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Optimal Capital, Regulatory Requirements and Bank Performance in times of crisis: Evidence from France[1]

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Abstract: The recent implementation of the Basel III framework has re-ignited the debate around the link between capital, performance and capital requirements in the banking sector. There is a dominant view in the earlier empirical literature in favor of a positive effect of capital on banking performance. Using panel data gathered for the supervision of French banks, we also find evidence of the beneficial effect of higher capital, but try to go one step further by distinguishing between regulatory and voluntary capital. Using a two-step estimation procedure, taking advantage of the variability of data since the crisis, and controlling for many factors (risk, asset composition, etc), we show that voluntary capital, i.e. capital held by banks irrespective of their regulatory requirements, turns out to be the sole component of capital that positively affects performance, as measured by the return on asset (ROA). In contrast, the effect of regulatory capital on the ROA appears insignificant, indicating that over the 2007-2014 period increasing capital requirements have not been detrimental to banking performance in France.

Keywords: Bank capital; Performance; ROA, Capital requirements; Financial crisis

JEL Classification: G01; G21; G28; G32

Capital Optimal, exigences réglementaires et performances bancaires en période de crise : l'exemple de la France

Résumé : La mise en place récente de Bâle III a relancé le débat sur le lien entre capital, performance et exigences en capital dans le secteur bancaire. Il existe une opinion dominante dans la littérature académique disponible indiquant un effet positif du capital sur la profitabilité bancaire. En utilisant des données de panel assemblées dans le cadre de la supervision des banques françaises nous mettons aussi en évidence cet effet positif d'un niveau plus élevé du capital, mais nous cherchons à aller plus loin en distinguant entre le capital « règlementaire » et le capital « volontaire ». Sur la base d'une estimation en deux étapes, en tirant partie de la variabilité des données depuis la crise et en contrôlant par plusieurs facteurs (niveau de risque, composition du capital), nous montrons que le capital volontaire, c'est-à-dire la capital détenu par une banque indépendamment des exigences règlementaires, apparaît comme la seule composante qui a un effet positif sur la performance, mesurée par le rendement des actifs (ROA). En sens inverse, le capital réglementaire ne semble pas avoir d'effet significatif sur la profitabilité, indiquant qu'au moins jusqu'à présent la hausse du capital règlementaire n'a pas eu d'effet négatif sur la performance bancaire.

Keywords: capital bancaire, performance, ROA, exigences en capital, crise financière

JEL Classification: G01; G21; G28; G32

Non-technical summary

Research question

Basel III has reignited the debate on the effect of capital requirements on banks' profitability. On the one hand, most practioners and some academics argue that higher capital requirements impede banks' profitability due to the fact that capital is more costly than other bank liabilities. On the other hand, other academics refute the detrimental effect of capital on banks' performance arguing that more capital has no significant impact on banks' average cost of financing and provide better incentives for banks' investment decisions (Holmstrom and Tirole, 1997; Mehran and Thakor, 2011). A dominant view in the empirical literature indeed finds a positive effect of capital ratios on banks' profitability. This paper goes one step further in the debate by distinguishing increases in capital that are voluntarily decided by banks from increases in capital that are the consequences of the Basel regulation. It is important to understand whether the positive effect of capital on banks' profitability documented in the empirical literature comes from banks' own decisions or is the effect of banking regulation.

Contribution

Our study is the first to disentangle the effect of capital increases that are voluntarily decided by banks from the effect of capital increases triggered by banking regulation. Distinguishing the effect of regulation from banks' business decisions is essential to contribute to the debate on Basel III. The analysis concentrates on France over the 2007-2014 period.

Results

We confirm empirically that banks increasing capital benefited, relatively to others, from a positive effect on profitability, as measured by the return on assets (ROA), and controlling from various factors (risk, business model, economic cycle, etc). However, only voluntarily capital increases produced this positive impact. We interpret this result as situations were banks were temporarily below their optimal level of capital, and facing favorable investment opportunities, increase their profitability by increasing their capital ratio towards their optimal target. On the other hand, we do not detect that, over the period, increases in capital ratios due to the regulation had any significant effect on banks' performance, either positive or negative.

Résumé non technique

Problématique

Bâle III a relancé le débat sur les effets des exigences réglementaires en capital sur la profitabilité des banques. D'un côté, la plupart des professionnels et certains universitaires arguent du fait que des exigences réglementaires en capital plus élevées entravent la profitabilité des banques du fait que le capital est plus coûteux que les autres passifs bancaires. D'un autre côté, d'autres universitaires réfutent l'effet préjudiciable du capital sur la performance des banques en arguant du fait que plus de capital n'a pas d'effet significatif sur le coût moyen de financement des banques et donne de meilleurs incitations pour les décisions d'investissement des banques (Holmstrom et Tirole, 1997; Mehran et Thakor, 2011). L'opinion prépondérante dans la littérature empirique trouve effectivement un effet positif des ratios de capital sur la profitabilité des banques. Ce document va plus loin dans le débat en distinguant les augmentations de capital qui sont volontairement décidées par les banques des augmentations de capital qui sont la conséquence de la réglementation bâloise. Il est important de comprendre si les effets positifs du capital sur la profitabilité des banques documentés dans la littérature empirique proviennent des décisions propres des banques ou bien sont la conséquence de la réglementation bancaire.

Contribution

Notre étude est la première á différencier les effets des augmentations de capital qui sont volontairement décidées par les banques des effets des augmentations de capital provoquées par la réglementation bancaire. Distinguer les effets de la réglementation des décisions financières des banques est essentiel pour contribuer au débat sur Bâle III. L'analyse se concentre en France sur la période 2007-2014.

Résultats

Nous confirmons empiriquement que les banques augmentant leur capital bénéficient, relativement aux autres établissements, d'un effet positif sur leur profitabilité, telle que mesurée par le taux de rendement sur actifs (ROA en anglais), et en contrôlant pour différents facteurs (le risque, le modèle économique, le cycle économique, etc). Cependant, seules les augmentations de capital volontaires produisent cet effet positif. Nous interprétons ce résultat comme des situations où les banques se retrouvent temporairement en dessous de leur niveau de capital optimal, et faisant face à des opportunités d'investissement, améliorent leur profitabilité par l'augmentation de leur ratio de capital vers leur niveau cible optimal. Symétriquement, nous ne trouvons pas, sur la période, que les augmentations de capital dues à la réglementation ont eu un impact significatif sur la performance des banques, qu'il soit positif ou négatif.

Introduction

After the great financial crisis, which witnessed many highly leveraged financial institutions failing and being bailed-out with public money, strengthening bank capital has become a major focus of banking regulation. According to Bank of England governor, M. Carney, "only well-capitalized 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,b). Based on this idea, the new Basel III Accords notably include an enhanced framework in terms of capital requirements for banks. The reform also leads to an increase in capital quality by requiring higher levels of common equity. It also requires a minimum leverage ratio as backstop taking into account banks' total assets and off balance sheet items.

The question of whether such requirements are harmful to bank performance, or to put it differently, of the relationship between capital and performance, has naturally resurfaced. Under the hypothesis of perfect markets, the seminal Modigliani and Miller (1958) framework concludes to the irrelevance, in terms of bank value, of capital structure decisions. The assumption of frictionless financial markets seeming unrealistic however, economists have tried to draw the implications of the introduction into the model of market imperfections like asymmetric information or tax shields, and test for it. The underlying idea is that capital is not neutral; rather there exists an optimal capital ratio, from the perspective of the banking firm, in the sense that there is a level of own funds which maximizes bank value. At the optimum, the net marginal effect of capital on bank performance should be zero for banks, balancing exactly the marginal cost of holding one more unit of capital with its marginal benefit (Berger et al., 1995). Two important properties of this optimum are that it is both bank-specific, as argued by Mehran and Thakor (2011), and time-varying. It is for instance likely to rise during periods of financial distress because of the increased probability of default. Since banks cannot adjust instantaneously their capital, they will lag behing their optimal ratio and therefore experience a positive relationship between capital and performance at the margin until they catch up with the long term target. Consistently with this prediction, Berger (1995) and later Osborne et al. (2012) as well as Berger and Bouwman (2013), find evidence of a positive association between capital and profitability during crises.

