Does the capital structure affect banks' profitability? Pre and Post-Financial crisis evidence from significant banks in France

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Abstract

This paper studies the effect of banks' capitalization on their Return on Equity (ROE). A debate has emerged on the costs for banks of the increase in capital requirements under Basel III. We bring empirical evidence on this issue by analyzing the effect of accounting and regulatory capitalization measures on banks' ROE on a sample of large French banks over the period 1993-2012, controlling for risk-taking as well as a range of variables including the business model. Correcting for a pure accounting effect, we uncover a positive impact of an increase in capital ratios on the ROE. The method chosen by a bank to increase capitalization (i.e. raising equity) does not alter the result. Banks that are more constrained by the capital requirement regulation, as measured by a lower capital buffer, appear to experiment the same positive effect as other banks. This effect of capital on the ROE appears to be driven by an increase in bank efficiency.

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Key Words : ROE, solvency ratios, capital, banking regulation, Basel III

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1. Introduction

The financial crisis has renewed attention on the role of bank capital because many highly levered financial institutions failed or had to be bailed-out by governments. The social cost of bank failures justifies the existence of regulatory capital requirements for financial institutions (Berger et al., 1995; Admati et al, 2011; Calomiris, 2013). According to the Bank of England Governor, M. Carney, "only well-capitalised banks can serve the needs of the real economy to promote strong, sustainable growth. […]. Where capital has been rebuilt and balance sheets repaired, banking systems and economies have prospered." (Carney 2013a and b).

The Basel III accords notably propose an enhanced framework in terms of capital requirements for banks. This reform imposes an increase in capital quality by requiring higher levels of common equity. It also requires a minimum leverage ratio taking into account banks' total assets and off balance sheet items. Such capital requirements could however create trade-offs for the economy. Banks often argue that higher capital requirements will jeopardize their performance. This could occur for example if banks' cost of financing were to increase significantly due to more capital holding. These higher funding costs could result in lower ROE for banks and have a disruptive effect on lending. Economic theory does not help to solve this debate because no consensus emerges on the effect of capital on bank performance. Relying on the hypothesis of perfect markets, the Modigliani-Miller (1958) framework makes irrelevant, in terms of bank value, capital structure decisions.[2] Another strand of the literature emphasizes the disciplinary role of debt on managers (see e.g. Hart and Moore, 1995; Diamond and Rajan, 2001). Thus, increasing capital might relax managers from this discipline and be detrimental for performance. Finally, a third view argues that capital should have a

[2] Some empirical papers have indeed found that an increase in capital leads to a decrease in equity risk premium, thereby showing that Modigliani and Miller (1958) partially apply to banks (see e.g. Miles et al., 2012).

positive effect on performance (e.g. Holmstrom and Tirole, 1997). Higher capital diminishes the moral hazard between shareholders and debtholders. As delegated monitors (Diamond, 1984), banks need incentives to act on behalf of their debtholders. In this view, higher levels of capital increase the banks' incentives to monitor their borrowers because shareholders will collect a larger share of assets payoffs and lose more in case of failure. This in turn explains why capital ratios might have a positive effect on banks' performance. Such an increase in ROE may be achieved, through higher margins, coming either from higher efficiency or higher market power.

Our empirical strategy is therefore to assess the role of bank capitalization measures on their ROE. We also investigate the channels through which the ROE may vary. However it is beyond the scope of the paper to address fully this second issue. We proceed in several steps. First, we check whether there is a significant relation between capitalization and ROE. Second, we test whether this effect takes some time to materialize. Third, we asses if the effect depends on the method the bank choose to increase its capitalization (e.g. raising equity). Next, we also assess if this relation is different for banks which are more constrained by capital requirement regulation. To measure capital requirement constraints, we rely on confidential supervisory data on individual additional capital requirements for banks. Finally, we also investigate the channel through which bank capitalization influences the ROE. From an accounting point of view, the expected ROE will decrease when capital increases because the same profit is divided by a larger amount of equity[3]. In our approach, we are interested in disentangling this accounting effect from the economic effect of bank capital on ROE.

This study contributes to the literature in several ways. First, we use a novel database assembled by the *Autorité de Contrôle Prudentiel et de Résolution*, the French Prudential Supervisory Authority, on the basis of confidential accounting and prudential data on French

[3] This does not mean however a loss in value. This change compensates for the lower risk-borne by equity holders. For a discussion, see Admati et al. (2011).

banking groups. In comparison to other publicly available data, the database exhibits a higher degree of harmonization of indicators because all banks report under the same regulatory format in a given year. Our capitalization measure reflects different types of bank capital either employed in the economic literature or by supervisory authorities. These measures take into account un-weighted and risk-weighted assets, as well as on and off balance sheet exposures of banks. Thus, they reflect the rationale of the new Basel III framework which combines all these features. We also have access to confidential supervisory data on additional capital requirements for banks. We are thus able to derive a measure of capital requirements constraints for banks. Our data allows us to precisely investigate how capitalization affects bank performance, whether it depends on the method used to increase capital or the capital requirements constraints, and finally the channel through which the effect occurs. Our identification strategy also disentangles the economic effect from the accounting effect of an increase in capitalization. Third, our sample comprises large banks from France, a country with one of the largest banking system in Europe, over the period 1993-2012. This large sample period allows us to draw results that are robust to different economic cycles. Moreover, by focusing on large banks we concentrate on significant institutions for which the prudential regulation is the most relevant, as it represents more than 90% of the total assets of French banks in 2012.

We perform fixed effect regressions with lagged values of capital measures to avoid endogeneity between contemporaneous measures of capital and the ROE. We find that an increase in lagged value of capital has a positive effect on the ROE for all our capital measures. This effect is stronger when we take two-year lags indicating that it takes some time to affect performance. Correcting for the pure accounting effect of an increase in capital, we provide evidence of a statistically significant and positive economic impact on the ROE. We therefore reject the hypothesis of a negative effect of capital on the ROE. Arguably,

disincentive effects of higher capital requirements may occur beyond a certain threshold (Calomiris, 2013) but our evidence is that capital ratios at current levels for French banks are still below that level. This effect does not depend on the method to increase capitalization (for example retaining earnings versus raising equity), nor it depends on the level of capital requirement constraints. The channel explaining this result is related to higher bank efficiency when capital increases.

