Bank capital and profitability: Evidence from a global sample

Paolo Coccorese[a]
University of Salerno

Claudia Girardone[b*]
University of Essex

Abstract

This study employs bank-level data for a global sample of 125 countries to examine the relationship between capital and profitability for a period of 19 years (2000-2018) that includes both normal and crisis time. Our evidence suggests that bank capital is positively related to bank profitability, although the estimated impact is relatively weak. The relationship depends on environmental conditions as well as bank size. It is typically stronger in crisis periods, in lower and middle income countries and for larger banks (but not for Global Systemically Important Banks, or GSIBs). Finally, for banks operating in more corrupt environments, the same increase in capital is associated with more profitable institutions compared with banks based in countries with lower corruption levels. Our findings are robust to different specifications of the baseline model, and carry useful implications for policy reforms aimed at ensuring stability to the banking sector globally.

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[a] Department of Economics and Statistics, University of Salerno, 84084 Fisciano (Italy); Tel.+39(0)89 962338; e-mail: coccorese@unisa.it
[b*] *Corresponding author* – Essex Business School, University of Essex, Wivenhoe Park, CO4 3SQ Colchester (United Kingdom); Tel. +44(0)1206 874156; e-mail: cgirard@essex.ac.uk

1. Introduction

In the wake of the global financial crisis (GFC), the issue of bank capital has largely dominated the debates about international banking sector reforms. The objective of this paper is to empirically explore the relationship between capital and profitability for a large international sample of banks over the past two decades. Using a global data set enables us to make comparisons of the extent of the link between bank capitalisation and performance in presence of different levels of economic development and other country-specific socio-economic features, namely corruption levels, political stability and economic freedom. This is important because although the Basle accords have helped standardise the regulation around capital adequacy globally with the introduction of minimum capital requirements, many differences remain across countries. The availability of data over a relatively long time period (2000-2018) allows us to capture the downturns and subsequent upturns in the business cycles of the sample countries that have been affected by a financial and/or banking crisis.

Better capitalized banking sectors help reduce default risk and contagion effects but can impact profitability due to increased banks' overall funding costs. However, several studies have observed that capital can also positively impact bank performance (e.g. Holmstrom and Tirole, 1997; Allen et al., 2011; Mehran and Thakor, 2011; Berger and Bouwman, 2013) and they largely base their predictions on the increased borrowers' monitoring activity that follows an increase in capital. This occurs because of lower moral hazard and greater exposure of shareholders to potential losses in case of failure. Berger (1995), one of the most cited early empirical works on the topic, finds that the relationship between capital and profitability – measured by Return on Equity (ROE) – is positive and robust to up to three lags for the variables of interest for the US banking sector. The author also finds that the relationship can run in the opposite direction, i.e. from profitability to capital. The most recent empirical banking literature employs either Return On Assets (ROA) and/or ROE and highlights the need to control for bank-specific factors such as bank size, cost effectiveness, liquidity and the economic cycle (e.g. Berger and Bouwman, 2013; Lee and Hsieh, 2013; Huang and Xiong, 2015).

Our analysis contributes to the extant literature in several different ways. First, we employ both regulatory and accounting definitions of capital, in order to assess whether differences emerge as regards their effects on performance, namely profits measured as ROA, with important indications on the weight that policy makers could (or could not) impose on banks in case they have to satisfy stronger capital requirements. Second, we rely on a global sample of banks operating in 125 countries belonging to both the developed and emerging world for the period 2000-2018. Hence our results should be robust to both different environmental conditions and different economic cycles. Third, we control for micro (size, liquidity, lending characteristics, income diversification) and macro/environmental determinants (GDP growth, credit sector development), including a dummy for country-specific banking crises constructed following Laeven and Valencia (2013, 2018). Finally, we evaluate how the relationships vary depending on economic crises, bank size, income levels (using the most updated World Bank income classifications), economic freedom, political stability, and corruption. As far as we are aware, there are no similar studies carrying out such in-depth investigation for a global sample and a relatively long time span (19 years) that includes distress periods. We design our methodological framework by carrying out a pooled estimation where we include lagged banking and macroeconomic variables, also controlling for country and time fixed effects, to minimise endogeneity problems (which are however specifically investigated by means of additional robustness tests).

Our findings suggest a positive and significant relationship between capital and profits. This is true for all definitions of capital and is confirmed in all robustness checks, including those that deal with possible reverse causality and endogeneity Our empirical evidence therefore provides support to the theoretical view that higher capital requirements translate in a stronger monitoring effect and greater safe investments that ultimately enhance performance. According to Berger and Bouwman (2013), this could occur through different channels (e.g. cheaper non-core funding) but could also derive from lower 'excessive risk' that leads to instability hence lower returns. We also find that although the overall estimated impact seems relatively small, the relationship clearly depends on different environmental conditions as well as bank size. Specifically, it appears to be stronger in crisis periods, for larger banks (but not for GSIBs), and in low and middle income countries. Finally, especially for banks operating in countries with more corrupt environments, the same increase in capital is associated with a higher level of profits.

The paper is structured as follows. Section 2 reviews the extant literature on the link between capital and profits in banking and identifies the main hypotheses. Section 3 explains the main methodological issues and the data used for the empirical analysis. Section 4 discusses the results. Section 5 concludes and draws the key implications of the study.

2. The relationship between capital and profitability in the banking literature

2.1 Theoretical background

According to the basic theory of financial intermediation, banks exist because of the advantages they have in the production of information about borrowers via loan screening and contracting as well as monitoring customers' behaviour in the long run. This causes an asymmetric information problem for banks *vis-à-vis* financial markets because, by having private information about their customers, bank managers will know more about the bank's earnings prospects and financial conditions. Therefore, they may signal private information that future prospects are good through capital decisions (Acharya, 1988), so that a positive link between capital and profits emerges. Another interpretation of the above positive relationship is given in the expected bankruptcy hypothesis. As noted in Berger (1995), if a bank is undercapitalised and the expected bankruptcy costs are high, higher capital should have a positive effect on the bank's earnings by decreasing interest costs on uninsured debt.

Several theoretical studies focus on banks' monitoring incentives as key channels in the relationship between capital and performance. Holmstrom and Tirole (1997) and Mehran and Thakor (2011), for example, find that greater bank capital increases performance by diminishing the moral hazard between shareholders and debtholders. This will increase the banks' incentives to monitor debtholders, as failure is costlier for shareholders of well capitalized banks. Another interpretation (Diamond and Rajan, 2001) acknowledges that the market discipline imposed by the highly leveraged capital structure encourages banks to commit to monitoring their borrowers. Consequently, more capital will relax managers from this discipline (i.e. it will decrease monitoring incentives) and ultimately adversely affect banks' performance.

2.2 Selected empirical studies

Over the past fifteen years or so, there has been a spurt of empirical research on bank capital. Similarly, the interest on bank profitability and its determinants has resulted in a plethora of literature focusing specifically on the relationship between earnings and market conditions. As comprehensively reviewed in Berger et al. (2004), these studies either focus on the collusion hypothesis (the SCP paradigm) and/or in the persistence of profit (see e.g. Chronopoulos et al., 2015). The models employed in these works typically do not include capital as a main variable of interest but test it as a control variable measured by book value of equity over total assets.

There are, however, several empirical studies that investigate specifically the relationship between bank capital and profitability. For example, Berger (1995) employs a two-equation reduced form framework with three lags and control variables for a sample of US banks in the mid-to-late 1980s. His evidence shows Granger causality in both directions between earnings (measured as ROE) and capital (measured as book value of equity over assets). The positive causality from earnings to capital is explained by the hypothesis that banks retain some of their marginal earnings in the form of equity increases. The finding that higher capital is followed by higher earnings can be explained by both the bankruptcy cost hypothesis (banks increase their earnings as the cost of uninsured debt decreases, since banks that were previously undercapitalised raise their capital levels closer to equilibrium levels); and the signalling hypothesis (bank management signals private information that prospects are good – in terms of higher revenues, lower costs or reduced risk – by increasing capital).

Empirical studies that followed Berger's work, such as those using banking data from the 1990s (e.g. Demirguc-Kunt and Huizinga, 2001; Goddard et al., 2004) as well as the more recent ones, tend to find a positive relationship between bank capital and profitability. This includes studies focusing on emerging markets, such as for example, Garcia-Herrero et al. (2009)'s empirical investigation on Chinese banks that reveals that their low profitability can be explained by scarce capitalisation, measured as equity over assets.

Concerning cross-country studies, Demirgüç-Kunt and Huizinga (2010) use a panel of 1,334 banks operating in 101 countries to investigate how bank activity and funding strategies affect bank risks and return for the 1995-2007 period. They show that there is a positive relationship between bank capital and bank profitability (measured as pre-tax ROA) and a negative one with risk. Gropp and Heider (2010) consider the determinants of bank capital structure for a sample of large US and European banks over 1991-2004. Their evidence suggests that more profitable, dividend paying banks with high market-to-book ratios face lower costs of issuing equity. According to the authors, the fact that more profitable banks tend to hold significantly more capital is explained by the lower cost of raising equity at short notice that these banks can benefit from because they are better known to outsiders and have more financial slack, so they can obtain a better price.