Regulation is an other crucial element in the picture (Goddart et al., 2011), and in particular capital requirements imposed by the regulator. These could be detrimental to bank performance if they turn out to be binding, that is to say if they are set above banks' optimal capital as determined by market forces (Berger et al., 1995; Barrios and Blanco, 2003). In this case, the excess capital implies a negative marginal effect on performance. Disentangling the effect of regulatory minima and market mechanisms on the level of capital and on bank performance is empirically challenging though. It requires getting a precise sense of the constraint exerted by regulation, a feature that some studies have tried to approximate using capital buffers (see Gropp and Heider, 2010). An issue with this approach is that holding a buffer above the regulatory minimum does not imply that the latter is not binding. Some papers indeed demonstrate that banks optimally hold a buffer above their regulatory requirements to avoid the high costs of regulatory intervention as long as there is a positive probability of falling below the threshold due to unexpected shocks (Estrella, 2004; Barrios and Blanco, 2003; Heid, 2007)). To assess the effectiveness of the constraint, one must therefore go further than just looking at the relative levels of actual and regulatory capital and take into consideration their co-movements (Francis and Osborne, 2012).

Using confidential supervisory data on French banking system, our study investigates how the relative effect on performance of the three dimensions of capital - actual, optimal and regulatory capital - and how they interacted during a peculiar time span in recent history, namely the 2008 global financial crisis and beyond. Using profitability as a proxy for performance, we first check whether the above prediction about the direction of the effect of capital on performance in times of financial distress is correct. We verify the hypothesis that banks have been lagging behind their optimal capital ratio during the period 2007-2014. We then use data on individual bank requirements to isolate the effect on bank performance of two new regulatory frameworks: Basel II, which entered into force in 2008 with the European directive called CRD3, and Basel III which has been implemented through the CRD4 with a progressive phase-in from January 2014. To that end, we proceed in two steps: we first separate capital ratios in two orthogonal components, the one that is correlated with capital requirements which reflects the adjustments made by banks in response to the new regulatory minimum, and the one that is orthogonal to it and captures variations in capital independently of regulatory requirements. Using this decomposition, we find evidence that the positive causality between capital and performance only survives when considering "voluntary" capital, i.e. capital whose movements are uncorrelated to requirements, confirming once again that banks tended to be undercapitalized during the crisis. However, we do not find evidence of a significant influence of regulatory minimum on performance. Finally, in some additional estimations, we investigate the potential deleveraging effects which could go with the positive effect of capital on performance. We find evidence of deleveraging effects concomitant to increases in capital and show that these appear strongest for compulsory increases induced by regulation.

This paper contributes to the literature in several ways. First, we use a novel database assembled by the Autorité de Contrôle Prudentiel et de Résolution (ACPR), the French Prudential Supervisory Authority, on the basis of confidential accounting and prudential data on French banking groups. A unique feature of this data set is that it comprises information on individual capital requirements under different regulatory regimes, namely Basel I, Basel II and Basel III. This makes it possible to identify precisely the regulatory shock that banks faced after the implementation of Basel II agreements in France. This is a key component of our estimation strategy and this had, to our knowledge, never been used before in the literature. Second, our method makes it possible to evaluate separately the effects of market and regulatory constraints on bank capital so that we are able to assess more accurately the predictions of the theory introduced above. Namely, our empirical strategy gives precise insights about the behavior of actual and optimal capital ratios during the financial crisis as well as about their interaction with capital requirements. Finally, we provide a unified theoretical framework to think about the relationship between capital, bank performance and banking regulation which enables us to formulate testable implications about the mechanisms at stake.

The rest of the paper is organized as follows. Section 1 gives an overview of the literature surrounding the relationship between capital and performance. Section 2 presents our empirical strategy. Section 3 describes the data we use and gives some summary statistics. Section 4 presents our results and section 5 performs some complementary investigations.

1 Literature review

There exists an extensive literature studying the effects of capital on banks' cash flows. Departing from Modigliani and Miller (1958) (hereafter M & M) which asserts that capital should be neutral to performance, researchers have assessed the consequences of the relaxation of the assumption of perfect financial markets (Berger et al., 1995). Several theories have emerged based on the introduction of some market imperfections into the M & M frictionless world.

Some papers have underlined the potentially adverse effects on performance from more capital holding by banks. There are three main strands of explanations to why more capital - or symmetrically, less debt - would be detrimental to cash flows. First, there is a large literature in corporate finance emphasizing the disciplinary role of debt (e.g. Hart and Moore, 1995). Managers may seek to ease market discipline by building an equity cushion. Debt also has an informational advantage over capital due to the existence of information asymmetries. Since managers likely have private information on the evolution of the firm's profits or on future investment opportunities, issuing debt might be a way to signal financial soundness to financial markets (Leland and Pyle, 1977). Banks may also reduce liquidity creation when capital is too high (Diamond and Rajan, 2001). All these factors contribute to creating marginal costs to holding more capital.

A competing view underlines however the likely benefits of capital. There are two main channels based on moral hazard between shareholders and debtholders. The first effect comes from the limited liability enjoyed by shareholders: losses are floored but potential gains increase with risk-taking. This creates incentives to take excessive risks at the expense of other stakeholders. Debtholders anticipate this behavior and the potential bankruptcy costs that ensue, and typically require a premium to finance banks which is inversely related to capital holding. Thus, increasing capital may reduce the premium and increase cash flows (Calomiris and Kahn, 1991). The second channel is based on monitoring efforts exerted by the bank. More capital internalizes the potential losses coming from a lack of monitoring. A bank therefore has stronger incentives to monitor when its capital ratio increases. Through this mechanism, the capital structure has a positive effect on asset cash-flows because monitoring affects the payoff from the bank's loans portfolio (Holmstrom and Tirole, 1997; Mehran and Thakor, 2011). In sum, capital has marginal benefits to be taken into account when deciding where to set the level of own funds.

As argued by Kraus and Litzenberger (1973), proponents of what Frank and Goyal (2009) call the "trade-off theory", marginal costs and benefits cause the relationship between capital and performance to be non-monotonic. Banks thus face a trade-off when choosing their capital level. Economically, they should raise their capital ratio as long as the benefits of doing so outweight the costs. This goes on until the point where marginal costs and benefits exactly offset each other. This point is the optimal capital ratio - in the sense of value-maximzing. It follows that capital surpluses with respect to this optimum should have a negative marginal effect on performance, whereas deficits should translate into positive relationship at the margin. In addition, the efficient point depends on both the internal characteristics of the bank (e.g. its business model, its size, etc.) and on market structure (e.g. competition, transparency, etc.) as argued by Mehran and Thakor (2011). It is also likely to vary through time: expected bankruptcy costs are for instance typically rising in times of crisis, leading to an increase in optimal capital ratios as well. Relying upon this idea of idiosyncratic optimum, Osborne et al. (2012) estimate the "target ratio" explicitely for each bank-period observation via a partial adjustment model, where banks fail to optimize their funding mix perfectly due to market frictions. Consistently with the theory, they analyze deviations from the target, and find evidence of a restoring force that drives banks back to their optimum.