Our results are in accordance with theories pointing out the effect of stronger monitoring when capital increases. They also corroborate previous empirical findings. Berger (1995) uncovers a positive effect of the level of capital ratios on the ROE for the US banking industry. Mehran and Thakor (2011) examine how capital ratio influences the target's price in banking acquisitions in the United States over the 1989-2007 period. They find that acquirers pay more for targets with a higher capital ratio in terms of assets fair-value and goodwill. Berger and Bouwman (2013) test how capital ratio influences bank performance during financial crises from 1984 to 2010 in the United States. Small banks with higher capital ratios have a higher probability of survival,market share and profitability both in 'normal' times and during financial crises. These results hold for large banks but only during banking crises episodes. We confirm some of their findings, but we show that higher capital has an unambiguous positive effect on ROE. Regarding this debate on heterogeneity among banks, our contribution is to consider whether Berger and Bouwman's (2013) results are not driven by regulatory intensity, as measured by a lower capital buffer, which would reduce the positive impact of capital on ROE. This is a relevant issue in times of tighter regulation for larger banks. Using confidential information on pillar 2 capital, we show that bank's capital buffer has no additional and differential effect on banks' ROE.

The rest of the paper is organized as follows. Section 2 presents a literature review and formulates our hypotheses. Section 3 describes the data and methodology. Section 4 presents

the results. Section 5 performs complementary investigations on the results. Section 6 presents some robustness checks. Section 7 concludes.

2. Literature review and hypotheses

There is an extensive theoretical literature studying the effect of capital on banks' value. Three views exist leading to different conclusions. In the M&M framework, funding sources have no effect on asset cash flows. Thus changing the mix of equity and debt does not have any effect on the firm value. The cost of equity is a function of asset risk and leverage and decreases when equity financing increases. This effect explains why the funding mix is neutral for firm value, despite the cost of equity being superior to the cost of debt. Miller (1995) argues that nothing prevents this framework to apply to the banking sector.

The two other views depart from M&M propositions and predict that capital levels have an effect on banks' asset cash flows. First, there is an extensive literature in corporate finance on the disciplinary role of debt (e.g. Hart and Moore, 1995). The manager may seek to ease market discipline by building an equity cushion. Debt may also present advantages compared to capital due to the existence of information asymmetries. Managers might have private information on the evolution of firm yields or on investment opportunities. The firm, by issuing debt, reveals to external investors its ability to repay the principal and interest on debt and signals its soundness (Ross, 1977; Leland and Pyle, 1977). Banks might also reduce liquidity creation when capital is too high (Diamond and Rajan, 2001).

A competing view, on the contrary, predicts that more capital will have an enhancing effect on banks' value. Two main channels based on the moral hazard between shareholders and debtholders explain this effect. The first channel is based on the risk premium required by debtholders. Potential losses of equity holders are floored because of the limited liability of

shares. However, gains increase with risk taking. This creates an incentive to take excessive risks at the expense of other stakeholders in the bank. Debt holders anticipate this behavior and require a premium to finance banks. Consequently, market discipline from debtors forces banks to detain positive amounts of capital (Calomiris and Kahn, 1991).

The second channel is based on monitoring efforts exerted by the bank. The (costly) monitoring effort depends on bank capital: higher capital internalizes the potential losses coming from a lack of monitoring. The bank has thus stronger incentives to monitor when its capital ratio increases. In this channel, capital structures have an effect on asset cash-flows because monitoring affects the loan portfolio pay-offs[4] (Holmstrom and Tirole, 1997; Mehran and Thakor, 2011; Allen, Carletti and Marquez, 2011).

3. Data and methodology

3.1.Data

Our sample covers the period 1993-2012 for 17 French banks on a consolidated basis. We use a novel database assembled by the *Autorité de Contrôle Prudentiel et de Résolution*, on the basis of confidential accounting and prudential data on French banking groups. The data allows us to access to on- and off-balance sheet items, as well as prudential information over this long period. The selection criterion includes banks that are significant in the definition retained by the European Single Supervisory Mechanism (SSM). Financial institutions with total assets over EUR 30 billion are included. In addition, banks in the 'grey zone' with total assets smaller but close to EUR 30 billion are also included in our sample.

[4] Banks can improve borrowers' performance in several ways. By acquiring private information, banks can improve the continuation/liquidation decision of a project, thus increasing firm value (Chemmanur and Fulghieri, 1994). Loan commitments allow the bank to provide more liquidity after obtaining private information to liquidity constrained borrowers. A bank that has a large portfolio in a certain industry can provide valuable advices about pricing, inventory planning and capital budgeting without violating confidentiality of other borrowers (Boot and Thakor, 2000).

Our sample is a unbalanced panel of 135 bank-year observations. Data availability constraints (on top of mergers and acquisitions over the sample period) explain the unbalanced structure of the database.

We compute three different un-weighted measures of bank capitalization: *Capital ratio*, *Tier1/Tangible assets* and *Tier1/TA with off-balance sheet (OBS)*. *Capital ratio* is simply the balance sheet value of equity over total assets. *Tier1/Tangible assets* is based on the leverage ratio enforced by the United States banking supervisory authority in parallel with the Basel regulatory framework. Its computation is as follows: (Tier1 capital – intangible assets) / (total assets – intangible assets). *Tier1/TA with OBS* approaches the Basel III leverage ratio definition. It is computed as Tier1 / (total assets + weighted off-balance sheet credit risk exposures). The weights of the off-balance sheet credit risk exposures follow the Basel 3 framework: a 10% weight is applied to all commitments that a bank can withdraw at any time without any condition. All other commitments are 100% weighted. We only include off-balance sheet credit risk elements as we are not able to obtain a consistent measure of off-balance market risk exposures over the whole period due to regulatory changes. In addition, we use the two solvency ratios defined in the Basel I framework. *Tier1 regulatory ratio* is computed as Tier 1 over Basel I risk-weighted assets. *Total regulatory ratio* is computed as Tier1+Tier2+Tier3 over Basel I risk-weighted assets. We prefer to rely on the Basel I framework for the whole period in order to remain consistent and avoid the Basel II change in regulatory definition of risk-weighted assets in 2008. Banks report minimum required capital under Basel I definition even after 2007, which allow us to compute the Basel I risk-weighted assets for the period 2008-2012. We use lagged values for all our capitalization measures because the contemporaneous measures of capital are endogenous to bank profit (non-distributed benefits increase banks' capital reserves). We consider one-year and two-year lags in our models. To check whether endogeneity might still be considered an issue with lagged