In a US study covering the years 1984 to 2010, Berger and Bouwman (2013) examine the implications of greater capital for banks' performance (proxied by bank survival and market share) during financial crises over the past quarter century. Results show not only that capital always enhances small banks' probability of survival and market share, but also that it improves the performance of medium and large banks particularly during banking crises. Berger and Bouwman (2013) explore three channels through which capital may generate these effects. On the relationship between capital and profitability (ROE), the authors find that high-capital banks of all sizes improve their profitability during banking crises (although this result is not significant for medium banks) and market crises. In addition, they find that capital enhances the profitability of small banks during normal times. These findings generally support the hypothesis that capital improves bank profitability (although with ROA the results are confirmed for small banks, but are weaker for medium and large banks). One of the key results of this study is that the economic roles of capital vary in the cross section of banks depending on size and time period.

Lee and Hsieh (2013) use bank financial data for 42 Asian countries over 1994-2008 to investigate how and to what extent capital affects bank profits and riskiness. The authors employ four measures of bank profitability: ROA, ROE, net interest margins and net interest revenue over total assets, and their main methodology is GMM. They find a positive relationship between capital and profitability for the entire Asian banking sample and a negative one with risk. However, the ROA and ROE results often do not go in the same direction. Their evidence broadly suggests that the relationship significantly depends on bank types (namely, commercial versus investment and cooperative banks), countries' income levels and geographical regions.

In another cross-country study that includes 12 developed economies' banking sectors, Demirgüç-Kunt et al. (2013) investigate the relationship between different measures of capital (Tier 1 and 2 ratios, leverage and tangible equity) and stock market performance over a period that includes the GFC (2006-2009). They find that prior to the crisis, differences in capital did not have much impact on stock returns; whereas during the crisis, a stronger capital position was associated with better stock market performance, especially for large banks. Another important result is that that higher quality forms of capital (e.g. Tier 1) were more relevant for equity prices. Beltratti and Paladino (2015) explore the relationship between leverage and residual income (i.e. the difference between the rate of return on equity and the expected rate of return) for 337 large banks from 44 countries over the period 2005-2011, and document a significant positive non-monotonic link between the capital ratio and their measure of banks' income.

Focusing on the case of China, Lee et al. (2015) use a panel of 171 commercial banks in 1997 to 2011, to analyse the effects of bank capital on profitability and risk during three sub-periods before and after China entered the WTO. The authors find a positive and significant relationship between capital and profitability as measured by ROA (which supports the expected bankruptcy cost hypothesis and the signalling hypothesis), but a negative and significant relationship between the two variables when using alternative profitability measures.

More recently, Tran et al. (2016) focus on an unbalanced sample of all US banks between 1996 and 2013 (507,715 observations) to study the interrelationships among liquidity creation, regulatory capital and profitability. The authors find that regulatory capital is negatively related to bank profitability for higher capitalized banks, but positively related to profitability for lower capitalized banks. Using data for French banks spanning 1993-2012, de Bandt et al. (2017) employ fixed effect regression models and Granger causality tests to study if better capitalised banking groups in France can be more profitable. Their robust findings, all else equal, suggest a positive and significant effect.

Finally, using a sample of 1,992 banks operating in 39 OECD countries for the years 1999 to 2013, Bitar et al. (2018) investigate whether the imposition of higher capital ratios is effective in reducing risk and improving the efficiency and profitability of banking institutions. With reference to profits, they find that risk- and non-risk-based capital ratios enhance bank profitability.

2.3 Hypotheses testing

One possible explanations of a positive relationship between capital and earnings is the signalling hypothesis. Under this theory, bank management signals private information that future prospects are *good* by increasing capital. Based on the literature surveyed in the previous section, the first research hypothesis (H1) can be formulated as follows:

H1 = *The relationship between bank capital and profitability is positive and significant*

There are several reasons why H1 may be supported by the data. First, capital has two main advantages as: (i) it provides a source of permanent funding, and (ii) it reinforces a bank's financial positions and so lowers the cost of its debt funds. This suggests that, although capital is the most expensive source of bank funding, having a large share of it can act as a signal of bank creditworthiness. Second, capital can be regarded as a cushion to increase the share of loans and other risky assets. This will foster profitability if a bank is able to originate more loans with a favourable risk/return profile. Third, in countries where the ability to borrow is subject to sudden stops, such as emerging countries, adequate capitalisation allows banks to have to borrow less to support a given level of assets. Fourth, banks with a high franchise value (measured in terms of capitalisation) have incentives to hold an adequate level of capital and behave more prudently in terms of lending (see e.g. Garcia-Herrero et al. 2009; de Bondt et al. 2017). Berger and Bouwman (2013) note that banks with high capital engage in more monitoring and safer investment policies that ultimately increase performance through different channels including cheaper noncore funding, greater relationship loans and more off-balance sheet guarantees.

Berger (1995) observes that an increase in capital may raise expected earnings by reducing the projected cost of financial distress, including bankruptcy. Regarding possible differences in the relationship between capital and profits in financially healthy vs. tough periods, in a second hypothesis we conjecture that in times of distress lower revenues might follow increases in capital. This may occur because, under the expected bankruptcy costs hypothesis, banks with greater than optimal insolvency risk would likely try to reduce the probability of failure both by increasing capital and by reducing portfolio risk (these measures could even be imposed by regulators). Lower portfolio risk is generally associated with lower expected revenues; so it is important to test our hypothesis (H2) separately for normal versus turbulent periods:

H2 = *The marginal impact of bank capital on profitability is greater in tranquil versus crisis times*

3. Methodology and data

3.1 Methodological approach

Our baseline model is the following:

$$\pi_{i,c,t} = \alpha_1 K_{i,c,t-1} + \sum_{j=2}^{7} \alpha_j X_{i,c,t-1} + \sum_{k=8}^{9} \alpha_k Z_{c,t-1} + \alpha_{10} CRISIS_{c,t} + \delta_c + \gamma_t + \varepsilon_{i,c,t} \qquad (1)$$

where the dependent variable $\pi_{i,c,t}$ is the profitability (*ROA*) of bank *i* in country *c* in the year *t*. The main explanatory variable is the lagged capital measure $K_{i,c,t-1}$; $X_{i,c,t-1}$ and $Z_{c,t-1}$ are, respectively, a vector of six bank-specific variables (*lnTOTAST*, *LIQUIDITY*, *NPLs*, *LOANAST*, *COSTREV*, and *NIRTR*; we will discuss them later) and a vector of two macroeconomic variables (*GDPGROWTH* and *CREDITGDP*); finally, *CRISIS* is the dummy for country-specific banking crises. We also control for country fixed effects (δ_c) and time fixed effects (γ_t).

In evaluating the relationship between capital and profitability, we face a number of challenges: including endogeneity, possible causality and unobservable heterogeneity across banks. The empirical methodology used in similar empirical investigations has evolved from early works using generalised and weighted least squares (respectively Angbazo, 1997 and Demirguc-Kunt and Huizing, 1999), to fixed or random effects (e.g. Maudos and Fernandez De Guevara, 2004; Claeys and Vander Vennet, 2005) and generalised method of moments (GMM) (e.g. Garcia-Herrero et al. 2009).

In our empirical approach we first specify a model that we estimate using standard method and that is widely used in the relevant literature (e.g. Dermirguc-Kunt and Huizinga, 2010; Lee and Hsieh, 2013). Then, we take into account of all recent developments in the methodology mentioned above to ensure robustness of our empirical results. Specifically, we estimate Equation (1) by ordinary least squares (OLS) with standard errors clustered at the bank level, which ensures that they are consistent to potential heteroskedasticity and correlation within banks. We then deal with endogeneity and reverse causality concerns. In the context of our research question, these problems may occur because capital ratios could result from earnings accrued over time; listed banks with over-valued shares might have an incentive to raise equity; and banks experiencing distress may be tempted to increase leverage in a 'gamble for resurrection'. Hence the need to control for such endogeneity bias, which could run also from profitability to other explanatory variables.

To correct for this potential bias, in line with other studies exploring the impact of capital variables on banks' behaviour and performance (e.g.: Demirguc-Kunt et al., 2013; Beltratti and Paladino, 2015; Kim and Sohn, 2017), all regressors – our measures of capital, bank-specific variables, macroeconomic variables – are lagged one period (except the banking crisis dummy). Additional robustness checks that address the endogeneity issues more directly are reported in Appendix A. In particular, we perform a series of tests that investigate the possibility of reverse causation: Granger-causality, instrumental variable and dynamic GMM regressions.

3.2 Data sources and variables

We use a multi-country panel of banks operating in 125 countries. Bank financial data are drawn from the international database BankScope/BankFocus (provided by Bureau van Dijk) over the period 2000-2018, while macroeconomic data are obtained from the World Bank Development Indicators.

Our initial sample included 189,111 observations on 30,430 banks. However, we have chosen to focus on banks normally engaged in the credit intermediation activity (e.g. commercial, cooperative and savings banks). In order to correct for outliers, the observations for which *ROA* and capital variables were lower than the 1st centile or larger than the 99th centile have been dropped. Finally, so as to ensure homogeneity between samples referring to the different notions of capital, we have removed all observations where one or more variables entering the various estimations were missing. Our final sample consists of 48,385 observations on 8,109 banks.

Following the relevant empirical literature (Brei and Gambacorta, 2014; 2016; Gambacorta and Shin, 2018; Bitar et al., 2018), we test alternative measures of bank capital. In our study we focus on: Tier 1 capital ratio (*TIER1RWA*); book value of equity over total assets (*EQAST*); and a third measure of capital surplus over the regulatory requirement (*CAPSURPLUS*). The first is a pure regulatory measure of capital, and it equals the sum of equity capital and disclosed reserves divided by total risk weighted assets. The second measure is a customary indicator of bank capitalization within the economic literature, which can be easily calculated from banks' balance sheets. Finally, the third measure is the surplus of total regulatory capital ratio over the minimum requirements[1] (divided by the latter figure) and represents a proxy of how banks voluntarily try to face the risk of unexpected losses.