The unconstrained optimization problem is only one piece of the picture though. Indeed, on top of their own corporate decisions as described above, banks must also comply with regulatory requirements. A significant fraction of them consist of minimal capital ratios that banks must satisfy at all time. This relies upon social preferences: regulation constrains the market outcome by potentially maintaining banks above their optimal capital ratio ; but in times of crisis, when banks fall short of their rising optimal capital ratio, it acts to maintain them closer to it than they would have been otherwise. This works like a public insurance against banks default: the economy pays a sunk cost in good times (e.g. through reduced credit or liquidity) to ensure financial stability through the cycle and over the crises (Admati et al., 2013). The presence of regulatory requirements is thus likely to affect the relationship between capital and performance: if they are binding, i.e. if they maintain banks above their optimum, then one should observe a negative marginal effect of capital on performance. Gropp and Heider (2010) try to differentiate banks using capital buffers as a proxy for the regulatory constraint. As argued above, we believe this gives only a rough estimate of the constraint exerted on banks so that we introduce a novel way to assess it thanks to unique supervisory data.

2 Empirical strategy

Turning to our empirical strategy, we decompose the effect of capital on performance using a two-step procedure, first regressing capital ratio on a measure of the regulatory constraint exerted on the bank. We then use these two orthogonal components, namely the fitted values and the residuals in a second step regression with banking performance as the dependent variable.

2.1 First-stage regressions: how do capital ratios respond to capital requirements?

The first part of our empirical analysis consists in regressing capital on a measure of capital requirements (denoted *REQ* and described later in this subsection) including bank fixed effects. In the remainder of the paper, the capital ratio refers to the *accounting* capital and is computed as the ratio of total accounting capital over total assets. We choose this measure for it yields the least time-varying definition of the capital owned by a bank.

$$CAP_{i,t} = \alpha + \beta.REQ_{i,t} + \eta_i + \nu_{i,t} \tag{1}$$

Equation (1) yields two orthogonal components of the capital ratio: the fitted values which are, by definition, the part of capital which is predicted by regulatory requirements and the residuals which are individual deviations from this benchmark and can be interpreted as market requirements (Berger, 1995), i.e. capital held voluntarily by banks. To estimate (1), we use alternatively the first difference estimator or the within estimator to ensure that we do not capture differences in level between banks.

In this model, capital requirements are measured by the *REQ* variable. To build this variable, we exploit as a source of identification the major regulatory changes that occurred in the 2007-2014 time span, namely the successive implementations of Basel II, Basel 2.5 and Basel III frameworks. One of the main differences of these frameworks with respect to Basel I lies in the way Risk Weighted Assets (RWAs), the variable used to compute capital requirements, are determined. Under Basel I, uniform weights set by the regulator are applied within asset classes whereas since Basel II the quality of the borrower is taken into account as well via the use of credit ratings. These are either provided by rating agencies for banks under the so-called "standard" approach or calculated by banks themselves for those which opted for the "Internal Rating Based" (IRB) approach. This new feature gives rise to significant differences between Basel I and post-Basel II (Basel II hereafter) capital requirements, calculated as a fixed proportion of RWA. Taking Basel I as a base case assimilated by banks for a long time (it came into force in 1993, i.e. 15 years before the introduction of Basel II), we can interpret these differences as the part of requirements which will effectively impact banks' behavior.

To capture this effect, we define *REQ* as the difference in RWAs between Basel I and Basel II (and beyond) calculation methods at a sgiven date[1] expressed as a percentage of total assets:[2]

$$REQ_{i,t} = \frac{RWA_{i,t}^{\text{Basel II}} - RWA_{i,t}^{\text{Basel I}}}{\text{Total assets}} \tag{2}$$

[1]Consistently with our identification strategy, we set $REQ = 0$ for year 2007 because Basel II had not been implemented yet.

[2]Basel II RWAs are available in our database for all banks from 2008 onwards. Basel I RWAs are available for all banks in 2007, but, as from 2008, they are only available for banks adopting Internal Rating Based approach. To compute RWAs for all banks, we use additional accounting data. More precisely, we regress Basel I RWAs for the period 1993-2014 on five key balancesheet items (market activities, interbank assets, loans, fixed assets and other assets) along with size and business model as explanatory variables. We use the linear projection and use it as our measure of Basel I RWAs for all banks after 2008.

Let us take the example of a bank for which REQ turns out to be negative. Then it experienced a relaxation of the constraint exerted by the supervisor, namely a drop in its capital requirements. We expect this bank to either lower its capital ratio, if the capital constraint was binding, or to keep it unchanged, if it was not. This buys us two things: first, we expect β to be positive in (1) (hypothesis 1 below); second, the part of capital which is uncorrelated with REQ is not determined by any regulatory requirement but rather by market pressure. That is why we call the first component *regulatory* capital and the second one *voluntary* capital. These two components constitute the core of our strategy, because we expect them to affect performance differently.

Hypothesis 1. $\beta \geq 0$

2.2 Second-stage regressions: how do capital ratios affect performance?

2.2.1 Total capital ratio

We first investigate the the relationship between total capital ratio and performance, before turning to the two components we got thanks to the above regression procedure. In the remainder of the paper, performance is approximated by profitability, and more precisely by the Return on Assets (RoA). This indicator is a widely used proxy in the literature (Naceur and Kandil, 2009; Kok et al., 2015; Osborne et al., 2012). In comparison to Return on Equity (RoE), which is admittedly a more common indicator of financial performance for investors (e.g. Goddart et al., 2004, 2011), RoA has the big advantage of being adjusted for leverage (in the accounting sense). This seems a desirable feature in our setting, for such accounting effects would certainly affect our measure of the underlying economic relationships (ECB, 2010). In particular, the mechanical negative effect of holding more equity on RoE could - and in practice does - mitigate potential positive effects stemming from economic mechanisms.

We regress banks' ROA on their capital ratio (denoted as CAP), controlling for a broad set of idiosyncratic factors described hereafter as well as for macroeconomic shocks via the inclusion of a measure of the output gap for France:[3]

$$ROA_{i,t} = \alpha_0 + \beta_0.CAP_{i,t} + X_{i,t}\gamma_0 + \eta_{0,i} + \delta_0 GAP_t + \epsilon_{0,i,t} \tag{3}$$

where i denotes banks and t indexes time; β_0 is the coefficient of interest; η and GAP represent, respectively, bank fixed effects and the current output gap; ϵ is an idiosyncratic error term assumed to be i.i.d and normally distributed. $\boldsymbol{X}$ is a vector of control variables which includes:

- **Size**: the natural logarithm of total assets. This variable is meant to capture the potential differential effect of capital on larger banks stemming, for instance, from their ability to

[3] We use quarterly data on the output gap, as produced by the Forecasting Directorate of the Banque de France, expressed as a percentage of GDP.

use their size to diversify risks away more efficiently, to access capital market more easily (Schrieves and Dahl, 1992) or to gain from market power for which size is a proxy (Naceur and Kandil, 2009). Berger and Bouwman (2013) even make separate regressions depending on bank size to capture these effects;

- **Loan share**: the volume of loan claims on non-financial counterparts over earning assets. This variable controls for the nature of the activities of a given bank, namely whether it concentrates on lending or on market activities. Symmetrically, Berger and Bouwman (2013) rely on the trading assets share. As shown by the ECB (2010), investment banks tended to outperform traditional ones, a pattern that has been reversed after the crisis;

- **Share of deposits**: the volume of deposits over total debt. This variable is aimed at controling for the way banks are financed as well as for the implicit state guarantee granted to deposits in France since 1980. Similarly, Berger and Bouwman (2013) include the ratio of core deposits to total assets to take this effect into account. Such garantee is indeed expected to influence risk-taking (Merton, 1977; Keeley, 1990) and therefore performance;

- **Asset diversification**: the Hirshmann-Herfindal Index of four types of earning assets (cash, credit to financial institutions, credit to non-financial institutions and other earning assets) to account for the diversification in the activities of the bank. HHI is an often used proxy to measure diversification (Stiroh and Rumble, 2006; Thomas, 2002);

- **Loan risk**: individual and collective depreciations over volume of loans granted by the bank. This variable is intended to account for the credit risk endorsed by the bank. As argued by Osborne et al. (2012) and Jokipii and Milne (2011), this provides an accurate ex-post measure of the risks endorsed by the bank since this represents the amount of losses it incured.