values, we perform Granger-causality test with two year lags including bank and time fixed effects. We find that lagged values of ROE never Granger-cause any of our measures of bank capitalization.[5]

Our model controls for several aspects influencing the ROE. The variable labelled as *Equity accounting effect* is a dummy variable equal to 1 when equity increased between two periods, and 0 otherwise. An increase in equity has a negative accounting effect on ROE.[6] This dummy is thus included to disentangle the "pure" negative accounting effect from the economic effect of capital measures. We rely on the dummy variable to pool the subgroup that experiments an absolute increase in capital (different from the change in capital ratios) because this subgroup will experiment on average the same economic effect of capital ratio change but will have a lower ROE due to the negative accounting effect. We consider a one-year lag of this variable because the contemporaneous variable is endogenous: benefits increase capital reserves and thus contemporaneously cause equity growth.

The other variables are introduced in order to take into account banks' business model, as well as asset risk-levels, given the usual risk-return tradeoff. *Asset diversification* is the Herfindhal-Hirschman index (HHI) computed on four different asset classes: cash, interbank loans, non-financial institutions bank loans and other earning assets. Higher indexes indicate a high concentration in asset classes and, hence, lower diversification. Diversification is often computed using the HHI (see e.g. Thomas, 2002; Stiroh and Rumble, 2006).

Loan share represents the proportion of loans divided by all earning assets. Symmetrically, Berger and Bouwman (2013) rely on the trading assets share. *Loan share* captures to what extent banking institutions pursue 'traditional' credit activities. Investment banks tended to have higher ROE compared to traditional banks on average before the

[5] Results are not reported for the sake of brevity but available upon request. .

[6] Capitalization might change due to a variation in equity or in the denominator. The latter does not lead to any accounting effect.

financial crisis. This pattern has, however, been reversed during the financial crisis (ECB, 2010).

Safety net is computed as deposits over total assets. Deposits are insured in France since 1980,[7] thus banks with a higher proportion of deposits benefit more from the public guarantee. Similarly, Berger and Bouwman (2013) include the ratio of core deposits to total assets to account. *Safety net* is expected to influence risk-taking (Merton, 1977; Keeley, 1990).

In a portfolio approach, the average return has to be explained by risk. We thus add the variable *Portfolio risk*. Following Berger (1995) and Berger and Bouwman (2013), *Portfolio risk* is computed as the Basel I definition of risk-weighted assets over total assets. It reflects the allocation of assets among the four weighting categories (0, 20, 50 and 100%) defined in the Basel framework. Using such a measure allows us to control banks' portfolio reallocation effects on the ROE. Again, we prefer to rely on the Basel I definition of risk-weighted assets in order to remain consistent over the whole period.

Finally, we also include a *Liquidity ratio*. It corresponds to the French regulatory liquidity ratio, which is computed as available liquid assets over liquid liability requirements. Berger and Bouwman (2013) also take into account liquidity, albeit in a cruder way by including cash holdings and other liquid assets divided by total assets in their model. Banks with more liquidity have a lower probability to suffer financial distress. Liquid assets also tend to be less risky, and thus have a lower expected return.

Table 1 presents descriptive statistics for our sample. With an average ROE of 10.71%, French banks have been highly profitable over the period. Our capital measures reveal relatively different situations across banks and over time. The first decile *Capital ratio* is 2.68%, meanwhile the last decile is at 10.10%. Banks also appear to have different business

[7] In practice deposits are insured only up to EUR 100 000 for each account in a given bank. We cannot distinguish between deposits above or below EUR 100 000 and take all deposits as a proxy.

models: the first decile of *Asset diversification* is at 0.39 (high level of diversification) and the last decile at 0.79 (very high level of concentration). The same observation can be made for *Loan share* (first decile at 28.50% to the last decile at 88.37%) and *Risk portfolio* (first decile at 21.01% to 90.29%), which reveal that banks choose different business models in our sample.

3.2.Methodology

To assess the effect of bank capitalization on ROE, we perform fixed effects regressions at the bank level. Standard-errors are corrected for heteroscedasticity using Hubert/White standard errors. We include in turn our lagged values of capitalization measures. Our baseline model is as follows:

$$ROE_{i,t} = \alpha_i + \theta_t + \beta_1 . Capitalization_{i,t-j} + \beta_2 . Equity\ accounting\ effect_{i,t-1} + X_{c,i,t} . \beta_c + \varepsilon_{i,t}$$

Where i is a subscript for the i[th] bank, t for the t[th] time period and $j \in \{1,2\}$. α_i and θ_t are, respectively, bank and time fixed effects. $Capitalization_{i,t-j}$ is one of the five measures of bank capitalization described above in the data section. $Equity\ accounting\ effect_{i,t-1}$ is a dummy variable equal to 1 when the bank i increased its equity in year *t-1* and 0 otherwise. $X_{c,i,t}$ is a vector of the following independent variables: *Asset diversification, Loan share, Safety net, Portfolio risk* and *Liquidity ratio*. β_1, β_2 and β_c are parameters to be estimated. $\varepsilon_{i,t}$ is the disturbance term.