Turning to the set of bank-specific variables that are included in all regressions, the natural logarithm of total assets (*TOTAST*) is a proxy for banks' size (Pasiouras and Kosmidou 2007; Kim and Sohn, 2017). A large size might result in economies of scale that reduce the cost of gathering and processing information, hence increasing profits, but makes banks less able to adapt to changes in the external environment. While smaller banks can more quickly adjust their business and hence earn more than larger financial institutions. Therefore, the sign of this variable is not a priori predictable. The liquidity ratio (*LIQUIDITY*), measured as non-customer deposits plus cash over total deposits (Carbo Valverde and Rodriguez Fernandez, 2007; Gambacorta, 2011; Lee and Hsieh, 2013), aims at capturing the role that holding more liquid liabilities has on banks' profits (which could be either positive, if liquidity allows a better perception in funding markets and hence a reduction of financing costs, or negative, if liquidity levies an opportunity cost due to the need of keeping liquid liabilities and liquid

[1] The values of the minimum capital-asset ratio requirement are drawn from the 'Bank Regulation and Supervision Survey', carried out by the World Bank and providing information on bank regulation and supervision for up to 160 jurisdictions (Anginer et al., 2019). Five surveys have been conducted in 2001, 2003, 2007, 2012 and 2017. For the years prior to 2001 we assume that the minimum levels are the same of 2001, while for the remaining years not covered by any survey, we use the values reported in the previous available survey.

assets in balance, which translates into lower returns relative to other assets). The ratio of non-performing loans to net loans (*NPLs*) represents an indicator of loan quality and credit risk, which should negatively affect ROA because, when loan losses emerge, banks will earn less interest income and therefore gain less profits (Beltratti and Paladino, 2015). The loans to assets ratio (*LOANAST*) is a proxy for lending specialisation. Its coefficient is expected to be positive as long as a higher level of loans generates a higher interest margin and therefore is associated to higher profits (Maudos and Fernandez De Guevara, 2004; Lee and Hsieh, 2013). The cost to revenue ratio (*COSTREV*) is added in order to account for bank efficiency: an increase in this ratio indicates a reduction of management quality or performance, which normally turns into lower profits, so a negative sign is expected (Maudos and Fernandez De Guevara, 2004; Bitar et al, 2018). Finally, the share of non-interest revenue over total revenue (*NIRTR*) is used to measure banks' income diversification. We expect that banks generating higher fee income earn more profits (Demirguc-Kunt and Huizinga, 2010; Chronopoulos et al., 2015).

Concerning macroeconomic factors, we employ the GDP yearly rate of growth (*GDPGROWTH*) and the domestic credit to GDP ratio (*CREDITGDP*). The *GDPGROWTH* variable controls for business cycle fluctuations and overall economic conditions (Albertazzi and Gambacorta, 2009; Demirguc-Kunt and Huizinga, 2010): a higher GDP growth rate may involve that banks can generate more profitability due to more business opportunities during favourable economic times. The credit-to-GDP ratio helps to take into account the role and importance of bank financing in the economy (Ben Naceur and Omran, 2011; Lee and Hsieh, 2013). Since a greater *CREDITGDP* refers to a financial environment that is more competitive, it should be negatively related to profitability.

The dummy for individual countries' systemic banking crises (*CRISIS*) is constructed following Laeven and Valencia (2013, 2018). This is defined as an event that meets the two following conditions: i) significant signs of financial distress in the banking system (e.g. significant bank runs, losses in the banking system and/or bank liquidations); and ii) significant banking policy intervention measures in response to significant losses in the banking system (Laeven and Valencia, 2013, p. 228).

Bank profitability is measured by Return on Assets (*ROA*), calculated as net income over total assets. We choose to focus on ROA, rather than on the Return on Equity (ROE), because, as Admati et al. (2013) note, the use of ROE becomes problematic when comparisons are made across different capital structures.[2]

Table 1 lists the variables used in this study as well as their description and the specific data sources, while Table 2 reports the summary statistics. Significant variations can be observed in banks' profits and capital ratios (see also Gropp and Heider, 2010), but the highest variability characterises total assets, which evidences the significant heterogeneity across banks in our sample. In the period 2000-2018, average sample banks' ROA amounted to 0.73%, their Tier 1 ratio was 15.4% and their equity-to-assets ratio was 10.4%, while their total regulatory capital ratio was slightly over the double of the minimum required level. Banks' average size amounted to 35.8 billion US dollars (at constant 2010 values), their liquid assets were about 18% of total deposits, and non-performing loans amounted to 4.8% of total loans, while the latter were 60.5% of total assets. We can also observe that sample banks' costs were 74% of revenues, and that their non-interest income was about 21.4% of total income. Looking at the macroeconomic variables, our banks operated in countries with an average GDP growth of +2.4% and a credit-to-GDP ratio of 73.6%. Finally, almost 11% of observations fell in banking crisis years. The total number of observations by country and by year are reported in Table 3. They are the same in all regressions (i.e., we always keep constant the number of observations across estimations).

[Insert Table 1 about here]

[2] As an example, Admati et al. (2013:14) observe that a manager who generates a 7% ROA with 20% capital will have a ROE of 15%, while a less productive manager who generates a 6.5% ROA but has 10% capital will have a ROE of 20%. Clearly, they operate with different capital structures, so a higher ROE does not necessarily imply that the second bank has deployed its assets more productively than the first.

[Insert Table 2 about here]

[Insert Table 3 about here]

Table 4 shows the correlation matrix for selected bank variables with significance levels. The correlation between capital variables and *ROA* is always positive and significant (ranging between +0.03 and +0.23). As expected, there is a significant correlation between *TIER1RWA* and *CAPSURPLUS* (+0.93), reflecting their common regulatory aim. In addition, the correlation coefficients among all regressors are of fairly low magnitude (their absolute value is always lower that 0.36), which means that the problem of multicollinearity in our estimations should not be of concern.

[Insert Table 4 about here]

4. Empirical results

4.1 Baseline regression

Results derived from our baseline model described in Equation (1) for the full sample are reported in Table 5. In particular, columns (1)-(3) report the regression results when considering the three specifications of bank capital as the only explanatory variables (together with country and time dummies), columns (4)-(6) encompass also bank-specific characteristics, and columns (7)-(9) further comprise macroeconomic and crisis variables. All coefficient signs and significances appear to be robust to the inclusion of additional control variables; hence, we will focus our discussion of results on the full specification in columns (7)-(9).

[Insert Table 5 about here]

We find a clear indication that the relationship between capital, however measured, and ROA is positive and significantly different from zero at the 1% level, although the effect is not very large.

The estimated coefficient of *TIER1RWA* in column (7) indicates that an increase of one percentage point in the ratio between Tier 1 capital and risk weighted assets generates, all else equal, a 0.0117 percentage points growth of ROA. As an example, for a representative bank in our sample, a rise of Tier 1 over risk weighted assets from 13.3% (median value) to 18.3% (a growth of about 38 percentage points) would move the bank from the 50th centile to the 79th centile of the Tier 1 distribution. In contrast, the estimated ROA for the same bank would rise from 0.65% (still considering the median value) to 0.71% (an increase of 9.2 percentage points), corresponding to a shift from the 50th to the 53th centile. We get similar qualitative results when using *EQAST* – column (8) – and *CAPSURPLUS* – column (9) – as the capital variable.

Our evidence gives therefore support to our first hypothesis H1 that implies that more capitalized banks can also be more profitable. This may occur because, consistent to the signalling hypothesis, by increasing capital, bank managers convey private information on good prospects, in terms of expectations of revenues, costs or risk, that are more favourable than is publicly thought. As noted in Berger (1995), to the extent that management has a stake in the value of the bank (e.g. through personal ownership, stock options, etc.), it is less costly for a “good” bank to signal high quality through the increase in the level of capital than for a “bad” bank; thus, banks that expect to have better future performance have an incentive to have higher capital. With the expected bankruptcy hypothesis, a bank holding a higher level of capital tends to have lower expected bankruptcy costs (because the probability of a failure reduces, and the deadweight liquidation costs that must be absorbed by creditors in the event of failure become more remote), and this in turn lowers interest expenses on uninsured debt, i.e. the cost of funding, thus raising banks’ profitability.

Assuming that the relationship goes from capital to profitability and not vice versa (we test this for our sample in Appendix A), under a policy perspective, this outcome would allow to deduce that, on one hand, increases in bank capital have a positive impact on profitability, but they are rather narrow; and that, on the other hand, since they do not certainly produce negative effects on bank profits, the possibility that credit institutions finance a higher fraction of their lending with equity may appear reasonably acceptable. Miles et al. (2012) argue that substantially high capital requirements could create considerable benefits by reducing the probability of systemic banking crises. Nonetheless, excessive capital could result in greater idiosyncratic risk, if, for example, banks shift their business towards less traditional banking assets.