- **Autoregressive term**: in some specifications, we also control for the past level of profitability by the inclusion in the regression model of an autoregressive term. This is common practice in the literature (e.g. Kok et al., 2015; Goddart et al., 2004) and intended to cope with the observed persistence of profits (Berger et al., 2000; Goddart et al., 2011). The inclusion of this term can be theoretically justified via a partial adjustment model, where banks fail to realize their target performance due to market frictions (see Goddart et al., 2011).

Capital may however be endogenous to performance in this specification. It could for instance be the case, as argued by the proponents of the pecking order theory (see Myers and Majluf, 1984) that in the short run more efficient banks are able to use past profits to build up more capital. Working in the opposite direction is the long run effect that more profitable banks may choose permanently lower levels of capital because they anticipate high future income on which to draw if necessary. These mechanisms are two credible channels through which performance might affect the optimal capital level of a given bank. Depending on the relative magnitude of short and long term effect, the bias they induce in our estimates may be upward or downward, respectively. This is why, in addition to the pooled OLS and fixed effects estimates, we also display the Blundell and Bond (1998) system GMM estimates which are meant to account for this type of serial endogeneity. This estimation method, widely used in financial economics where one usually lacks external instruments, consists in exploiting the panel structure of our data set by using first differences to instrument levels and levels to instrument first differences.[4]

If our guess that banks have been lagging behind their optimal capital ratios during the crisis is right, then one should observe a positive relationship at the margin between capital and performance. In our model, this translates into:

Hypothesis 2. $\beta_0 \geq 0$

2.2.2 Voluntary and regulatory capital

We now use the same framework as (3), just replacing CAP by either the predicted values $\widehat{CAP_{i,t}} = \hat{\alpha} + \hat{\beta}.REQ_{i,t}$ or the residuals $\hat{\nu}_{i,t} = CAP_{i,t} - \widehat{CAP}_{i,t}$ issued from (1):

$$ROA_{i,t} = \alpha_1 + \beta_1.\hat{\nu}_{i,t} + X_{i,t}\gamma_1 + \eta_{1,i} + \delta_1 GAP_t + \epsilon_{1,i,t} \quad (4)$$

$$ROA_{i,t} = \alpha_2 + \beta_2.\widehat{CAP}_{i,t} + X_{i,t}\gamma_2 + \eta_{2,i} + \delta_2 GAP_t + \epsilon_{2,i,t} \quad (5)$$

Equation (4) models the relationship between performance and capital held in response to voluntarily held capital, whereas (5) does the same for regulatory requirements.

Changes in voluntary capital reflect spontaneous changes in capital which should be positively associated with performance as banks rationally always move towards their optimum. Movements in regulatory capital, on the other hand, captures increases subsequent to changes in binding regulatory minima so that its effect on profitability is more ambiguous, because it depends on the actual position of the bank vis-à-vis its optimum: when banks are close to the efficient point, binding capital requirements can only maintain banks above their optimum what implies a negative relationship at the margin. Conversely, when banks experience a capital shortfall, as it is likely the case in times of crisis, binding capital requirements may act to push banks closer to their optimum and thus cause a positive marginal effect of capital on performance too. The following hypotheses summarize this discussion:

Hypothesis 3. $\beta_1 \geq 0$

Hypothesis 4. $\beta_2 \leq 0$ *or* ≥ 0

3 Data

We use a novel database gathered by the ACPR (*Autorité de Contrôle Prudentiel et de Résolution*), the French supervisor for the banking and insurance sectors, on the basis of confidential accounting and prudential data on French banking groups. Our sample covers the period 2007-2014 on a half-yearly basis. It includes all banks operating in France at the consolidated level

[4]For system GMM estimation, we use the *xtabond2* Stata command developped by David Roodman.

whose balance sheet is above 1 billion euros on average over the observation period. This represents around 25 banks per semester or 400 observations overall. Data starts in 2007 because of the implementation of IFRS accounting standards. This way, we are able to avoid shocks associated with changes in reporting standards. Besides, focusing on this peculiar time span may not be a too much of a "curse": the crisis likely induced large movements in banks' optimal capital ratios so that we expect large catch-up phenomena. Consequently, what often turns out to be a weakness in most identification stategies reinforces ours: we want to exploit the financial crisis of the post 2008 years induced by the crisis as exogenous shock that pushed banks away from their optimum.

Based on this sample, Table 1 gives some summary statistics of the variables introduced in the previous section while table 2 displays their correlation matrix. As it can be seen in the table, our sample gathers banks which are quite different both in their characteristics and their business models. Regarding size, observations range from 250 million euros to more than 2,000 billion euros of total assets, with an average balance sheet of 269 billion euros. As far as the nature of the activity is concerned, banks report on average to hold half of their assets under the form of loans to non-financial counterparts, although the standard deviation is quite high at 0.3. These loans are on average rather safe, with a median depreciation rate of less than 2%. Banks are on average quite diversified with an index of 0.5, where 0.25 would indicate perfect diversification and 1.0 full specialization. Financing is also very unequal, with an average of 44% of total debt in the form of deposits but a standard deviation of 30%.

Now turning to our variables of interest, Returns on Assets have seemingly been quite low over our observation period, with an average performance of around 0.6%. Capital ratios on the other hand are pretty high, with a median at 9% of total balance sheet. Note, however, the high heterogeneity in the sample, with some banks holding as little as 2% of capital and others as much as 27%. The change in requirements between Basel I and Basel II and beyond (REQ) is slightly positive on average but negative for the median, with significant volatility across banks, some having seen their requirements fall significantly, a phenomenon that appears to be linked in our dataset to the adoption of the IRB approach, whereas others experienced a sharp rise. In addition, Basel III later introduced an increase in capital requirements with respect to Basel II. This variability is of a great interest for us, since it strengthens the identification power of our strategy.

4 Results

We now turn to the estimations based on the data introduced in the previous section. We first show that our data confirms that capital had a positive effect on bank performance as mesured by the Return on Assets (RoA) during the crisis. We then try to decompose this effect to disentangle the potentially contradictory influences of regulatory and voluntary capital.

4.1 Total capital ratio

The estimates from the regression of banks' RoA on their capital ratios (equation (3)) are shown in Table 3.

First of all, capital is positively and significantly associated with performance under our three estimation methods, with estimated coefficients suggesting that a 1 point increase in capital would translate into a rise in the return on assets of around 10 bp. Considering that the median ROA in our sample is about 0.4%, the effect is not economically negligeable. Note that the effect remains positive and significant when adding the autoregressive term to the model, although its magnitude decreases. Besides, this result is robust to the choice of control variables, to the number of lags used as instruments in the system GMM estimation and to the calculations of standard errors, namely whether they are clustered or not.