4. Main results

4.1.Bank capital and ROE

Table 2 reports the results of the fixed effects regressions of ROE on our capitalization measures. For all equations, the coefficient on the capitalization variable is positive; except for column (1), namely the *Capital ratio* variable, they are statistically significant. ROE tends to *increase* on average after an increase in capitalization. This result also holds for risk-weighted measures. Thus, our analysis supports the "positive view": more capital increases the monitoring effort of the bank and thus the pay-offs it collects. Moreover, the *Total regulatory ratio* exhibits the lowest significant effect on ROE. This is consistent with the fact that this ratio includes other forms of capital such as long term subordinated debt and some hybrid instruments. These forms of capital should influence less the monitoring effort of the bank because only pure form of equity will entirely capture the gains from increased monitoring. These results are in line with Berger and Bouwman (2013). They find that banks with higher capital ratio in pre-crisis times experiment an increase in profitability compared to less capitalized banks.

As expected, our variable *Equity accounting effect* is significantly negative, capturing the accounting effect of an increase in equity. We also find a significant impact of *Asset diversification* and *Loan share* on ROE. The positive coefficient on *Asset diversification* indicates that banks with more concentrated activities tend to have a higher ROE on average. This might reflect the high risk profile of banks choosing to focus their activities on one business which leads to higher profits on average. The negative sign on *Loan share* indicates that increasing banks' loan activity led to a decrease of the ROE on average. These models consider that capital ratio affect ROE over one period. Arguably, if the positive effect relies on increased monitoring, it might take longer for the bank to benefit entirely from an increase

in capitalization. To check this, we estimate the effect of capitalisation by including two-years lags.

4.2.Considering two-year lags in capital measures

Table 3 reports the results when both one-year and two-year lags are included in the model. We compute a joint significance test and the sum of lagged variables coefficients. The results indicate that the effect is mainly explained by the two-year lag as it is strongly significant in models (1) to (3). The one-year lag is never significant in all specifications. The joint test on the coefficients of one-year and two-year lagged capitalization measures being equal to 0 rejects the null hypothesis in all specifications. Moreover, the sum of coefficients of lagged capitalization measures is strongly significant and positive in all specifications. Again, *Total regulatory ratio* has the lowest coefficient among regressions.

Overall, capitalization has a positive effect on a bank's ROE. The effect is particularly important two years after the initial increase in capital. We thus find strong empirical support for the "positive view" of the effect of capital on banks' performance.

4.3.The economic effect of capital increase

The results indicate that capitalization has a statistically positive effect on ROE. The effect appears to be economically significant. From Table 2, which considers a one-year lag in capitalization measures, the *ceteris paribus* effect of a 100 bps increase in capitalization is an increase of ROE in the range of 0.54 % to 1.50% on ROE depending on the capital ratio measure. When considering the inclusion of two year lag in the same specification as reported in Table 3, the average effect on ROE (i.e. the sum of lagged coefficients) is between 0.57%

and 2.19%. Interestingly, non risk-weighted capitalization measures have the stronger effect on ROE, especially when off-balance sheet items are taken into account. Among regulatory ratios, increasing Tier1 regulatory capital is almost twice as effective as increasing total regulatory capital (0.97% against 0.57%).

However, the net effect on ROE of an increase in capitalization depends both on the positive economic effect and negative accounting effect, the latter being significantly offset by the former.[8]

5. Complementary investigations

5.1. Does the way banks increase capital matter?

As noted above, one view is that capital requirements impose a cost on banks because equity is a costly source of financing[9] that impedes banks' profits. However, our results suggest the reverse: higher capitalization leads to better accounting profits. How do our empirical results bear on that issue? Miller (1995) discusses the application of M&M propositions to banks and stresses the fundamental distinction between the cost of *raising new equity* and the cost of *having equity*.

On the one hand, *raising equity* is generally supposed to be costly in the short-term: it creates dilution costs for existing shareholders and imposes issuance costs. Moreover, new shares might be sold at a discount if the issuance is interpreted as a bad signal of the bank's prospects. On the other hand, *capital structure* is irrelevant in the M&M framework. Thus,

[8] To measure the final effect, we can use the estimation below of the effect on the ROA. As shown in Table 7, an increase in the capital ratio has a positive effect on the ROA. For example, in the case of the T1/TA with OBS ratio, the coefficient of 0.152 associated with the capital ratio variable implies that a 100 bp increase in the capital ratio leads to an upward shift in the ROA by 0.152 bp, hence an increase by 0.152/0.61= 24,9%, around the sample average (see Table 1). As ROE= ROA x (Capital Ratio), $\frac{\Delta ROE}{ROE} = \frac{\Delta ROA}{ROA} - \frac{\Delta Capital\ ratio}{Capital\ ratio}$. A 100 bp increase in the capital ratio is equivalent to an increase by 23.3% around the sample average (or 1%/4.28%). The final effect would be a moderate increase in the ROE by 24.9%-23.3% = 1.6%.

[9] This argument is all but new. In the discussion Miller wrote on that topic in the *Journal of Banking and Finance* in 1995 (Miller, 1995), he explains that he was already confronting this argument 15 years before the discussion in a banking conference about capital requirements.

bankers might be right that *raising* new equity is costly and wrong on the effects of *having* equity[10].

To check whether the cost of raising equity has a negative effect on ROE, we compute a lagged dummy variable[11] *Growth of paid-up capital* equal to 1 when the growth in paid-up capital is strictly positive and 0 otherwise. Paid-up capital excludes all other forms of equity such as retained earnings. Change in paid-up capital should thus only account for increases in capital after raising equity (e.g. via Seasoned Equity Offering). Note that this variable is different from our previous variable *Equity accounting effect* which accounted for growth of all sources of equity (paid-up capital plus retained earnings and other form of equity). The correlation between *Equity accounting effect* and *Growth of paid-up capital* is -0.06. We are interested in the interactions between *Growth of paid-up capital* and our capital measures. More precisely, we want to check if the effect of capitalization on ROE is different when equity is raised. As argued in the discussion, the costs of *raising* equity might reduce banks' profits in accordance with the bankers' view. If this view holds, we expect a negative sign for the interaction term between *Growth of paid-up capital* and each of our capitalization measure.

