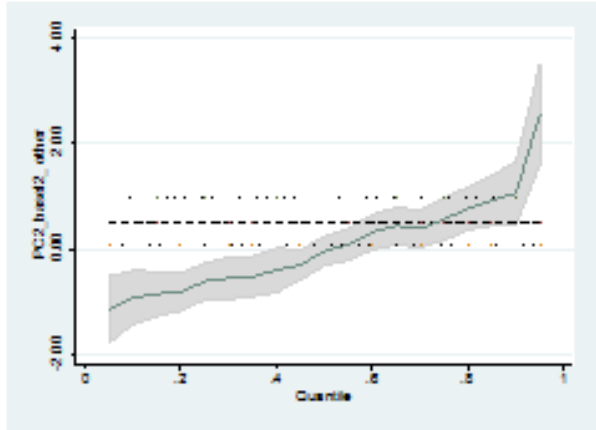

Figure 2.B. PC2_basel2_other

Quantile Plots – (Continued)

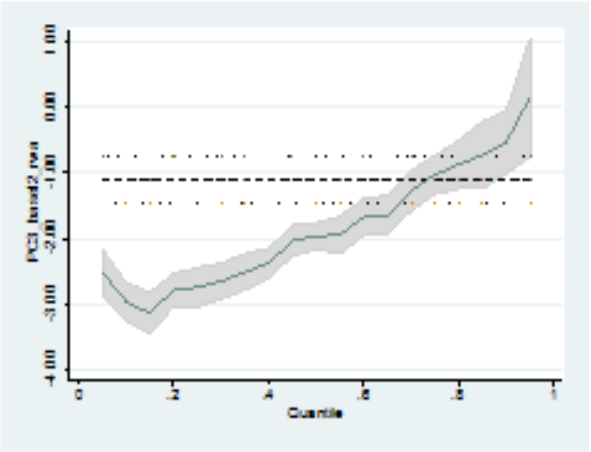

Figure 2.C.: PC3_basel2_rwa

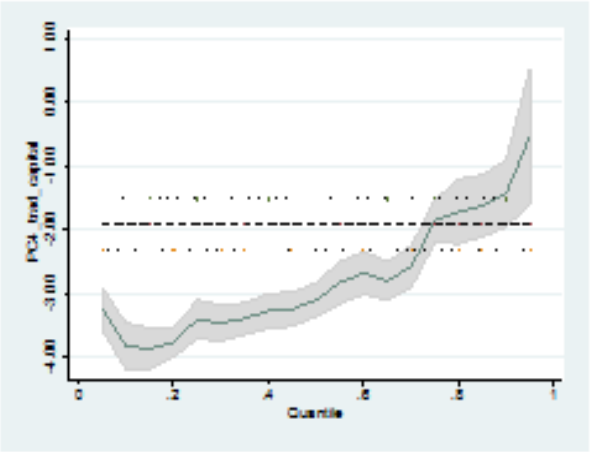

Figure 2.D.: PC4_trad_capital

Figure 3. Profitability model

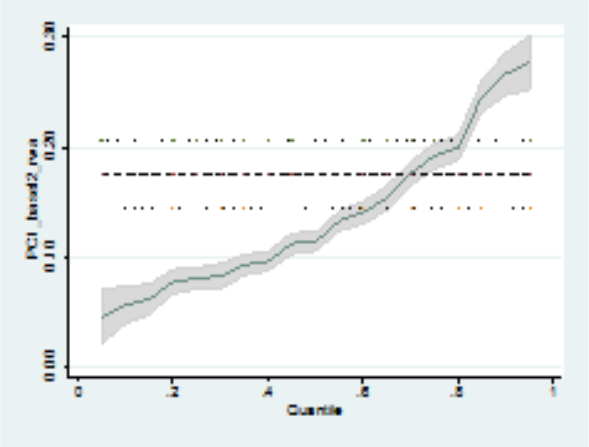

Figure 3.A.: PC1_basel2_rwa

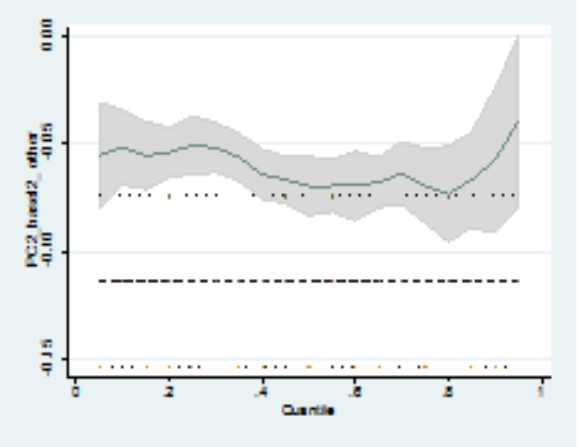

Figure 3.B.: PC2_basel2_other

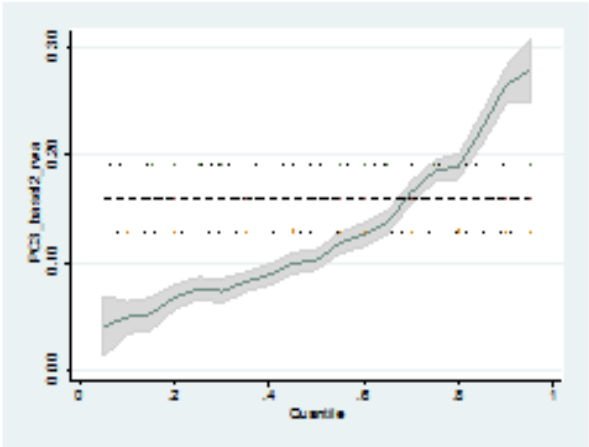

Figure 3.C. PC3_basel2_rwa

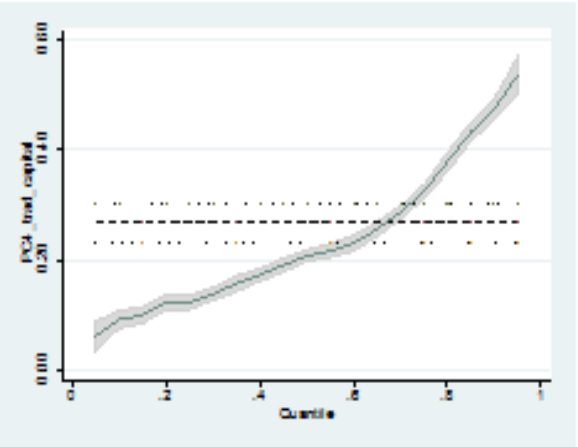

Figure 3.D. PC4_trad_capital

Appendix A

Variable definitions and data sources

Variable	Definition	Data Sources
Dependent variables		
1. Risk model		
Loan loss reserves/ta	Bank reserves for loan losses divided by total assets	Authors' calculations based on Bankscope
Loan loss/gross loans	Bank reserves for loan losses divided by gross loans	Bankscope
Loan loss reserves/impaired loans	Bank reserves for loan losses divided by impaired loans	Authors' calculations based on Bankscope
2. Efficiency model		
Cost to income	The ratio of bank costs to bank income before provisions times 100	Bankscope
Non-interest expenses/gross revenues	The ratio of overhead (e.g. salaries) to gross revenues	Bankscope
Non-operating items/average assets	Bank costs or non-operating items minus taxes as a percentage of average assets	Bankscope
3. Profitability model		
Net interest margin	Bank interest income minus bank interest expenses as a percentage of earning assets	Bankscope
Earnings/ta	Bank net income as a percentage of total assets	Authors' calculations
Other operating income/average assets	Bank fees and other operating income as a percentage of average assets	Bankscope
Independent variables		
1. Capital ratios		
Tier 1/rwa	This measure of capital adequacy measures Tier 1 capital divided by risk-weighted assets computed under the Basel rules. Banks must maintain Tier 1 capital of at least 4%.	Bankscope
Total capital/rwa	This ratio is the capital adequacy ratio. It is the sum of Tier 1 plus Tier 2 capital as a percentage of risk-weighted assets. Under the Basel II Accord, this ratio must be maintained at a level of at least 8%.	Bankscope
Common equity/rwa	Bank common equity includes common shares, retained earnings, reserves for general banking risks, and statutory reserves. This amount is calculated as a percentage of risk-weighted assets.	Bankscope
Other capital/rwa	Bank total capital minus common equity as a percentage of risk-weighted assets.	Bankscope