The evidence that a higher capital increases ROA could fit with a model of banks' asset expansion (Admati et al., 2013), where, because of e.g. increased capital requirements, banks expand their balance sheet by raising additional equity capital and using the proceeds to acquire new assets (see Figure 1 for a hypothetical example). Due to the increase in equity and the consequential growth in assets, with the same level of profits, ROA would tend to fall. However, banks will be able to increase income and profits owing to the related expansion in assets, which would positively impact ROA. This situation is a case that specifically reflects our results. The equity to assets ratio can rise even if overall assets do not, and it can rise fast even when assets decline. A bank that issues equity and uses it to reduce reliance on deposits would see its capital ratio increase most and see no growth in assets because of the switch in funding. The positive coefficients of the capital variables in Table 5 suggest that the increase in profits should be larger (in relative terms) than the assets growth. As Figure 1 portrays, the most effective way to obtain this result is to drive the additional assets mainly to non-traditional banking activities, which usually are riskier, but they can translate in higher revenues for the banks.

[Insert Figure 1 about here]

Concerning the control variables, the relation between size (*lnTOTAST*) and profitability is significant (even if at the 10% level) and negative only for *CAPSURPLUS*: in this case, there is some evidence that smaller banks are characterized by a higher ROA, while the opposite is true for their larger counterparts. This is in line with the studies that found economies of scale for smaller banks and/or diseconomies for larger credit institutions (Pasiouras and Kosmidou, 2007; Chronopoulos et al., 2015). The negative and significant sign of the *LIQUIDITY* coefficient makes clear that holding more liquid liabilities exerts a negative impact on banks' profits, thus emphasizing that the 'opportunity cost' effect exceeds the 'signalling benefit' effect. As expected, a higher portion of non-performing loans (*NPLs*), hence credit risk, negatively affects banks' ROA, and the same occurs for the loans to assets ratio (*LOANAST*), with the exception of *EQAST*. In the latter case, we deduce that more profitable banks are those with a smaller loan portfolio, and consequently that try to take advantage of the access to non-traditional markets. This is confirmed by the positive and significant coefficient of the *NIRTR* variable, which proves that more diversified banks, i.e. those relying more on non-interest income, have a higher ROA, essentially because they are less exposed to loan impairments. Higher profits also characterize more efficient banks, i.e. those with a lower cost to revenue ratio (*COSTREV*).

Banks that operate in countries with a high level of GDP growth (*GDPGROWTH*) appear to earn more profits; a possible explanation is that bank profitability should be procyclical if more lending increases interest income and if this in turn encourages economic activity via increased loan demand and lower provisions. In addition, more sizeable and developed credit markets (*CREDITGDP*) cause a reduction in profitability for banks, largely because they are also more crowded and hence competitive, so that banks' margins are negatively affected (Demirguc-Kunt and Huizinga, 1999). Finally, the (expected) negative coefficient of the dummy variable *CRISIS* confirms that ROA is significantly lower during periods of banking crises.

The results described so far hint that the relationship between bank capital and profitability, albeit small, is positive and significant. However, one should be cautious in interpreting the above findings, as the evidence of a causal relationship could be a strong correlation instead. Another potential issue is reverse causality between our variables of interest. As discussed above, we have used lagged explanatory variables in our empirical implementation. In addition, in Appendix A we address this endogeneity problem more directly by means of three different econometric strategies: Granger causality tests, IV-GMM regressions, and two-step system GMM regression. Our findings confirm our OLS results.

4.2 The impact of bank capital on profitability in crisis years

To check the validity of our second hypothesis (H2) that the marginal impact of bank capital on profitability is greater in normal versus crisis times, we investigate possible and significant differences in the link between capital and profits in crisis and non-crisis periods.

Particularly, we consider the role of both individual countries' banking crises and the GFC. In the first case, we build a group of interaction terms by multiplying the capital variables with two binary variables, *NOCRISIS* and *CRISIS*, derived from Laeven and Valencia (2018): for each country, they take value 0 or 1 in the years characterized by the absence or presence, respectively, of a local banking crisis (of course, here we drop the *CRISIS* variable from the regression). A similar approach is found e.g. in Anginer et al. (2014) and Demirguc-Kunt et al. (2013). In the second case, we behave in a similar fashion, and interact the capital variables with two binary variables (again, *NOCRISIS* and *CRISIS*) that assume value 1 in the GFC years as reported for each country by Dominguez et al. (2012), and 0 for the remaining years.

Our evidence is provided in Table 6. We generally observe that, all else equal, during (either banking or global financial) crisis periods the same increase in capital translates in a higher level of profits (the only exceptions concern *TIER1RWA* and *EQAST* in case of banking crises): just as an example, an increase of one percentage point in *TIER1RWA* was able to generate a 0.0108 percentage points growth of ROA before the GFC, and a 0.0226 percentage points growth of profits in the crisis years. In other words, far from being a problem, in bad times having more capital allows banks to increase their profitability. Berger and Bouwman (2013) find that capital enhances the performance of medium and large banks primarily during banking crises. Our result is also a confirmation that crises emphasize the fragility of banks financed with short-term funds raised in the money markets rather than with capital (Beltratti and Stulz, 2012).

[Insert Table 6 about here]

From the bottom lines of Table 6 we deduce that the difference between non-crisis and crisis periods is also statistically significant (as mentioned, with the exceptions of *TIER1RWA* and *EQAST* for banking crises), thus providing clear support to the importance of capitalization in turmoil periods. However, when using a broader notion of capital, i.e. *EQAST*, the empirical findings are reversed as regards the case of banking crises: moving from non-crisis to crisis years, the relationship between capital and profitability drops in magnitude, as the coefficient shrinks from 0.0263 to 0.0184 (and their difference is significant at the 1% level). Hence, we find that, in the years characterized by banking crises, holding more equity per dollar of assets implies less profitability than in normal times. Although we do not formally test it in this study, it is reasonable to assume that there could also be an effect of pro-cyclicality of capital ratios that could amplify this effect (e.g. Albertazzi and Gambacorta, 2009; Repullo and Suarez, 2012). This is because banks in recession periods cannot easily recapitalise themselves (too difficult and/or too costly to issue new shares) so they increase capital by reducing lending that in turns further lowers the economic activity.

4.3 Impact of bank size and country-specific characteristics

4.3.1 Does the relationship between capital and profitability differ across bank sizes?

We now interact the capital variables with four size dummies based on banks' average total assets over the sample period: *SMALL* (i.e. banks below the first quartile of the yearly distribution of total assets), *MEDIUM* (i.e. banks in the second and third quartiles of the yearly total assets distribution), *LARGE* (i.e. credit institutions with total assets in the fourth quartile of the yearly distribution), and *GSIBs* (i.e. systemically important banks, based on the lists provided by the Financial Stability Board for the sample years). Our way of classifying banks into small, medium and large is common in the economic literature (e.g., Giordana and Schumacher, 2013; Pathan and Faff, 2013; Lambert et al., 2017; Barucci et al., 2018) and is also adopted by the European Banking Authority (EBA, 2019).

Table 7 reveals that the strength of the relationship between capital and profitability differs across alternative bank sizes. First, while non-GSIBs banks in our sample display positive and significant coefficients, for GSIBs the relationships of interest are never significant, meaning that changing capital requirements does not affect their profits. Among non-GSIBs, our findings suggest that the estimated marginal effect of bank capital on profitability is lower for smaller banks, while it progressively increases with size; the bottom rows of Table 7 clearly show that there are significant differences among them. We are, therefore, in line with e.g. Mergaerts and Vander Vennet (2016), whose analysis shows that a high capital ratio appears to have the greatest impact on larger banks (i.e. those that are furthest away from the retail business model).

[Insert Table 7 about here]

For smaller banks, the lower impact of capital growth on profits can be attributable to reduced possibility of diversifying income sources. In fact, an increase in capital that is followed by assets expansion might benefit more larger banks because of their greater flexibility and business diversification. Finally, there could also be a ‘too-big-to-fail’ effect that tolerates larger banks to operate at lower capital levels.

4.3.2 Is the relationship between capital and profitability affected by economic and political factors?

To check whether the relationship capital-profits varies across different buckets of countries, we split the sample using the World Bank income levels of the countries to whom banks belong. Particularly, we interact the capital variables with two different dummy variables: *LOWMIDDLE* takes value 1 when the country is classified by the World Bank as a low or middle income country, while *HIGH* equals 1 for nations regarded as high income. The results of this empirical analysis are presented in Table 8. We find that the marginal effect of bank capital on profitability is greater in lower and middle income countries than in their richer counterparts. It is possible that such results are driven by the fact that in high income countries the regulatory/monitoring activity is more stringent, effective and transparent than in less developed frameworks, which depresses profitability. According to the test of equality of coefficients (bottom rows of the table), the differences among groups are of a remarkable and significant magnitude for *TIER1RWA* and *CAPSURPLUS*, while the same test fails to reject the null hypothesis for the *EQAST* variable.

[Insert Table 8 about here]

A second group of regressions focus on the role of three country characteristics: economic freedom, political stability, and corruption control. Since these factors are positively correlated, we test them separately in the models in order to check whether they exert any influence on banking markets and, in general, on banks' behaviour.

A good degree of economic freedom (with governments protecting and safeguarding the rights of economic agents) allows a more efficient functioning of markets, promotes a competitive background, and ultimately boosts economic growth. In this sense, it can increase the ability of banks in obtaining and managing more resources. On the other side, in such environment the fostered competition inevitably hits banks as well, so that revenues and profits may be negatively affected.

Therefore, it is not clear whether economic freedom should affect banks' performance in a positive or negative way (e.g.: Sufian and Habiboullah, 2010; Djalikov and Piesse, 2016).

We use the Index of Economic Freedom provided by the Heritage Foundation (an average of ten specific components of economic freedom, each being graded on a scale from 0 to 100), and create two dummy variables, *LOW* and *HIGH*, marking each country for which the index is below or above the sample median value (equal to 71), respectively, and interact the capital variables. The regression results are exhibited in Table 9, columns (1)-(3).