Table 4 reports the results of the fixed effects regressions with our capital measures interacted with the growth of paid-up capital. All the interaction terms are insignificant. We do not find statistical evidence that the way of increasing capital ratios (i.e. raising equity) reduces the positive effect of having high capital ratios.[12] We also tested the same fixed effects models only including capitalization measures, *Growth of paid-up capital* and the interaction terms. Results are unchanged.

[10] One should note that capital requirements are not imposed overnight. For example, the Basel III framework is only progressively implemented and will not be fully binding before the 1st January 2019. This allows banks to pursue different strategies, such as retaining more earnings or reallocating assets, to attain the required levels of capitalization. Moreover, the costs of *raising* equity can thus be spread over the whole period of implementation. Consequently, this progressive implementation alleviates the bankers concerns on the costs of *raising equity*, especially after taking into account the beneficial effects of *having more equity*.

[11] Because the cost of raising equity can have an effect in the short run, we also tested with non lagged variables of growth of paid-up capital. The results remain unchanged.

[12] Banks that need to raise external capital in order to balance losses do not seem to wipe out the positive effect of capital on ROE.

5.2. Does the result holds for banks with high capital requirement constraints?

Next, we check whether the extent to which binding capital requirements can affect the result. So far, our measure can reflect the fact that some banks choose to have higher capital levels. An important question is whether banks, to which higher capital ratios due to the Basel regulatory framework are imposed, continue to experience this positive relation between capital and performance. To test this issue, we measure banks' capital buffer, and investigate whether for banks that are more constrained, i. e. for which the capital buffer is closer to zero, an increase in capital would have a negative instead of a positive effect on ROE. Indeed, in that case, banks would be closer to their optimal capital, so that any tightening of the regulation would have a detrimental impact on ROE. We use confidential supervisory data on additional pillar 2 capital requirements: the supervisor may request from individual banks to hold additional capital in supplement to the minimum regulatory ratio.[13] This provides a better measure of bank's capital requirements, hence it allows us to identify the degree to which banks are constrained in their capital ratio choice.

To measure this constraint, we compute the capital buffer at the bank level in each year, i.e. the difference between their level of regulatory capital and their individual capital requirements (minimum requirements, plus the optional additional requirements). A bank with a lower buffer is more constrained by the regulation as it has either a higher level of capital requirements or chosen a level of capital close to the capital requirements imposed by regulation. We consider banks with a lower buffer than the median[14] as the subgroup of banks that are more constrained by the capital requirement regulation. Our variable of constraint is

[13] Since Basel II, this is known as 'Pilar II' capital requirements. These requirements are not disclosed to the market..

[14] We also construct four different subgroups according to the 25th, 50th, and 75th percentiles. Our results remain unchanged.

thus a dummy variable equal to 1 if the bank has a buffer under the sample median (higher capital requirement constraint) and 0 otherwise (lower capital requirement constraint).

We interact this measure of capital requirement constraint with the capitalization of the bank. We want to test whether, for a given level of capitalization, banks which are more constrained by capital requirements experiment the same positive relation between capitalization and ROE. Table 5 presents the results of the interaction between capitalization and capital requirement constraint. It confirms that no difference appears between banks with different capital requirement constraints. All coefficients of capitalization measures are significantly positive, meanwhile coefficients for the interactions, albeit being overall negative, are not significant. The positive relation between capitalization and ROE appears to prevail whatever the level of capital requirement constraint.

5.3.What drives the positive relation between bank capitalization and ROE?

The positive effect of capital on bank performance is theoretically a result of a stronger monitoring from the bank which increases the value added of its assets, all else being equal. To assess whether this hypothesis drives our results, we further analyze the impact of capital on the ratio of net operating income to administrative expenses (*Efficiency*) in order to explain the positive association between capital and ROE. This ratio should capture a more efficient behavior of banks if net operating income increases more than administrative expenses. Table 6 shows a strong positive relationship between banks' capital ratios and the ratio of net operating income to administrative expenses. This indicates that an increase in capital ratios is associated with a more efficient behavior from the bank: income increases more than expenses.

To confirm the channel through which higher capital is associated with higher future earnings, we assess the impact of capital on the different components of earnings namely the ratios of revenue to equity, interest expenses to equity, commission expenses to equity and administrative expenses to equity. Since the coefficients associated with the capital measures may reflect the fact that equity is the denominator of the dependent variable and in the numerator of the capital measures, we also express these dependent variables as ratios to total assets. Overall, our results suggest that banks tend to become more efficient after an increase in capital by increasing revenues more than costs.[15]

6. Robustness checks

We rerun all our models using alternative measures of performance as the dependent variable.[16] First, we use *Return on Assets* (ROA) as LHS variable. The ROE is simply the ROA multiplied by the accounting leverage ratio *Total assets over equity*. In these models, we should not expect a negative accounting effect with the ROA and drop the variable *Equity accounting effect*. For the sake of brevity, we only report the baseline model in Table 7. The same results hold as before and capital measures are positive and significant in all specifications that were tested using ROE.

We also employed a *Return on Risk-ajusted Capital* (RORAC) measure. The RORAC measures the return of a project over its economic capital (i.e. the capital that could be lost in a worst case scenario). We measure economic capital of the bank as 8% of Basel I RWA. This follows from the fact that banks hold capital to absorb unexpected losses. Thus, our measure of return is $Net\ Profit/8\%\ of\ RWA$.

[15] These results are available upon request from the authors.

[16] In addition, when we remove all explanatory variables, the positive relationship between ROE and capitalization measure remains.

Table 7 also reports the results of the regression with RORAC as a dependent variable and a one-year lag in capital ratios measures. Because RORAC is adjusted for the risk, we do not include anymore the variable *Risk portfolio*. We also exclude from the model the variable *Equity accounting effect* as RORAC does not suffer from an adverse accounting effect. All capital ratios measures are significantly positive.