Tier 1/ta	This measure of capital adequacy measures Tier 1 capital divided by total assets.	Authors' calculations based on Bankscope
Total capital/ta	This measure is bank Tier 1 plus Tier 2 capital divided by total assets.	Authors' calculations based on Bankscope
Common equity/ta	Bank common equity divided by total assets.	Authors' calculations based on Bankscope
Other capital/ta	Bank total capital minus common equity divided by total assets.	Authors' calculations based on Bankscope
Tangible equity/ta	Bank tangible equity divided by total assets. This measure removes goodwill and all other intangible assets from both the equity and asset side of a bank's balance sheet.	Authors' calculations based on Bankscope
2. Bank control variables		
Net loans/ta	The share of net loans as a percentage of total assets.	Authors' calculations based on Bankscope
Growth assets	The current year growth rate of total assets compared to the previous year's total assets.	Bankscope
Income diversity	1 – [(Net interest income – other operating income)/(operating income)]. Higher values mean more diversified activities.	Authors' calculations based on Bankscope
Size	The natural logarithm of total assets.	Authors' calculations based on Bankscope
3. Country control variables		
Deposit insurance	A dummy variable that takes on a value of 1 if a country has explicit deposit insurance and 0 otherwise.	Banking regulation and supervision database, World Bank; Barth et al., (2000, 2003, 2008)
HHID	The Herfindahl-Hirschman index equals the sum of the squared market share (in terms of deposits) for banks in each country.	Authors' calculations based on Bankscope
Certified audit	A variable that takes on a value of 1 if a country's banking system requires a mandatory external audit by a licensed or certified auditor, and 0 otherwise.	Banking regulation and supervision database (The World Bank and Barth et al. (2000, 2003, 2008))
Capital stringency	This variable is based on surveys by Barth et al. (2000, 2003, 2008, see details therein). The variable increases by 1 if the answer is yes to questions 1–6 of their survey with no increase if the answer is no. The opposite occurs for questions 7 and 8. The variable thus ranges between 0 and 8 and addresses 8 questions with higher values indicating greater stringency: (1) Is the minimum required capital asset ratio (risk weighted) in line with the Basel Accords? (2) Does the ratio vary with market risk? (3–5) Before determining minimum capital adequacy, are any of the following deducted	Banking regulation and supervision database (The World Bank and Barth et al. (2000, 2003, 2008))