Regarding the other variables, they globally act in the expected direction. Focusing on the first three columns we see that more risk-taking, as measured by more defaulted loans, translates into lower returns which is consistent with the ex-post vision of risk embedded in the construction of the variable. The effect of diversification is negative, a result in line with the findings of Stiroh and Rumble (2006) who argue that, contrary to popular wisdom, diversification can also be harmful to bank performance. The share of deposits seems to act against profitability in pooled OLS, which is contradictory with the safety net hypothesis, although the effect becomes insignificant when including fixed effects. Size on the other hand tends to influence performance positively, potentially revealing economies of scope or increased market power, although the effect diappears in system GMM estimates. The output gap is positively associated with performance, which is rather intuitive. Now turning to the following three columns, where we include an autoregressive term, we see that it is positive and very significant around 0.4, a result in line with Goddart et al. (2011) who find a persistence of 0.45 for French banks. However, most other explanatory variables become insignificant after the inclusion this term, most likely because they exhibit a high degree persistence over time.

Our estimations therefore support the idea of a positive association between capital and performance (hypothesis 2). More precisely, banks that increase their capital ratio more than their peers exhibit a relatively higher performance. These results are in line with the literature on this issue. Berger (1995), Goddart et al. (2011) and Kok et al. (2015) also find that capital tend to affect performance positively in times of crisis. The positive marginal effect of capital on performance confirms our first guess: on average, French banks experienced a capital shortfall with respect to their optimum during the financial crisis.

4.2 Regulatory and voluntary capital

We now present the results of our first step regression (1) of banks' capital on the mesure of regulatory constraint, REQ. Table 4 shows the output of this regression under several specifications. The first two columns show the estimates under first differences specifications, the next two columns use the within estimator. As the table shows, the coefficient before REQ is always positive and significant, varying between 0.06 and 0.09. This confirms our initial guess, discussed in hypothesis 1, that more requirements translate into more capital holding. These estimates suggest that a 1 percentage point increase in REQ could more or less translate into a 0.08 point increase in capital. These values appear consistent with the fact that capital requirements over the period correspond to roughly 8% of RWAs, the variable used in the calculation of REQ. Turning to the explanatory power of our model, we see that the R^2s are around 20% in fixed effects and 10% in first differences. This is in line with Gropp and Heider (2010) who show that capital requirements are not the primary determinants of bank's capital ratios. Still, 20% of the variance in capital is captured by this single variable which is arguably quite significant, in comparison to the R^2 obtained using similar univariate models with other determinants of bank capital identified in Gropp and Heider (2010), like loan risk (R^2=0.3% with our data) or collateral (R^2=7%). The inclusion of time dummies (columns (2) and (4)) does not affect the results, so that we are confident the results are not driven by specific time periods, like the crisis years 2008-2009. For the remainder of the analysis, we choose fixed effects specification (3) for it maximizes the number of observations and the explanatory power of our model though only using variable REQ.

We can use the output of this first step regression in our second stage by plugging the predicted values $\widehat{CAP}$ and the residuals $\hat{\epsilon}$ into the estimation of (4) and (5), which respectively investigate the effect on performance of voluntary and regulatory capital. The results are displayed in tables 5 and 6.

Let us describe the results for voluntary capital first (equation (4)). Voluntary capital gets a positive sign and is significant in all specifications. Most importantly, it is significant using system GMM. This allows us to conclude to the existence of a positive marginal effect of voluntary capital on performance. The magnitude of the effect varies between 0.13 and 0.18 in system GMM. This is in accordance with our theoretical framework and hypothesis 3. Our results suggest therefore that banks indeed moved towards a new optimum during the crisis in order to improve their performance. Note that the effect is stronger here than the ones for overall capital in table 3. This suggest that we have isolated the component of capital which has most effect on performance.

Turning to Table 6, regulatory capital gets, in equation (5), a non-significant coefficient, negative in only one specification. This suggests that regulatory minima did not constrain banks in the "wrong" way during our observation period: they do not seem to have maintained banks above their optimum for this would have implied a negative marginal effect of regulatory capital on performance. In other words, capital requirements have not been detrimental to banks' performance during the crisis. There are two potential explanations to this: either capital requirements were not binding which would indeed imply an absence of effect; or there has been a beneficial effect for some undercapitalized banks that mitigated the negative effect on others so that the average effect is non-significant. Although disentangling these two cases is empirically challenging, we favor the second explanation for our first step regression clearly suggests that banks did react to regulatory constraints.

In a nutshell, we bring a more finely-shaded and realistic argument than what currently exists in the literature on capital and performance: capital has been profitability enhancing during the crisis for banks have found themselves lagging behind their optimal capital ratios. In this peculiar context, it does not seem that regulation has undermined profitability though: rather, it may have acted to help banks catch up with their target ratio.

4.3 Capital requirements and deleveraging

So far we investigated how capital affects bank profitability, putting aside another potential channel through which bank capital may affect the economy as a whole, through intermediation activities. To measure the effectiveness of policies enforcing higher capital requirements like Basel III, it seems therefore crucial to assess the extent of the potential "deleveraging" , i.e. the reduction of total assets, that could ensue.

To that end we use the same data and methodology as above in some additional estimations, using total assets as our dependent variable. The results are displayed in table 10 for total capital ratio. As it turns out, we find evidence of a deleveraging effect; namely, we find an unambiguous significant negative effect of capital ratio on banks' total assets. The magnitude of the coefficients, which lie between -6.5 and -7.6, suggests that a 1 percentage point decrease in capital ratio translates into a 7% drop in assets.

Another interesting question that our methodology allows to adress is whether this effect differs between compulsory and voluntary increases in capital stocks. We therefore reproduce the same regression, with regulatory capital (table 11) and voluntary capital (unreported, but available upon request). The coefficient on regulatory capital appears significant and suggests a stronger deleveraging effect of increases in capital requirements, with potentially a 10% drop in assets following a 1 point rise in capital requirements. Conversely, we show that voluntary capital gets a much smaller coefficient of -5, what means that voluntary capital increases induce twice as much deleveraging effects than their regulatory counterparts. These facts, partially documented in the literature already and refined by our methodology, are key to the understanding of the economic implications of regulatory capital requirements.

5 Robustness checks

We now provide robustness checks of our results in several directions: the measurement of the regulatory constraint, risk corrected performance measures, as well as the indicator of banks' capitalisation.

5.1 Identifying the regulatory constraint

One key component of our model is the variable REQ, which is the one we use to identify the regulatory constraint exerted on banks. As discussed in section 2, this variable is built as the difference in RWA stemming from Basel I and Basel II weighting methods. So far, we have used a "continuous" version of this variable since it is computed every semester and can move even absent any regulatory change due to variations in the composition of assets. Although this feature does not affect the fact that we capture the stringency of the regulatory constraint, it could potentially cause our variable to embody some other undesirable effects, for example linked to risk taking. As a robustness check, we therefore adopt an alternative approach aimed at better isolating the effects of regulatory changes alone. To that end, we build another more exogenous version of REQ, that we call REQ^{Step}, as a step function which takes the value of REQ at the dates of regulatory change and is constant in between. There are three such dates in France, which correspond to the implementations of European directives themselves deriving from Basel accords: January 2008 for Basel II; January 2012 for Basel 2.5; January 2014 for Basel III. Although this method does not completely eliminate the problem, it greatly reduces its magnitude, so that we are confident that this provides a good measure of the regulatory constraint.