In all estimations, we find that more economic freedom translates into a reduced impact of bank capital on profitability. However, such difference is not statistically significant for any definition of capital (except for *CAPSURPLUS*, but only at the 10% level), even though for *TIER1RWA* and *CAPSURPLUS* the estimated coefficients differ by about 20% and 30%, respectively. Overall, in countries with higher freedom on the business that firms can undertake, more capitalized banks appear to earn less profits compared to banks with a similar degree of capitalization operating in countries with lower economic freedom. This is likely to be the consequence of the higher level of competition that generally characterizes freer economies, a result that we have checked empirically by adding a competition variable drawn by the World Bank dataset.

[Insert Table 9 about here]

Another factor that could affect the capital-profits relationship in the banking industry is political stability. More stable governments and stronger institutions are likely to guarantee more stability in the economy. Roe and Siegel (2011) note that a country's capacity and willingness to build and maintain investor and property protection institutions depend largely on its relative democratic political stability, while unstable policies cannot, or will not, reliably protect investors. Moreover, in a politically stable nation financial development can generate much more economic opportunities. Interestingly, Kleinhow and Nell (2009) suggest that political stability may contribute to increase the systemic risk of European banks, possibly since in a stable system actors establish, operate, and interconnect financial institutions beyond the level that the institutional framework reliably provides, while in more unstable contexts links between financial units may disappear, in this way reducing the systemic risk and the possibility of contagion. However, in a recent study, Fungacova et al. (2019) emphasise the importance of trust as one main contributors of financial stability even in normal times.

To measure political stability, we employ the 'Political Stability and Absence of Violence' index from the Worldwide Governance Indicators database of the World Bank, a measure of the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means (ranging from -2.5 to +2.5, with higher values indicating greater political stability), and again generate the binary variables *LOW* and *HIGH*, which identify countries whose index is below or above the sample median (amounting to 0.495), respectively. Lastly, we interact the three capital variables and the above dummy variables, and use this regressor in our model. Empirical results are reported in Table 9, columns (4)-(6).

With reference to *EQAST*, there is a robust and statistically significant evidence that in more stable countries more bank capital generates, all else equal, higher ROA than in more unstable nations. For example, increasing the equity-to-assets ratio by one percentage point would cause a growth of ROA equal to 0.024% in the first group of countries and 0.029% in the second group. This confirms that banks are (slightly) more profitable in presence of political stability. As regards *TIER1RWA* and *CAPSURPLUS*, i.e. our 'regulatory' definitions of capital, the test of equality of coefficients (last two rows of Table 9) shows that the differences between the two groups of countries are not statistically significant.

Regarding the role of corruption, it is widely recognized that it represents a severe obstacle to an optimal allocation of resources. If corruption is sometimes accepted as a 'cost of doing business' in many countries, it is increasingly seen as a barrier to development and economic growth (Wilhelm, 2002), especially through channels such as private investment and public expenditure (Murphy et al., 1993; Shleifer and Vishny, 1993; Mauro, 1995; Wei, 2000; Beck et al., 2005). In an empirical analysis of cross-country differences in the rate of saving, Swaleheen (2008) demonstrates that corruption is positively correlated with real interest rates.

As to the banking sector, Demirguc-Kunt and Huizinga (1999) find that in countries with an environment relatively free of corruption, banks are characterized by lower interest margins (hence, profitability), because they may require a lower risk premium on their investments. This result is in line with Ben Naceur and Omran (2011), who consider a selection of Middle East and North Africa countries and notice that corruption increases the net interest margins. Park (2012) shows that corruption significantly aggravates the bad loans problems, since it distorts the allocation of bank funds from normal projects to bad projects, which decreases the quality of private investments and hence economic growth. Zheng et al. (2013) obtain robust evidence that firms operating in collectivist countries perceive a higher level of lending corruption than firms in other countries, attributed to the influence that norms in collectivist societies have both on the interactions between bank officers and bank customers and on the dynamics among bank colleagues. In the same vein, working on a survey database concerning over 4,000 firms in 54 countries, Beck et al. (2005) also find that corruption of bank officials represents a significant constraint on firm growth.

Following the same empirical approach as before, we start from the ‘Control of Corruption’ index (again drawn from the Worldwide Governance Indicators database managed by the World Bank), capturing perceptions of the extent to which public power is exercised for private gain or is captured by elites and private interests, and ranging from -2.5 (the poorest level of corruption control, i.e. likely high corruption) to +2.5 (strong corruption control, i.e. low expected corruption). It allows to build the dummy variables *LOW* and *HIGH*, referring to countries with values below and above its median value (amounting to 1.353), respectively, which are interacted with the capital variables to become regressors for new estimations, whose results are exposed in Table 9, columns (7)-(9).

The coefficients of the interaction variables show that banks operating in countries with more perceived corruption are always characterized by substantially higher marginal effects of bank capital on ROA, the gaps being also statistically significant. We interpret this result as evidence that, in line with Demirguc-Kunt and Huizinga (1999) and Ben Naceur and Omran (2011), banks operating in a more corrupt environment have the possibility to charge higher interest on loans and lower interest for deposits, with positive impact on margins and profits and irrespective of (or even notwithstanding) factors like management quality or efficiency. Therefore, the same increase of capital allows the above credit institutions to enjoy more profits than banks operating in countries with low corruption.

4.3.3 Further robustness checks

To ensure the robustness of our findings, we now conduct some additional tests based on the full specification of Equation (1).

First, we assess whether our results change when considering only banks for which at least 75% of observations (i.e. at least 15 over 19) are available during the time span, in order to focus on a more balanced dataset, even though smaller. As columns (1)-(3) of Table 10 show, the positive relationship between bank capital and profitability is confirmed (and the coefficients appears to be slightly higher than in Table 5). We also note a drop in the significance levels of *LOANAST*, while that the coefficients of *lnTOTAST* become significant.

[Insert Table 10 about here]

Second, we exclude US banks from the analysis, since they represent an important fraction of our sample (about 28% of total observations). From columns (4)-(6) of Table 10 we again get proof that our results are robust, since the coefficients of the capital variables are all positive, of comparable magnitude and highly significant (this holds also for the control variables, except *CRISIS*).

Third, we focus only on banks for which we observe only moderate changes in the values of *TIER1RWA*, *EQAST* and *CAPSURPLUS* from one year to another, as large yearly variations of capital variables might be due to mergers or acquisitions (as well as to financial difficulties) that could alter both the sign and the significance of the estimated coefficients. Particularly, in three different estimations we consider only banks for which the annual changes of *TIER1RWA* and *EQAST* range between -10% and +10%, and the annual change of *CAPSURPLUS* vary between -20% and +20%. Results reported in columns (7)-(9) of Table 10 indicate that our main inferences hold even under this alternative sample composition.

Finally, we estimate our baseline model by means of a hierarchical linear model (HLM), also known as multi-level modelling. Such technique is particularly suited to deal with data that have different levels of aggregation (in our case, bank-level and country-level), because it provides error terms controlling for the potential dependency due to nesting effects of banks within countries. By simultaneously modelling regressions at both levels of aggregation, a HLM estimation takes into account that banks operating within a country are more similar to one another than banks from other countries. In addition, this approach allows the separation of the variance in bank profits explained by the bank-level versus country-level characteristics (Doumpos et al., 2015). The estimation employs an iterative maximum likelihood algorithm in which the fixed effects (i.e. the slope coefficients) and the random effects (i.e. those allowing the intercepts to be random and unique to every bank and country) are estimated simultaneously until the model converges.

The empirical results are shown in Table 11 and clearly show that both the size and the significance of the estimated coefficients are comparable to those of the last three columns of Table 5, thereby confirming the robustness of our results. It should be also noted that in all estimations of Table 11, the LR test comparing the HLM results with those coming from the linear regression (reported in the last row), favours the multi-level specification.

[Insert Table 11 about here]

5. Conclusions

Using bank-level data, we provide an in-depth empirical analysis on the relationship between alternative measures of bank capital and profitability in a large cross-country setting over 2000-2018. Our evidence suggests that, in line with the most recent literature, the relationship between capital and Return on Assets (ROA) is consistently positive, although overall the impact appears relatively marginal. This is true for all definitions of capital – both those that are linked to regulatory requirements and the crude leverage ratio. Having a global sample of banks operating in 125 developed and developing countries, allows us to test the impact of both bank-specific factors, shock factors (i.e. crises) as well as political and socio-economic ones. Our results suggest that the relationship between capital and profitability is usually stronger in crisis periods, for larger banks – although not for the largest i.e. the global systemically important ones –, and in lower and middle income countries. In addition, we find that in countries with more corrupt environments the same increase in capital is associated with more profitable institutions rather than banks operating in countries with lower corruption levels.

Our findings are robust to different specifications, endogeneity and robustness tests, and carry important implications for policy reforms aimed at ensuring both prosperity and soundness to the banking sector globally. Specifically, our evidence suggests that the regulatory focus on strengthening capital requirements does not appear to hinder banks' profit opportunities: actually, both Basel-based and traditional capital ratios show a positive, albeit modest, effect on banks' profits. This implies that reinforcing requirements on bank capital does not alter, but may even benefit, banks' profitability, which seems to offer some support Basel III's recommendations to impose constraints on supplementary capital. However, our findings also indicate that the impact of bank capital on profitability can be stronger in countries that are inherently more corrupt and politically unstable, hence supporting a regulatory approach that is more dynamic and accounts for country heterogeneity.