In unreported results, we consider the one-year lag growth of equity instead of the dummy variable to capture the *Equity accounting effect*. The results remain qualitatively unchanged for all specifications tested in the paper for our capitalization measures.

We also test for potential nonlinear effects for measures of capitalization, *Asset diversification* and *Loan share*. To do so, we include in separate specifications the square term of each variables. We do not find any evidence of a nonlinear effect on ROE.

To take into account of the difference in market power between banks, we alternatively include the deposit share of the bank according to the total deposits in the banking system for a given year and the total assets share of the bank according to the total assets of the banking system in a given year. Banks with higher market power should be able to attract more deposits or increase their assets size (e.g. Berger, 1995). Our main results are robust but the measures of market power are not significant.

7. Conclusion

This paper brings new evidence of the effect of bank capitalization on performance. We contribute to the debate on the effect of capital requirements where no consensus emerges from previous literature. We find an unambiguous support of a positive effect of an increase in capital on banks' ROE. Our economic estimates of this effect highlight a modest but significant effect of capital increase on ROE. This effect does not depend on the way banks

choose to increase their capital (specifically through raising equity). It also does not depend on the level of capital requirements constraint banks face. Capital appears to drive higher performance through the channel of higher bank efficiency. In conclusion, at current levels, capital requirements do not appear to be detrimental to banks' performance in this study. This alleviates common critics on the potential adverse effects of prudential regulation on the banking system.

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Table 1: Summary statistics

Variables	Definition	N	Mean	SD	10%	Median	90%
ROE	Net profit over balance sheet equity.	135	10.71%	5.84%	4.23%	10.82%	17.77%
ROA	Net profit over balance sheet total assets.	135	0.61%	0.47%	0.14%	0.46%	1.33%
RAROC	Net profit over 8% of risk-weighted assets (Basel I).	135	14.45%	8.34%	3.82%	13.83%	24.95%
Efficiency	Net operating income over administrative expenses	132	1.95	0.74	1.4	1.63	3,3
Capital ratio $_{t-1}$	One year lagged value of balance sheet equity over total assets.	135	5.56%	2.93%	2.68%	4.58%	10.10%
Tier1/Tangible assets $_{t-1}$	One year lagged value of Tier 1 capital minus intangible assets over total assets minus intangible assets.	135	5.00%	2.60%	2.40%	4.01%	8.96%
Tier1/TA with OBS $_{t-1}$	One year lagged value of regulatory Tier 1 over the sum of balance sheet total assets and off-balance sheet weighted credit risk exposures.	135	4.28%	2.57%	1.88%	3.17%	8.81%
Tier1 regulatory ratio $_{t-1}$	One year lagged value of regulatory Tier 1 over risk-weighted assets (Basel I).	135	9.20%	2.28%	6.86%	8.87%	11.96%
Total regulatory ratio $_{t-1}$	One year lagged value of total regulatory capital over risk-weighted assets (Basel I).	135	11.39%	2.16%	9.15%	11.18%	14.22%
Equity accounting effect $_{t-1}$	Dummy variable equal to 1 when the one year lag growth rate of balance sheet equity is positive. 0 otherwise.	135	0.83	0.38	0	1	1
Asset diversification	HH index of 4 different asset classes: cash, interbank assets, loans and other earning asset.	135	0.53	0.15	0.39	0.47	0.79
Loan share	Loans to non-financial entities over total earning assets.	135	54.06%	22.31%	28.50%	49.65%	88.37%
Safety net	Deposits over total assets.	135	22.48%	16.16%	1.39%	25.02%	39.98%
Portfolio risk	Risk-weighted assets (Basel I) over total assets.	135	51.47%	23.91%	21.01%	46.63%	90.29%
Liquidity ratio	Available liquid assets over liquid liability requirements.	135	1.95	1.75	1.18	1.41	2.99

Table 2 : Bank capital and ROE

This table reports estimates of the fixed effect regressions at the bank level of ROE on a set of independent variables over the period 1993-2012. Variable definitions appear in table 1. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. ***, ** and * denote statistical significance respectively at 1%, 5% and 10%

	(1)	(2)	(3)	(4)	(5)
Capital ratio $_{t-1}$	0.586				
	(0.464)				
T1/Tang. Assets $_{t-1}$		0.856*			
		(0.460)			
T1/TA with OBS $_{t-1}$			1.502**		
			(0.588)		
T1 reg. ratio $_{t-1}$				0.794**	
				(0.334)	
Total reg. ratio $_{t-1}$					0.540**
					(0.242)
Equity accounting effect $_{t-1}$	-0.021**	-0.021*	-0.023**	-0.024**	-0.022*
	(0.010)	(0.011)	(0.011)	(0.012)	(0.012)
Asset div.	0.260*	0.251*	0.245*	0.268**	0.262*
	(0.152)	(0.142)	(0.138)	(0.135)	(0.136)
Loan share	-0.244*	-0.257*	-0.277**	-0.309**	-0.273**
	(0.139)	(0.131)	(0.128)	(0.130)	(0.130)
Safety net	0.135	0.172	0.162	0.141	0.141
	(0.141)	(0.129)	(0.130)	(0.128)	(0.129)
Portfolio risk	-0.006	-0.026	-0.027	0.098	0.052
	(0.112)	(0.117)	(0.114)	(0.120)	(0.119)
Liquidity ratio	0.004	0.004	0.003	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Constant	0.009	0.004	0.009	-0.050	-0.047
	(0.057)	(0.056)	(0.055)	(0.056)	(0.057)
Year effects	Yes	Yes	Yes	Yes	Yes
Observations	135	135	135	135	135
N. of banks	17	17	17	17	17
Adj. R^2 (%)	45.54	46.11	47.11	47.11	46.83

Table 3: Bank capital one-year and two-year lags included

This table reports estimates of the fixed effect regressions at the bank level of ROE on a set of independent variables over the period 1993-2012. Variable definitions appear in table 1. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. ***, ** and * denote statistical significance respectively at 1%, 5% and 10%