We then use REQ^{Step} the exact same way we used REQ, as a regressor in a univariate regression with capital ratio as a dependent variable. This yields very similar results to the ones in 4, with a very significant point estimate of 0.079 using the within estimator. As can be seen in table 7, the results for the second step regression also look very much like the ones of table 5. As this additional estimation suggests, it seems that our results in the second step regressions are not driven by changes in the composition of assets.

Another concern might be that banks anticipate regulatory changes so that the relevant value of REQ, the one that effectively affect banks choices, is not the contemporaneous one but future ones. We therefore reproduced our first step regression using $REQ_{i,t+1}$ instead of $REQ_{i,t}$. As it turns out, we get a positive coefficient of 0.054 significant at the 1% level, indicating that higher levels of regulatory requirements next semester are also associated with larger capital stocks today. Note that the coefficient is lower than when using current values, maybe reflecting the fact that banks do not fully anticipate future levels of capital requirements. Consistently, when using REQ_{t+2} - i.e requirements one year from now - the coefficient drops even more to 0.026 and is significant only at the 10% level. Considering further forwarded values of REQ we loose all significance, what suggests that one year maybe the maximal horizon of banks' anticipation of the regulatory constraint. Plugging the predicted values using REQ_{t+1} in our second step regressions we get very similar results to the ones obtained using current values, so that we strongly believe that the fact that we use contemporaneous values of REQ does not represent a flaw in our analysis[5].

[5]We do not report the results of these regressions here due to space constraints. They are available from the authors.

Finally, one may consider that RWAs already implement the prudential regulation and its evolution, and can therefore be viewed as a alternative indicator of regulatory pressures. We replace therefore the REQ ratio by the level of Basel II and beyond RWAs divided by total assets, and find very similar results. This indicates that our REQ indicator does not create any bias (results are also available upon request).

5.2 Measuring banks performance

In our model, we choose to approximate banks performance by profitability as measured by Return on Assets (RoA). Although we believe this indicator best suits our purpose for it embodies all the factors that contribute to banks profits, it does not account for the risk endorsed by banks, or to put it differently, for the potential variability of these profits. We do include a variable that controls for this type of effect in our regressions, since credit risk is measured by the depreciation rate, but we acknowledge that it does not control for other types of risks like market or operational risks. The ECB (2010) suggests an alternative measure to assess banks performance, namely the Risk Adjusted Return on Capital (RARoC), that embodies all the risks endorsed by the bank and provides a benchmark to compare profitability levels across entities with different risk levels.

To check whether our results are robust to this risk assessment issue, we reproduce our regressions using RARoC instead of RoA as dependant variable. The results for voluntary capital are displayed in table 8. Voluntary capital gets a significantly positive coefficient in all specifications. This confirms our previous results that banks have spontaneously been moving towards their new optimum over the period and more importantly that the subsequent profitability gains were not achieved through riskier positions. In addition, in unreported regressions available from the authors, we show that regulatory capital gets a negative coefficient in most specifications, marginally significant (P-value = 0.13) in system GMM. This is consistent with our theory that regulation may maintain banks above their idiosyncratic optimum what translates into a negative relationship between capital and performance at the margin.

5.3 Defining banks capitalization

So far we have focused on the accounting definition of capital ratio to measure the quantity of own funds of banks. As a robustness check, we now use an alternative capital ratio, CAP^{OBS} defined as Capital/(Total assets + off-balance sheet items), in our estimations. This enables us to tackle two potential issues with our empirical strategy. First, by ignoring off-balance sheet items (OBS herefafter), the accounting capital ratio may induce an omitted variable bias: more OBS activities may generating some revenues which show up in our performance measure. This could result in an upward bias in our estimates of the coefficient before CAP. Second, since Basel II standards entered into force in 2008, off-balance sheet items are converted in credit equivalents and added to RWAs when setting the level of regulatory requirements. Using CAP^{OBS} instead of CAP may therefore affect the results of our first step regression, as it affects the comovement of actual capital and capital requirements.

In what follows, OBS is proxied by financing and garantee commitments granted by banks. In our sample, this represents on average 30% of total assets so that CAP^{OBS} is worth on average 7.4% to be compared with the 8.4% average CAP. The results of our baseline, reported in Table 9, show that CAP^{OBS} gets a positive and significant coefficient of 0.120 (to be compared with 0.139 using CAP) in system GMM without autoregressive term. Although this drop might be imputed to the upward bias mentionned earlier, it does not seem to survive the inclusion of the autoregressive term (0.134 instead of 0.106 with CAP). Overall, there is therefore mixed evidence of a statistically significant bias in our estimates due to OBS items. Once again, we then proceed in two steps using CAP^{OBS} instead of CAP in our first step regression. The within estimation yields an estimated coefficient of 0.073 significant at the 1% level. This is lower than our previous estimate of 0.092 obtained with CAP, which is not surprising considering that larger amounts of OBS (so lower CAP^{OBS}) are also reflected in higher $RWA^{\text{Basel II}}$ (so higher REQ) via the conversion procedure discussed above. Plugging the predicted values and residuals in our second step regressions, whose results are not reported here due to space constraints, we get very similar results to the previous ones, namely: voluntary capital has a positive significant marginal effect on performance whereas regulatory capital is still insignificant.

Conclusion

This paper sheds new light on the way banks performance and capital interacted with regulatory requirements after the Great Financial Crisis. We first find an unambiguous positive marginal effect of capital on banks profitability. Building on a simple theoretical framework drawing from the trade off theory, we use this result to conclude that banks have been undercapitalized relative to the increased risks induced by the crisis. This then leads us to question the role of the new regulatory framework that meanwhile entered into force.

We propose a new framework to distinguish between regulatory constraints and voluntary increases in capital. Using unique reporting on French banks' capital requirements gathered by the French supervisor, which allows to measure the difference between current regulation and Basel I Risk Weighted Assets, we build a robust indicator of regulatory constraints. We develop a two-step procedure aimed at a strict identification of the effect of the regulatory constraint exerted on banks. We find evidence that banks spontaneously moved towards their new optimum over the period, so that voluntary increases in capital have a positive impact on the ROA. Conversely, our results do not support the common view that capital requirements have been detrimental to banks performance during the crisis. Rather, the figures suggest that on average, regulation has been neutral to banks performance. Our estimations do however confirm the existence of deleveraging effects, apparently much stronger when it comes to compulsory increases in capital than voluntary ones.

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Table 1: Summary statistics

Variable	Mean	Median	Std. dev.	Minimum	Maximum
Return on Asset	.006	.004	.008	-.032	.039
Capital ratio	.087	.074	.053	.018	.276
Asset diversification	.480	.422	.172	.033	.965
Loan share	.527	.474	.281	.001	.975
Share of deposits	.443	.384	.300	.000	.951
Loan risk	.019	.008	.036	.000	.261
Total assets (billion €)	269	12.0	510	0.25	2240
REQ	.005	-.016	.185	-.340	.666

Sample: Banks operating in France. Period: 2007-2014. Number of observations: 400 banks-period data points. *REQ* corresponds to the ratio of the difference in risk-weighted assets between Basel I and Basel II calculation methods over total assets. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 2: Correlation matrix

	RoA	Capital	Size	Loans	Risk	Divers.	Deposits
RoA	1						
Capital	.526	1					
Size	-.210	-.558	1				
Loans	.071	.168	.023	1			
Risk	.110	.050	.046	.336	1		
Divers.	.057	.100	-.160	.695	.206	1	
Deposits	-.131	.185	-.254	-.157	-.233	-.315	1

Sample: Banks operating in France. Period: 2007-2014. Number of observations: 400 banks-period data points. *REQ* corresponds to the ratio of the difference in risk-weighted assets between Basel I and Basel II calculation methods over total assets. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 3: Capital ratio and Return on Asset