The findings that increases in bank capital do not appear to produce negative effects on bank profits lend support to the possibility that bank managers signal private information that bank prospects are good by increasing capital. Bankers may prefer higher leverage because of the superior returns from agency costs that more than counterbalance career penalties in case of bankruptcy or bail-out (Beltratti and Paladino, 2015, p. 56). In reality, they may also expect that stronger capital requirements will translate in a reduced capability to adapt to changes in the economic landscape, in the fear that – due to asymmetric information – rising capital would signal an overvaluation of the bank equity and hence a drop in share price after the issue of equity .

A crucial research issue would be to be able to establish the 'optimal' level of regulatory capital, that satisfies both bankers and regulatory authorities. In this context, the joint consideration of the effects of capital on risk and lending activity (two aspects of banks' activity that have important influence on real economy), besides profitability, could usefully provide additional insights on the optimal capital structure for banking firms. These questions are left to future research.

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Appendix A - Endogeneity and reverse causality issues

To assess whether our main results suffer from endogeneity and reverse causality problems, we first perform a series of Granger-causality tests to investigate the possibility that capital is causing profitability but at the same time there is reverse causation. In line with Berger (1995), we regress each variable y_t on three annual lags of both itself (y_{t-1}, y_{t-2}, y_{t-3}) and the other variable (x_{t-1}, x_{t-2}, x_{t-3}): there will be Granger-causality going from *x* to *y* if the coefficients of the three lagged *x*'s variables are statistically significantly different from zero. The two panels of Table A1 report the regression results of these simple causality regressions – involving our three definitions of capital – in a compact way (all control variables, time dummies and country dummies are included in the regressions) and the Granger-causality tests on capital and profitability coefficients.

[Insert Table A1 about here]

The sum of the coefficients of the three *TIER1RWA* lags amounts to 0.0049 and is statistically significantly different from zero at the 1% level: hence, higher levels of *TIER1RWA* seem to predict a higher future level of *ROA* (in line with our empirical evidence). In the same regression, the sum of the coefficients of the three *ROA* lags is equal to 0.5435 and is again significant at the 1% level, which indicates positive conditional serial correlation. On the other side, when we employ the same regressors but use *TIER1RWA* as the dependent variable (second column), we verify that the sum of the *ROA* gives -0.0374, a value that is not significantly different from zero, and conclude that *ROA* does not Granger-causes *TIER1RWA* (while the latter has significantly positive conditional serial correlation).

Columns from third to sixth of both tables report the results of similar regressions and tests for the other definitions of capital, from which we again deduce that, at the 5% level of significance, increases in capital normally predict higher future values of profits, but not vice versa. Similar to Berger (1995), we also find a higher R^2 value in the regressions with the capital as the dependent variable, which indicates that capital is more stable and predictable than profits.

Summing up, there is no evidence of reverse causality going from profits to capital.[3]

Another strategy for identifying possible presence of endogeneity is an instrumental variable regression implemented using the Generalized Method of Moments (IV-GMM). Particularly, we apply IV-GMM with robust standard errors (whose estimates are generally considered as more efficient than

[3] Even if this test makes us confident that we would not need to control for possible backward effects from ROA to capital, to account for the possibility that influences on a bank's profits could cause it to adjust its level of capital, we have nonetheless opted for using lagged values of the level of capital in our regressions.

the robust 2SLS estimates) and, to deal with potential endogeneity of the (lagged) bank capital variables, we use the second and third lags as instruments for *TIER1RWA*, and just the second lag as instrument for both *EQAST* and *CAPSURPLUS*. This choice relies on a canonical correlations test for assessing the redundancy of instruments (Hall and Peixe, 2003). For each regression, we have progressively added further *n*-order lags of the capital variables and tested the relevance of such group of instruments. We have then stopped adding them (thus finding the optimal number of lags) when the we have not been able to reject the null hypothesis that the *n*+1-order lag of the capital variables did not contribute to the asymptotic efficiency of the equation (i.e. its insertion in the IV-GMM regression was useless). Such included instruments are valid, as they should be correlated with the (lagged) capital but should not directly affect the level of bank profitability, and should also exhibit appropriate variation within a bank's observations over time. The IV-GMM estimation results for the full specification of our model are shown in Table A2.

[Insert Table A2 about here]

In terms of sign and significance of coefficients, they are virtually the same as those we obtained in Table 5: a higher bank capital allows greater ROA (even if the coefficient magnitudes are slightly higher for *TIER1RWA*, and slightly lower for *EQAST* and *CAPSURPLUS*). The same holds for the set of control variables. In addition, the first-stage regressions (not reported here) show that the lagged capital variables are always significant (for *TIER1RWA* this is supported also by the Sargan-Hansen test of overidentifying restrictions, as its null hypothesis cannot be rejected at the 5% level). Overall, we get confirmation of both the correct specification of the model and the validity of our choice of instruments, and hence of the overall estimates.

As a third approach to control for possible reverse causality between capital and profits, we employ a dynamic panel data approach, where the equation to be estimated has at least one lagged dependent variable on the right-hand side. Particularly, we use a two-step system GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998), where the first differenced values as well as lagged values are used as instruments for the lagged dependent variables. This estimator can be suitably employed when the left-hand-side variable is dynamic and depends on the past realizations, and some regressors may be endogenous. In addition, with respect to the first-difference GMM estimator, the system GMM can noticeably improve efficiency and avoid the weak instruments problem. It consists in the estimation of a system of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments). Hence, the system GMM estimation only requires 'internal' instruments.

Table A3 reports the results of the system-GMM estimations (still including all control variables and dummies). They again confirm the positive and significant relationship between our bank capital variables, on the one side, and ROA, on the other side. Also, the evidence regarding the control variables is generally coherent with the previous sets of results. We just note that the coefficients of both *LOANAST* and *GDPGROWTH* lose their significance, while *lnTOTAST* becomes significant. The rows with ROA_{t-1} confirm that there is persistence of profitability with no exceptions, as all lagged coefficients are positive and significantly different from zero. Their values range between 0.28 and 0.31, implying that higher than normal profits continued in banking markets over the years under study, even if to a modest extent, which highlights that in a global perspective banks are not much far from a competitive market structure, being able to retain only one fourth of their profit from year to year. Our evidence is somewhat in line with that of Goddard et al. (2011), who focus on 65 countries and estimate an average persistence of profits (measured through ROE) of 0.43.

[Insert Table A3 about here]

Regarding first-order and second-order serial correlation in the residuals of the estimated equations, as expected the AR(1) test is rejected (high first-order autocorrelation), while the AR(2) test cannot be rejected at the 5% significance level (no evidence of second-order autocorrelation). Under this respect, our GMM specification is consistent. In contrast, the Hansen tests of overidentifying restrictions (which verifies validity of the full instrument set) are rejected at the 5% level, thus casting doubts on the validity of instruments.[4]

[4] The failure of this test, however, could be justified by a couple of reasons. First, the Hansen test should not be relied upon too faithfully, as it is prone to weaknesses (Roodman, 2009: 98). Furthermore, while performing some Monte Carlo experiments to assess potential biases of the Sargan/Hansen test statistic, Blundell and Bond (2000) observe some tendency for these test statistics to reject a valid null hypothesis too often in these experiments, and that this tendency is greater at higher values of the autoregressive parameter.

Table 1 – List of variables

Variable	Description	Source
ROA	Net income/Total assets (%)	BankScope/BankFocus
TIER1RWA	Tier 1 capital/Risk weighted total assets (%, beginning of period)	BankScope/BankFocus
EQAST	Total equity/Total assets (%, beginning of period)	BankScope/BankFocus
CAPSURPLUS	(Total regulatory capital ratio-Minimum capital requirement ratio)/Minimum capital requirement ratio (beginning of period)	BankScope/BankFocus & World Bank
TOTAST	Total assets (millions 2010 USD)	BankScope/BankFocus
LIQUIDITY	(Non-customer deposits+Cash)/Total deposit (%)	BankScope/BankFocus
NPLs	Non-performing loans/Net loans (%)	BankScope/BankFocus
LOANAST	Net loans/Total assets (%)	BankScope/BankFocus
COSTREV	Total costs/Total revenue (%)	BankScope/BankFocus
NIRTR	Revenue from non-traditional activities/Total revenue (%)	BankScope/BankFocus
GDPGROWTH	GDP yearly rate of growth (%)	World Bank
CREDITGDP	Domestic credit to private sector by banks/GDP (%)	World Bank
CRISIS	Dummy for years with a banking crisis	Laeven and Valencia (2018)

This table provides a description of the variables used in our models as well as the data sources.

Table 2 – Descriptive statistics

Variable	**Mean**	**St.dev.**	**Min**	**Median**	**Max**	**N. obs.**
ROA	0.7327	1.0446	-6.4413	0.6528	13.5987	48,385
TIER1RWA	15.4043	8.3056	5.3400	13.3300	87.1854	48,385
EQAST	10.4249	5.0531	1.8792	9.3924	75.7584	48,385
CAPSURPLUS	1.0841	0.9748	-0.1014	0.8475	10.5000	48,385
TOTAST	35,806.36	183,121.00	4.90	1,590.90	4,119,619.00	48,385
LIQUIDITY	17.6462	16.6280	0.1021	12.9475	95.7345	48,385
NPLs	4.7548	6.6332	0.0051	2.4053	59.5659	48,385
LOANAST	60.5102	16.4884	0.1320	62.8270	91.8320	48,385
COSTREV	74.0354	14.0832	6.7392	74.9443	137.9352	48,385
NIRTR	21.3661	13.1329	0.0108	19.2851	94.9786	48,385
GDPGROWTH	2.3554	2.7245	-14.7585	2.1571	34.4662	48,385
CREDITGDP	73.6028	33.8039	0.1859	67.5855	308.9784	48,385
CRISIS	0.1084	0.3109	0	0	1	48,385

This table presents the descriptive statistics (mean, standard deviation, minimum, median and maximum) of the dependent variable (Return On Assets, ROA) and all explanatory variables included in the baseline model (for details, see Table 1).