	(1)	(2)	(3)	(4)	(5)
Capital ratio $_{t-1}$	-0.510				
	(0.896)				
Capital ratio $_{t-2}$	1.525*				
	(0.905)				
T1/Tang. Assets $_{t-1}$		-0.352			
		(0.888)			
T1/Tang. Assets $_{t-2}$		1.654*			
		(0.911)			
T1/TA with OBS $_{t-1}$			-0.076		
			(0.977)		
T1/TA with OBS $_{t-2}$			2.262**		
			(1.031)		
T1 reg. ratio $_{t-1}$				0.276	
				(0.502)	
T1 reg. ratio $_{t-2}$				0.694	
				(0.535)	
Total reg. ratio $_{t-1}$					0.388
					(0.407)
Total reg. ratio $_{t-2}$					0.184
					(0.408)
Sum of lag coefficients	1.015**	1.302***	2.186***	0.970**	0.572**
	(0.455)	(0.486)	(0.628)	(0.372)	(0.256)
Test for all lags=0	3.12**	4.12**	6.48***	3.42**	2.54*
p-value	0.049	0.019	0.002	0.037	0.085
Equity accounting effect $_{t-1}$	-0.016	-0.018	-0.020*	-0.023*	-0.021*
	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)
Asset div.	0.193	0.188	0.161	0.255*	0.260*
	(0.139)	(0.130)	(0.132)	(0.134)	(0.140)
Loan share	-0.210	-0.250*	-0.274**	-0.329**	-0.279**
	(0.133)	(0.128)	(0.125)	(0.135)	(0.130)
Safety net	0.102	0.105	0.083	0.104	0.132
	(0.135)	(0.124)	(0.129)	(0.131)	(0.139)
Portfolio risk	-0.049	-0.025	-0.028	0.122	0.056
	(0.116)	(0.115)	(0.112)	(0.123)	(0.123)
Liquidity ratio	0.003	0.002	0.001	0.003	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Constant	0.041	0.031	0.049	-0.045	-0.045
	(0.056)	(0.055)	(0.058)	(0.058)	(0.058)
Year effects	Yes	Yes	Yes	Yes	Yes
Observations	135	135	135	135	135
N. of banks	17	17	17	17	17
Adj. R^2 (%)	46.54	46.98	48.56	47.55	46.26

Table 4: Bank capitalization interacted with growth of paid-up capital variables

This table reports estimates of the fixed effect regressions at the bank level of ROE on a set of independent variables over the period 1993-2012. *Growth of paid-up capital* is a dummy equal to 1 when growth of paid-up capital is positive and 0 otherwise. Other variable definitions appear in table 1. Models (1) to (5) include the variable *Growth of paid-up capital*. Models (6) to (10) include the variable *Growth of paid-up capital dummy*. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. ***, ** and * denote statistical significance respectively at 1%, 5% and 10%

	(1)	(2)	(3)	(4)	(5)
Capital ratio $_{t-1}$	0.555				
	(0.459)				
Capital ratio $_{t-1}$×Growth of paid-up capital $_{t-1}$	-0.410				
	(0.293)				
T1/Tang. Assets $_{t-1}$		0.818*			
		(0.449)			
T1/Tang. Assets $_{t-1}$×Growth of paid-up capital $_{t-1}$		-0.258			
		(0.294)			
T1/TA with OBS $_{t-1}$			1.375**		
			(0.586)		
T1/TA with OBS $_{t-1}$×Growth of paid-up capital $_{t-1}$			-0.172		
			(0.292)		
T1 reg. ratio $_{t-1}$				0.490*	
				(0.297)	
T1 reg. ratio $_{t-1}$×Growth of paid-up capital $_{t-1}$				0.347	
				(0.253)	
Total reg. ratio $_{t-1}$					0.464
					(0.327)
Total reg. ratio $_{t-1}$ × Growth of paid-up capital $_{t-1}$					0.031
					(0.366)
Growth of paid-up capital dummy $_{t-1}$	0.035	0.025	0.020	-0.018	0.010
	(0.021)	(0.019)	(0.017)	(0.023)	(0.045)
Equity accounting effect $_{t-1}$	-0.021**	-0.021*	-0.022**	-0.023*	-0.020*
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)
Asset div.	0.254*	0.244*	0.241*	0.261**	0.258*
	(0.144)	(0.136)	(0.134)	(0.130)	(0.131)
Loan share	-0.247*	-0.259**	-0.276**	-0.325**	-0.277**
	(0.138)	(0.130)	(0.127)	(0.138)	(0.136)
Safety net	0.135	0.164	0.160	0.153	0.146
	(0.140)	(0.127)	(0.128)	(0.131)	(0.127)
Portfolio risk	0.008	-0.020	-0.023	0.099	0.045
	(0.111)	(0.115)	(0.112)	(0.120)	(0.126)
Liquidity ratio	0.003	0.003	0.003	0.004	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	-0.010	-0.004	0.002	-0.032	-0.046
	(0.060)	(0.056)	(0.056)	(0.052)	(0.062)
Year effects	Yes	Yes	Yes	Yes	Yes
Observations	135	135	135	135	135
N. of banks	17	17	17	17	17
Adj. R^2 (%)	46.25	46.25	46.98	47.27	46.69

Table 5: Bank capitalization and capital requirement constraint

This table reports estimates of the fixed effect regressions at the bank level of ROE on a set of independent variables over the period 1993-2012. *CR constraint* is a dummy equal to 1 when bank regulatory capital buffer is under the sample median and 0 otherwise. Other variable definitions appear in table 1. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. ***, ** and * denote statistical significance respectively at 1%, 5% and 10%