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Capital ratio	0.101***	0.119***	0.139**	0.043**	0.089**	0.106***
	(0.019)	(0.040)	(0.057)	(0.017)	(0.037)	(0.029)
Size	0.000	0.008*	-0.002	0.000	0.007	0.001
	(0.000)	(0.004)	(0.003)	(0.000)	(0.005)	(0.001)
Loan share	-0.002	0.003	0.018	-0.000	0.004	-0.006
	(0.003)	(0.008)	(0.013)	(0.002)	(0.009)	(0.008)
Loan risk	0.011	-0.025	-0.081**	-0.005	-0.045	0.019
	(0.015)	(0.028)	(0.034)	(0.017)	(0.030)	(0.077)
Asset diversification	-0.002	0.000	-0.037**	-0.001	-0.003	-0.008
	(0.006)	(0.005)	(0.018)	(0.003)	(0.006)	(0.019)
Share of deposits	-0.007**	-0.003	-0.009	-0.003	-0.002	0.005
	(0.003)	(0.008)	(0.011)	(0.002)	(0.009)	(0.008)
Output gap	0.001***	0.001***	0.002***	0.000	0.001*	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA_{t-1}				0.553***	0.239***	0.344***
				(0.114)	(0.086)	(0.117)
Constant	-0.002	-0.132*	0.037	-0.001	-0.114	-0.017
	(0.008)	(0.070)	(0.050)	(0.005)	(0.081)	(0.023)
Adjusted R^2	0.39			0.57		
Within R^2		0.20			0.25	
P-value AR(2)			0.56			0.60
P-value Hansen test			0.36			0.95
Observations	400	400	400	353	353	353

Dependant variable: Return on Assets. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 4: Capital ratio and changes in regulatory requirements

	FD	FD	FE	FE
ΔREQ	0.052***	0.055***		
	(0.010)	(0.010)		
REQ			0.085***	0.092***
			(0.012)	(0.011)
Constant	0.001**	0.008**	0.087***	0.071***
	(0.001)	(0.003)	(0.001)	(0.004)
Time dummies	Yes	No	Yes	No
Adjusted R^2	0.07	0.10	0.21	0.24
Observations	353	353	400	400

First-differences (FD) and fixed-effects (FE) regressions at the banks level of capital ratio on the percentage difference between risk-weighted assets under Basel I and Basel II calculation methods. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 5: Voluntary Capital and Return on Asset

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Voluntary capital	0.106***	0.105***	0.178***	0.046**	0.074**	0.130***
	(0.019)	(0.034)	(0.044)	(0.017)	(0.030)	(0.046)
Size	-0.000	0.005	-0.003	-0.000	0.004	-0.000
	(0.000)	(0.003)	(0.003)	(0.000)	(0.004)	(0.002)
Loan share	-0.002	0.006	0.018	-0.001	0.006	-0.003
	(0.003)	(0.008)	(0.015)	(0.002)	(0.008)	(0.023)
Loan risk	0.011	-0.019	-0.059*	-0.006	-0.041	0.009
	(0.015)	(0.032)	(0.035)	(0.017)	(0.033)	(0.068)
Asset diversification	-0.004	-0.002	-0.030	-0.001	-0.004	-0.008
	(0.006)	(0.005)	(0.023)	(0.003)	(0.007)	(0.019)
Share of deposits	-0.008**	-0.004	-0.015	-0.003*	-0.002	-0.003
	(0.003)	(0.008)	(0.012)	(0.002)	(0.008)	(0.014)
Output gap	0.001***	0.001***	0.002***	0.000	0.001	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ROA_{t-1}				0.555***	0.262***	0.286**
				(0.107)	(0.092)	(0.133)
Constant	0.013*	-0.081	0.066	0.005	-0.070	0.012
	(0.007)	(0.060)	(0.051)	(0.005)	(0.074)	(0.029)
Adjusted R^2	0.39			0.57		
Within R^2		0.18			0.23	
P-value AR(2)			0.68			0.73
P-value Hansen test			0.26			0.52
Observations	400	400	400	353	353	353

Dependant variable: Return on Assets. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 6: Regulatory Capital and Return on Asset

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Regulatory capital	0.060	0.047	-0.068	0.012	0.033	0.029
	(0.075)	(0.083)	(0.236)	(0.029)	(0.077)	(0.154)
Size	-0.001**	0.001	-0.004*	-0.000*	0.001	-0.002
	(0.000)	(0.003)	(0.002)	(0.000)	(0.004)	(0.002)
Loan share	0.005	0.012	0.028	0.002	0.010	0.009
	(0.004)	(0.009)	(0.018)	(0.002)	(0.008)	(0.016)
Loan risk	0.014	-0.016	-0.089**	-0.005	-0.040	-0.000
	(0.016)	(0.037)	(0.041)	(0.016)	(0.035)	(0.058)
Asset diversification	-0.007	-0.006	-0.035	-0.002	-0.007	-0.017
	(0.007)	(0.007)	(0.024)	(0.003)	(0.008)	(0.019)
Share of deposits	-0.005	-0.003	-0.020	-0.001	-0.000	-0.007
	(0.004)	(0.009)	(0.014)	(0.002)	(0.009)	(0.012)
Output gap	0.001***	0.001***	0.001***	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA_{t-1}				0.687***	0.313***	0.392**
				(0.096)	(0.081)	(0.186)
Constant	0.017	-0.009	0.088	0.005	-0.019	0.038
	(0.011)	(0.055)	(0.057)	(0.005)	(0.074)	(0.054)
Adjusted R^2	0.13			0.53		
Within R^2		0.08			0.18	
P-value AR(2)			0.74			0.36
P-value Hansen test			0.48			0.75
Observations	400	400	400	353	353	353

Dependant variable: Return on Assets. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 7: Return on Asset and Voluntary capital using REQ^{Step}

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Voluntary capital*	0.103***	0.111***	0.208**	0.044**	0.076**	0.134**
	(0.020)	(0.035)	(0.089)	(0.018)	(0.031)	(0.056)
Size	0.000	0.006	-0.001	-0.000	0.005	-0.000
	(0.000)	(0.004)	(0.004)	(0.000)	(0.005)	(0.002)
Loan share	-0.003	0.005	0.009	-0.001	0.006	-0.009
	(0.003)	(0.008)	(0.017)	(0.002)	(0.009)	(0.017)
Asset diversification	-0.003	-0.003	-0.029	-0.001	-0.004	-0.005
	(0.006)	(0.006)	(0.021)	(0.004)	(0.007)	(0.027)
Loan risk	0.009	-0.017	-0.048	-0.006	-0.041	0.003
	(0.017)	(0.031)	(0.043)	(0.018)	(0.034)	(0.059)
Share of deposits	-0.008**	-0.005	-0.010	-0.003	-0.003	0.001
	(0.003)	(0.010)	(0.014)	(0.002)	(0.009)	(0.013)
Output gap	0.001***	0.001***	0.002***	0.000	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA_{t-1}				0.558***	0.251**	0.307**
				(0.112)	(0.093)	(0.141)
Constant	0.012	-0.093	0.047	0.005	-0.072	0.011
	(0.008)	(0.067)	(0.064)	(0.005)	(0.077)	(0.042)
Adjusted R^2	0.38			0.56		
Within R^2		0.19			0.23	
P-value AR(2)			0.95			0.71
P-value Hansen test			0.29			0.64
Observations	367	367	367	332	332	332

*Voluntary capital obtained using REQ^{Step}. Dependant variable: Return on Assets. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 8: Risk Adjusted Return on Capital (RAROC) and Voluntary capital