Table 3 – Sample countries, number of banks, and number of observations

a) Number of banks and observations by country entering the sample

Country	# of Banks	# of Obs.	Country	# of Banks	# of Obs.	Country	# of Banks	# of Obs.
Albania	9	35	Honduras	2	4	Panama	48	299
Algeria	1	8	Hong Kong	30	336	Paraguay	9	37
Angola	15	44	Hungary	13	101	Peru	17	80
Armenia	15	94	Iceland	14	59	Philippines	33	235
Australia	72	392	India	87	817	Poland	38	213
Austria	48	255	Indonesia	117	647	Portugal	112	474
Azerbaijan	32	176	Ireland	14	80	Qatar	12	124
Bahrain	25	140	Israel	16	174	Republic of Korea	25	164
Bangladesh	49	210	Italy	810	7,289	Republic of Moldova	12	47
Belgium	18	106	Jamaica	9	38	Romania	23	143
Benin	1	12	Japan	271	990	Russian Federation	290	1,077
Bolivia	14	64	Jordan	18	222	Rwanda	9	31
Bosnia and Herzegovina	20	84	Kazakhstan	18	71	Saudi Arabia	12	180
Botswana	13	80	Kenya	39	209	Senegal	2	3
Brazil	160	601	Kosovo	5	18	Serbia	20	79
Bulgaria	21	171	Kuwait	11	107	Singapore	12	75
Burkina Faso	2	4	Kyrgyzstan	7	31	Slovakia	13	75
Cambodia	1	1	Latvia	9	45	Slovenia	16	95
Canada	28	121	Lebanon	25	147	South Africa	29	251
Cape Verde	5	18	Lithuania	7	31	Spain	108	462
Chile	23	150	Luxembourg	16	84	Sri Lanka	18	120
China	217	1,164	Macao	2	8	Swaziland	3	11
Colombia	23	99	Macedonia	9	44	Sweden	86	443
Costa Rica	2	2	Malawi	6	29	Switzerland	107	355
Cote d'Ivoire	1	3	Malaysia	53	284	Tajikistan	4	10
Croatia	27	132	Mali	2	4	Thailand	30	308
Czech Republic	21	132	Malta	8	38	Togo	1	15
Dem. Rep. of Congo	2	5	Mauritius	18	83	Trinidad and Tobago	6	15
Denmark	105	698	Mexico	49	328	Tunisia	7	19
Dominican Republic	10	10	Montenegro	6	21	Turkey	31	299
Ecuador	28	84	Morocco	9	41	Uganda	21	154
Egypt	8	13	Namibia	10	81	Ukraine	44	140
El Salvador	2	5	Nepal	23	126	United Arab Emirates	21	65
Estonia	9	60	Netherlands	37	204	United Kingdom	109	684
Finland	175	449	New Zealand	16	123	United Rep. of Tanzania	25	150
France	104	415	Nicaragua	3	15	USA	1,988	13,483
Germany	1,377	7,145	Niger	3	11	Uruguay	2	3
Ghana	20	96	Nigeria	22	89	Venezuela	1	1
Greece	16	92	Norway	151	1,128	Vietnam	5	13
Guatemala	1	1	Oman	10	117	Yemen	3	6
Guyana	5	30	Pakistan	34	162	Zimbabwe	15	83
Haiti	2	4	Palestinian Territories	6	23	*Total*	*8,109*	*48,385*

b) Number of observations included in the sample by year (pooled)

Year	# of Obs.
2000	588
2001	1,346
2002	1,857
2003	1,929
2004	1,893
2005	1,940
2006	1,691
2007	1,778
2008	2,049
2009	2,098
2010	2,232
2011	2,395
2012	2,630
2013	2,719
2014	3,680
2015	4,005
2016	4,653
2017	4,685
2018	4,217
Total	*48,385*

This table reports detailed account of the number of observations included in the sample by country (panel a) and by year (panel b).

Table 4 – Correlation matrix

	ROA(t)	*TIER1RWA(t-1)*	*EQAST(t-1)*	*CAPSURPLUS(t-1)*	*lnTOTAST(t-1)*	*LIQUIDITY(t-1)*	*NPLs(t-1)*	*LOANAST(t-1)*	*COSTREV(t-1)*	*NIRTR(t-1)*	*GDPGROWTH(t-1)*	*CREDITGDP(t-1)*	*CRISIS(t)*
ROA(t)	1												
TIER1RWA(t-1)	0.0982*	1											
EQAST(t-1)	0.2259*	0.6628*	1										
CAPSURPLUS(t-1)	0.0323*	0.9267*	0.5695*	1									
lnTOTAST(t-1)	0.0491*	-0.3467*	-0.3509*	-0.3141*	1								
LIQUIDITY(t-1)	-0.0072	0.0214*	0.0349*	-0.0088	0.2095*	1							
NPLs(t-1)	-0.1539*	0.1271*	0.1302*	0.0825*	-0.1583*	0.1307*	1						
LOANAST(t-1)	-0.0453*	-0.2510*	-0.0467*	-0.2437*	-0.0626*	-0.2324*	-0.1836*	1					
COSTREV(t-1)	-0.3644*	-0.0954*	-0.1501*	-0.0711*	-0.1118*	-0.0116*	-0.0786*	0.0090*	1				
NIRTR(t-1)	0.0872*	0.1167*	0.1019*	0.1291*	0.1004*	0.1351*	0.0313*	-0.2839*	-0.0430*	1			
GDPGROWTH(t-1)	0.2273*	-0.0242*	0.0186*	-0.0652*	0.1179*	0.0698*	-0.1315*	-0.0911*	-0.0887*	-0.0291*	1		
CREDITGDP(t-1)	-0.2008*	-0.0154*	-0.1818*	0.0631*	0.1797*	0.1175*	-0.0072	0.0076	-0.0423*	0.0308*	-0.1486*	1	
CRISIS(t)	-0.1352*	-0.0770*	-0.0263*	-0.0739*	0.0677*	-0.0612*	-0.0409*	0.1119*	0.1394*	-0.0952*	-0.1882*	0.0071	1

This table reports the correlation coefficients of the variables used in the empirical analysis over the period 2000-2018. Variable definitions are provided in Table 1. * denotes significance at the 5% level or better.

Table 5 – The relationship between capital and profitability (ROA): baseline regressions

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TIER1RWA(t-1)	0.0132***	-	-	0.0120***	-	-	0.0117***	-	-
	(8.92)			(8.33)			(8.16)		
EQAST(t-1)	-	0.0353***	-	-	0.0258***	-	-	0.0256***	-
		(11.67)			(9.69)			(9.66)	
CAPSURPLUS(t-1)	-	-	0.1038***	-	-	0.0921***	-	-	0.0899***
			(8.54)			(7.65)			(7.52)
lnTOTAST(t-1)	-	-	-	-0.0055	0.0001	-0.0084**	-0.0044	0.0016	-0.0072*
				(-1.48)	(0.03)	(-2.29)	(-1.18)	(0.43)	(-1.95)
LIQUIDITY(t-1)	-	-	-	-0.0033***	-0.0034***	-0.0033***	-0.0030***	-0.0032***	-0.0030***
				(-6.35)	(-6.80)	(-6.30)	(-5.85)	(-6.26)	(-5.79)
NPLs(t-1)	-	-	-	-0.0304***	-0.0307***	-0.0306***	-0.0298***	-0.0299***	-0.0299***
				(-17.50)	(-17.68)	(-17.58)	(-17.15)	(-17.31)	(-17.23)
LOANAST(t-1)	-	-	-	0.0011*	-0.0008*	0.0010*	0.0012**	-0.0006	0.0012**
				(1.90)	(-1.67)	(1.74)	(2.19)	(-1.25)	(2.04)
COSTREV(t-1)	-	-	-	-0.0278***	-0.0271***	-0.0279***	-0.0276***	-0.0268***	-0.0277***
				(-41.68)	(-40.73)	(-41.69)	(-41.41)	(-40.48)	(-41.43)
NIRTR(t-1)	-	-	-	0.0095***	0.0081***	0.0095***	0.0090***	0.0077***	0.0090***
				(11.11)	(9.85)	(11.15)	(10.51)	(9.24)	(10.54)
GDPGROWTH(t-1)	-	-	-	-	-	-	0.0081*	0.0104**	0.0081**
							(1.96)	(2.53)	(1.97)
CREDITGDP(t-1)	-	-	-	-	-	-	-0.0056***	-0.0055***	-0.0057***
							(-10.40)	(-10.27)	(-10.58)
CRISIS(t)	-	-	-	-	-	-	-0.1629***	-0.1629***	-0.1605***
							(-6.31)	(-6.33)	(-6.22)
N	48,385	48,385	48,385	48,385	48,385	48,385	48,385	48,385	48,385
R^2	0.2119	0.2258	0.2107	0.3628	0.3675	0.3617	0.3672	0.3721	0.3662

This table reports the OLS estimates of our baseline model (Equation 1) for the full sample that allows us to assess the impact of bank capital on profitability. The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 6 – The relation between capital and profitability (ROA): non-crisis vs. crisis years