	(1)	(2)	(3)	(4)	(5)
Capital ratio $_{t-1}$	0.941**				
	(0.462)				
Capital ratio $_{t-1}$ × CR constraint $_{t-1}$	-0.377				
	(0.382)				
T1/Tang. Assets $_{t-1}$		1.352**			
		(0.519)			
T1/Tang. Assets $_{t-1}$ × CR constraint $_{t-1}$		-0.205			
		(0.431)			
T1/TA with OBS $_{t-1}$			2.153***		
			(0.693)		
T1/TA with OBS $_{t-1}$ × CR constraint $_{t-1}$			-0.206		
			(0.385)		
T1 reg. ratio $_{t-1}$				1.134***	
				(0.427)	
T1 reg. ratio $_{t-1}$ × CR constraint $_{t-1}$				-0.112	
				(0.576)	
Total reg. ratio $_{t-1}$					0.747**
					(0.320)
Total reg. ratio $_{t-1}$ × CR constraint $_{t-1}$					0.022
					(0.642)
Equity accounting effect $_{t-1}$	-0.026**	-0.027**	-0.029**	-0.031**	-0.027**
	(0.011)	(0.012)	(0.013)	(0.014)	(0.013)
CR constraint $_{t-1}$	0.044*	0.039	0.039*	0.040	0.027
	(0.026)	(0.026)	(0.022)	(0.049)	(0.069)
Asset div.	0.242	0.240*	0.237*	0.285**	0.273*
	(0.149)	(0.139)	(0.138)	(0.135)	(0.138)
Loan share	-0.262*	-0.295**	-0.326**	-0.374***	-0.321**
	(0.139)	(0.135)	(0.135)	(0.142)	(0.138)
Safety net	0.091	0.161	0.146	0.136	0.135
	(0.132)	(0.124)	(0.128)	(0.126)	(0.131)
Portfolio risk	0.007	-0.030	-0.023	0.145	0.080
	(0.107)	(0.110)	(0.107)	(0.116)	(0.114)
Liquidity ratio	0.003	0.003	0.002	0.002	0.002
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Constant	-0.005	-0.011	-0.008	-0.097	-0.086
	(0.056)	(0.053)	(0.052)	(0.066)	(0.075)
Year effects	Yes	Yes	Yes	Yes	Yes
Observations	135	135	135	135	135
N. of banks	17	17	17	17	17
Adj. R^2 (%)	63.3	63.8	64.7	64.7	64.3

Table 6: Efficiency and bank capital

This table reports estimates of the fixed effect regressions at the bank level of the ratio of net operating income over administrative expenses on bank capital and a set of independent variables over the period 1993-2012. Variable definitions appear in table 1. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. *** denotes statistical significance respectively at 1%

	(1)	(2)	(3)	(4)	(5)
Capital ratio $_{t-1}$	11.854***				
	(2.523)				
T1/Tang. Assets $_{t-1}$		12.607***			
		(2.854)			
T1/TA with OBS $_{t-1}$			19.575***		
			(3.330)		
T1 reg. ratio $_{t-1}$				8.819***	
				(1.664)	
Total reg. ratio $_{t-1}$					5.192***
					(1.267)
Asset div.	0.186	0.233	0.224	0.605	0.577
	(0.820)	(0.763)	(0.742)	(0.751)	(0.767)
Loan share	1.292	0.971	0.706	0.358	0.752
	(0.891)	(0.904)	(0.856)	(0.861)	(0.950)
Safety net	-1.096	-0.421	-0.516	-0.786	-0.802
	(0.751)	(0.737)	(0.715)	(0.744)	(0.826)
Portfolio risk	-0.592	-0.620	-0.555	0.957	0.482
	(0.760)	(0.826)	(0.808)	(0.795)	(0.861)
Liquidity ratio	-0.008	-0.009	-0.011	-0.015	-0.013
	(0.028)	(0.028)	(0.026)	(0.031)	(0.032)
Constant	1.128***	0.952**	0.972***	0.274	0.377
	(0.381)	(0.384)	(0.368)	(0.403)	(0.436)
Year effects	Yes	Yes	Yes	Yes	Yes
Observations	132	132	132	132	132
N. of banks	17	17	17	17	17
Adj. R^2 (%)	90.26	89.86	90.64	90.07	89.23

Table 7: Bank capital, ROA and RORAC

This table reports estimates of the fixed effect regressions at the bank level of ROA and RORAC on a set of independent variables over the period 1993-2012. Variable definitions appear in table 1. Hubert/White heteroscedasticity robust standard-errors are reported into brackets. ***, ** and * denote statistical significance respectively at 1%, 5% and 10%

	ROA					RORAC				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Capital ratio $_{t-1}$	0.096***					1.647**				
	(0.023)					(0.683)				
T1/Tang. Assets $_{t-1}$		0.095***					1.802***			
		(0.029)					(0.624)			
T1/TA with OBS $_{t-1}$			0.152***					2.831***		
			(0.035)					(0.784)		
T1 reg. ratio $_{t-1}$				0.068***					1.462***	
				(0.016)					(0.391)	
Total reg. ratio $_{t-1}$					0.041***					0.765**
					(0.012)					(0.330)
Asset div.	0.007	0.008	0.008	0.010**	0.010*	0.363*	0.371*	0.367*	0.353*	0.376**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.215)	(0.200)	(0.196)	(0.185)	(0.188)
Loan share	-0.007	-0.009*	-0.012**	-0.014**	-0.011*	-0.398**	-0.448**	-0.482***	-0.397**	-0.381**
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.178)	(0.171)	(0.170)	(0.167)	(0.174)
Safety net	0.001	0.006	0.005	0.003	0.003	0.151	0.240	0.228	0.282*	0.250
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.187)	(0.162)	(0.159)	(0.147)	(0.160)
Portfolio risk	0.002	0.002	0.002	0.014**	0.010*					
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)					
Liquidity ratio	0.000	-0.000	-0.000	-0.000	-0.000	0.004	0.004	0.003	0.001	0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Constant	-0.003	-0.004	-0.004	-0.010***	-0.009**	-0.059	-0.084	-0.079	-0.122*	-0.122*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.071)	(0.067)	(0.068)	(0.070)	(0.072)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	135	135	135	135	135	135	135	135	135	135
N. of banks	17	17	17	17	17	17	17	17	17	17
Adj. R^2 (%)	78.14	77.01	78.28	77.43	76.30	52.82	52.40	53.66	53.52	51.00