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Voluntary capital	2.254***	3.221***	3.148**	1.732***	1.837**	2.859*
	(0.516)	(1.166)	(1.557)	(0.543)	(0.705)	(1.696)
Size	0.008	0.404**	0.026	0.010	0.142	-0.055
	(0.009)	(0.173)	(0.115)	(0.007)	(0.101)	(0.036)
Loan share	-0.182**	-0.378	0.199	-0.040	-0.031	0.723
	(0.083)	(0.275)	(0.566)	(0.088)	(0.216)	(0.574)
Asset diversification	-0.125	0.264	-0.953	-0.107	-0.089	-1.195**
	(0.177)	(0.161)	(0.592)	(0.130)	(0.142)	(0.547)
Loan risk	-0.175	-1.139	-3.024**	-0.568	-2.314	-1.961
	(0.535)	(1.337)	(1.174)	(0.775)	(1.371)	(1.703)
Share of deposits	-0.144	0.192	-0.291	-0.066	-0.039	-0.296
	(0.088)	(0.453)	(0.345)	(0.069)	(0.293)	(0.401)
Output gap	0.056***	0.064***	0.047***	0.012	0.019**	0.024**
	(0.017)	(0.022)	(0.014)	(0.007)	(0.009)	(0.012)
$RAROC_{t-1}$				0.208*	0.072	0.107
				(0.117)	(0.045)	(0.097)
Constant	0.294	-6.571**	0.273	0.044	-2.142	1.435**
	(0.274)	(3.018)	(1.935)	(0.163)	(1.773)	(0.709)
Adjusted R^2	0.16			0.35		
Within R^2		0.15			0.18	
P-value AR(2)			0.25			0.91
P-value Hansen test			0.37			0.64
Observations	400	400	400	353	353	353

Dependant variable: Risk Adjusted Return on Capital (RAROC). Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 9: Return on Asset and Capital ratio including OBS

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
Capital ratio with OBS	0.102***	0.114**	0.120**	0.045**	0.086**	0.134**
	(0.017)	(0.043)	(0.051)	(0.017)	(0.039)	(0.060)
Size	-0.000	0.006	-0.003	-0.000	0.005	0.001
	(0.000)	(0.003)	(0.003)	(0.000)	(0.004)	(0.003)
Loan share	0.000	0.004	0.031*	0.000	0.005	0.005
	(0.003)	(0.009)	(0.018)	(0.002)	(0.008)	(0.012)
Asset diversification	-0.005	0.000	-0.049**	-0.002	-0.003	-0.022
	(0.006)	(0.005)	(0.020)	(0.004)	(0.006)	(0.018)
Loan risk	0.043**	-0.014	-0.062*	0.010	-0.039	0.019
	(0.019)	(0.038)	(0.035)	(0.021)	(0.035)	(0.078)
Share of deposits	-0.008***	-0.002	-0.021	-0.003*	-0.001	-0.008
	(0.003)	(0.008)	(0.016)	(0.002)	(0.008)	(0.013)
Output gap	0.001***	0.001***	0.002***	0.000	0.001*	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA_{t-1}				0.541***	0.245***	0.299*
				(0.113)	(0.082)	(0.157)
Constant	0.005	-0.095	0.062	0.001	-0.090	-0.003
	(0.007)	(0.060)	(0.053)	(0.005)	(0.076)	(0.062)
Adjusted R^2	0.39			0.57		
Within R^2		0.18			0.24	
P-value AR(2)			0.92			0.38
P-value Hansen test			0.35			0.67
Observations	400	400	400	353	353	353

Dependant variable: Return on Assets. Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 10: Deleveraging and capital ratio

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
ΔCapital ratio	-6.515***	-6.525***	-7.636***	-5.984***	-5.419***	-5.628***
	(1.248)	(1.327)	(1.833)	(1.146)	(1.116)	(1.780)
ΔLoan share	-0.283	-0.310	-1.117*	-0.303	-0.341	-0.627
	(0.232)	(0.241)	(0.676)	(0.222)	(0.214)	(0.515)
ΔAsset diversification	-0.104	-0.115	0.223	-0.101	-0.072	0.038
	(0.142)	(0.143)	(0.271)	(0.138)	(0.123)	(0.275)
ΔLoan risk	-0.261	-0.261	0.389	-0.318*	-0.250	-0.100
	(0.178)	(0.165)	(0.453)	(0.156)	(0.159)	(0.443)
ΔSafety net	-0.095	-0.075	-0.638	-0.069	-0.060	-0.357
	(0.240)	(0.241)	(0.557)	(0.197)	(0.192)	(0.286)
ΔOutput gap	0.004	0.001	0.002	0.002	-0.003	0.000
	(0.006)	(0.006)	(0.009)	(0.008)	(0.008)	(0.008)
ΔLog(Total assets)$_{t-1}$				-0.154	-0.288***	-0.308**
				(0.106)	(0.083)	(0.126)
Constant	0.016***	0.015***	0.023***	0.018**	0.016***	0.019**
	(0.005)	(0.004)	(0.007)	(0.007)	(0.004)	(0.009)
Adjusted R^2	0.55			0.56		
Within R^2		0.58			0.64	
P-value AR(2)			0.22			0.53
P-value Hansen test			0.47			0.31
Observations	353	353	353	314	314	314

Dependant variable: ΔLog(Total assets). Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

Table 11: Deleveraging and regulatory capital

	OLS	Fixed effects	System GMM	OLS	Fixed effects	System GMM
ΔRegulatory capital	-6.606**	-6.105**	-9.955*	-6.105***	-4.919**	-6.861***
	(2.632)	(2.700)	(5.473)	(1.981)	(1.815)	(1.705)
ΔLoan share	-0.653*	-0.683*	-0.511	-0.566*	-0.585**	-0.782
	(0.381)	(0.392)	(1.103)	(0.322)	(0.286)	(0.627)
ΔAsset diversification	-0.146	-0.165	-0.546	-0.133	-0.084	0.005
	(0.236)	(0.245)	(0.731)	(0.199)	(0.169)	(0.371)
ΔLoan risk	-0.182	-0.151	0.558	-0.256	-0.144	-0.220
	(0.282)	(0.277)	(0.609)	(0.259)	(0.249)	(0.661)
ΔSafety net	-0.199	-0.236	0.053	-0.178	-0.177	-0.309
	(0.336)	(0.343)	(0.335)	(0.236)	(0.222)	(0.226)
ΔOutput gap	-0.001	-0.007	-0.001	-0.003	-0.010	-0.002
	(0.007)	(0.007)	(0.014)	(0.010)	(0.010)	(0.010)
ΔLog(Total assets)$_{t-1}$				-0.290**	-0.472***	-0.600***
				(0.116)	(0.075)	(0.127)
Constant	0.007	0.005	0.003	0.009	0.008**	0.014*
	(0.007)	(0.003)	(0.009)	(0.009)	(0.004)	(0.008)
Adjusted R^2	0.18			0.28		
Within R^2		0.22			0.43	
P-value AR(2)			0.10			0.67
P-value Hansen test			0.48			0.39
Observations	353	353	353	314	314	314

Dependant variable: ΔLog(Total assets). Sample: Banks operating in France. Period: 2007-2014. Clustered standard errors are reported between parentheses. Stars denote significance at the 1%, 5% and 10% level respectively. For system GMM estimation, twostep estimation is used and Windmeijer's finite sample correction is applied. System GMM regressions include lags 2 to 5 of all balancesheet variables as instruments. Source: Banque de France - Autorité de Contrôle Prudentiel et de Résolution (ACPR).

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