Variable	Definition	Data Sources
	from the book value of capital: (a) the market value of loan losses not realized on the financial statements, (b) unrealized losses on security portfolios, and (c) unrealized foreign exchange losses? (6) Have regulatory/supervisory authorities verified the sources of funds to be used as capital? (7) Can assets other than cash or government securities provide initial or subsequent injections of capital? (8) Can borrowed funds provide the initial disbursement of capital?	
Market discipline	Market discipline and private monitoring is an indicator of disclosing transparent information to the market. The variable is based on surveys by Barth et al. (2000, 2003, 2008, see details therein). It increases by 1 if the answer is yes to questions 1–7 of their survey with no increase if the answer is no. The opposite occurs for questions 8 and 9. The variable thus ranges between 0 and 9 and includes 9 questions with higher values indicating adequate information disclosure and market discipline: (1) Is subordinated debt allowed (or required) as capital? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? (3) Are off-balance-sheet items disclosed to the public? (4) Must banks disclose their risk-management procedures? (5) Are directors legally liable for erroneous/misleading information? (6) Do regulations require credit ratings for commercial banks? (7) Is an external audit by a certified/licensed auditor mandatory for banks? (8) Does accrued, unpaid interest/principal on non-performing loans appear on the income statement? (9) Is there an explicit deposit-insurance protection system?	Banking regulation and supervision database (The World Bank and Barth et al. (2000, 2003, 2008))
Supervisory power	The variable is based on surveys by Barth et al. (2000, 2003, 2008, see details therein). It increases by 1 if the answer is yes to questions 1–14 of their survey with no increase if the answer is no. The variable thus ranges between 0 and 14 with greater values indicating more supervisory power: (1) Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? (2) Are auditors legally required to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud, or insider abuse? (3) Can supervisors take legal action against external auditors for negligence? (4) Can the supervisory authorities force a bank to change its internal organizational structure? (5) Does the institution disclose off- balance-sheet items to supervisors? (6) Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? (7) Can the supervisory agency suspend directors' decisions to distribute dividends? (8) Can the supervisory agency suspend directors' decisions to distribute bonuses? (9) Can the supervisory agency suspend directors' decisions to distribute management fees? (10) Can the supervisory agency supersede bank shareholder rights and declare the bank insolvent? (11) Does banking law allow a supervisory agency or any other government agency (other than a court) to suspend some or all ownership rights at a problem bank? (12) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency (other than a court) supersede shareholder rights? (13) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency (other than a court) remove and replace management? (14) Regarding bank restructuring and reorganization, can the supervisory agency or any other government agency (other than a court) remove and replace directors?	Banking regulation and supervision database (The World Bank and Barth et al. (2000, 2003, 2008))
Entry requirements	The variable is based on surveys by Barth et al. (2000, 2003, 2008, see details therein). It increases by 1 if the answer is yes with no increase if the answer is no. The variable ranges between 0 and 8 with higher values indicating the existence of more stringent legal submissions to obtain a license to operate as a bank: (1) Draft by law? (2) Intended organization chart? (3) Financial projections for first three years, (4) Financial information on main potential shareholders, (5) Background experience of future directors, (6) Background experience of future managers, (7) Sources of funds to be disbursed in the capitalization of new banks, (8) Market differentiation intended for new bank?	Banking regulation and supervision database (The World Bank and Barth et al. (2000, 2003, 2008))
World governance index	The world governance index is the average of six governance dimensions including: (1) voice and accountability, (2) political stability and absence of violence, (3) government effectiveness, (4) regulatory quality, (5) rule of law, and (6) control of corruption.	World governance indicators database (The World Bank and Kaufmann et al. (2013))
Economic freedom	Economic freedom is an index computed as the average of 10 quantitative and qualitative factors that capture 4 categories of economic freedom including: (1) the rule of law, (2) limited governance, (3) regulatory efficiency, and (4) open markets.	The Heritage Foundation 2015 index of economic freedom
GDP growth	The annual percentage growth rate of a country's GDP.	World Development Indicators (WDI)

Appendix A – (Continued)