	COUNTRY- SPECIFIC BANKING CRISES (years vary by country)			*GLOBAL FINANCIAL CRISIS* (years vary by country)		
Variable	(1)	(2)	(3)	(1)	(2)	(3)
TIER1RWA(t-1)×NOCRISIS(t-1)	0.0117***	-	-	0.0108***	-	-
	(8.09)			(7.62)		
TIER1RWA(t-1)×CRISIS(t-1)	0.0117***	-	-	0.0226***	-	-
	(6.03)			(6.72)		
EQAST(t-1)×NOCRISIS(t-1)	-	0.0263***	-	-	0.0242***	-
		(9.79)			(9.10)	
EQAST(t-1)×CRISIS(t-1)	-	0.0184***	-	-	0.0375***	-
		(5.60)			(7.77)	
CAPSURPLUS(t-1)×NOCRISIS(t-1)	-	-	0.0859***	-	-	0.0819***
			(7.16)			(6.96)
CAPSURPLUS(t-1)×CRISIS(t-1)	-	-	0.1351***	-	-	0.1964***
			(6.75)			(5.28)
lnTOTAST(t-1)	-0.0047	0.0016	-0.0077**	-0.0044	0.0014	-0.0071*
	(-1.28)	(0.42)	(-2.08)	(-1.19)	(0.38)	(-1.93)
LIQUIDITY(t-1)	-0.0030***	-0.0032***	-0.0030***	-0.0030***	-0.0032***	-0.0030***
	(-5.87)	(-6.33)	(-5.80)	(-5.78)	(-6.20)	(-5.74)
NPLs(t-1)	-0.0301***	-0.0301***	-0.0303***	-0.0297***	-0.0299***	-0.0299***
	(-17.31)	(-17.38)	(-17.43)	(-17.18)	(-17.32)	(-17.33)
LOANAST(t-1)	0.0012**	-0.0006	0.0012**	0.0012**	-0.0006	0.0012**
	(2.16)	(-1.30)	(2.07)	(2.18)	(-1.22)	(2.02)
COSTREV(t-1)	-0.0278***	-0.0270***	-0.0279***	-0.0276***	-0.0268***	-0.0277***
	(-41.57)	(-40.53)	(-41.75)	(-41.40)	(-40.51)	(-41.47)
NIRTR(t-1)	0.0091***	0.0078***	0.0091***	0.0091***	0.0077***	0.0091***
	(10.58)	(9.34)	(10.61)	(10.58)	(9.34)	(10.58)
GDPGROWTH(t-1)	0.0111***	0.0106**	0.0128***	0.0085**	0.0104**	0.0087**
	(2.63)	(2.52)	(3.01)	(2.07)	(2.54)	(2.11)
CREDITGDP(t-1)	-0.0061***	-0.0060***	-0.0061***	-0.0056***	-0.0056***	-0.0057***
	(-11.26)	(-11.26)	(-11.41)	(-10.45)	(-10.30)	(-10.57)
CRISIS(t)	-	-	-	-0.1146***	-0.1243***	-0.1317***
				(-4.50)	(-4.89)	(-5.20)
N	48,385	48,385	48,385	48,385	48,385	48,385
R^2	0.3663	0.3715	0.3655	0.3683	0.3727	0.3670
CAP×NOCRISIS=CAP×CRISIS (F-test)	0.00	10.30***	8.23***	14.52***	9.22***	9.97***
CAP×NOCRISIS=CAP×CRISIS (p-value)	0.99	0.00	0.00	0.00	0.00	0.00

This table reports the OLS estimates of a variation of our baseline model (Equation 1) for the full sample that allows us to consider the role of both individual countries' banking crisis (Models 1-3) and the GFC (Models 4-6): the dummy variables *NOCRISIS* and *CRISIS* interact the capital variables. The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 7 – The relation between capital and profitability (ROA): estimations for bank size subgroups

Variable	(1)	(2)	(3)
TIER1RWA(t-1)×SMALL(t-1)	0.0099***	-	-
	(6.76)		
TIER1RWA(t-1)×MEDIUM(t-1)	0.0130***	-	-
	(7.79)		
TIER1RWA(t-1)×LARGE(t-1)	0.0174***	-	-
	(8.07)		
TIER1RWA(t-1)×GSIBs(t-1)	-0.0019	-	-
	(-0.59)		
EQAST(t-1)×SMALL(t-1)	-	0.0219***	-
		(7.65)	
EQAST(t-1)×MEDIUM(t-1)	-	0.0287***	-
		(9.88)	
EQAST(t-1)×LARGE(t-1)	-	0.0336***	-
		(9.86)	
EQAST(t-1)×GSIBs(t-1)	-	-0.0065	-
		(-1.10)	
CAPSURPLUS(t-1)×SMALL(t-1)	-	-	0.0736***
			(5.94)
CAPSURPLUS(t-1)×MEDIUM(t-1)	-	-	0.1006***
			(6.45)
CAPSURPLUS(t-1)×LARGE(t-1)	-	-	0.1427***
			(6.43)
CAPSURPLUS(t-1)×GSIBs(t-1)	-	-	-0.0519
			(-1.29)
lnTOTAST(t-1)	-0.0187***	-0.0136**	-0.0159***
	(-3.66)	(-2.46)	(-3.42)
LIQUIDITY(t-1)	-0.0030***	-0.0031***	-0.0030***
	(-5.83)	(-6.11)	(-5.81)
NPLs(t-1)	-0.0296***	-0.0298***	-0.0298***
	(-17.03)	(-17.28)	(-17.16)
LOANAST(t-1)	0.0012**	-0.0008*	0.0012**
	(2.17)	(-1.77)	(2.01)
COSTREV(t-1)	-0.0275***	-0.0266***	-0.0276***
	(-41.93)	(-41.08)	(-41.95)
NIRTR(t-1)	0.0090***	0.0074***	0.0090***
	(10.47)	(9.11)	(10.51)
GDPGROWTH(t-1)	0.0081**	0.0102**	0.0081*
	(1.97)	(2.48)	(1.95)
CREDITGDP(t-1)	-0.0056***	-0.0055***	-0.0057***
	(-10.33)	(-10.15)	(-10.53)
CRISIS(t)	-0.1638***	-0.1658***	-0.1615***
	(-6.36)	(-6.46)	(-6.26)
N	48,385	48,385	48,385
R^2	0.3678	0.3729	0.3667
CAP×SMALL=CAP×MEDIUM (F-test)	7.69***	11.63***	4.38**
CAP×SMALL=CAP×MEDIUM (p-value)	0.01	0.00	0.04
CAP×MEDIUM =CAP×LARGE (F-test)	7.62***	3.44*	4.27**
CAP×MEDIUM =CAP×LARGE (p-value)	0.01	0.06	0.04
CAP×SMALL=CAP×LARGE (F-test)	14.25***	11.73***	9.18***
CAP×SMALL=CAP×LARGE (p-value)	0.00	0.00	0.00

This table reports the OLS estimates of a variation of our baseline model (Equation 1) for the full sample that accounts for different bank sizes (*SMALL* = banks below the first quartile of the yearly distribution of total assets; *MEDIUM* = banks in the second and third quartiles of the yearly total assets distribution; *LARGE* = banks with total assets in the fourth quartile of the yearly distribution; *GSIBs* = systemically important banks; such dummy variables interact the capital variables). The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 8 – The relation between capital and profitability (ROA): estimations for country income level subgroups

Variable	(1)	(2)	(3)
TIER1RWA(t-1)×LOWMIDDLE(t-1)	0.0175***	-	-
	(6.40)		
TIER1RWA(t-1)×HIGH(t-1)	0.0088***	-	-
	(5.58)		
EQAST(t-1)×LOWMIDDLE(t-1)	-	0.0262***	-
		(6.21)	
EQAST(t-1)×HIGH(t-1)	-	0.0250***	-
		(7.87)	
CAPSURPLUS(t-1)×LOWMIDDLE(t-1)	-	-	0.1565***
			(6.25)
CAPSURPLUS(t-1)×HIGH(t-1)	-	-	0.0653***
			(5.07)
lnTOTAST(t-1)	-0.0046	0.0015	-0.0068*
	(-1.24)	(0.41)	(-1.85)
LIQUIDITY(t-1)	-0.0032***	-0.0032***	-0.0032***
	(-6.24)	(-6.20)	(-6.23)
NPLs(t-1)	-0.0298***	-0.0299***	-0.0300***
	(-17.18)	(-17.29)	(-17.30)
LOANAST(t-1)	0.0010*	-0.0006	0.0009
	(1.70)	(-1.26)	(1.57)
COSTREV(t-1)	-0.0276***	-0.0268***	-0.0277***
	(-41.33)	(-40.76)	(-41.38)
NIRTR(t-1)	0.0089***	0.0077***	0.0089***
	(10.32)	(9.31)	(10.30)
GDPGROWTH(t-1)	0.0088**	0.0105**	0.0089**
	(2.14)	(2.54)	(2.16)
CREDITGDP(t-1)	-0.0056***	-0.0055***	-0.0058***
	(-10.45)	(-10.25)	(-10.69)
CRISIS(t)	-0.1640***	-0.1627***	-0.1608***
	(-6.36)	(-6.33)	(-6.23)
N	48,385	48,385	48,385
R^2	0.3681	0.3721	0.3673
CAP×LOWMIDDLE=CAP×HIGH (F-test)	8.16***	0.05	11.11***
CAP×LOWMIDDLE=CAP×HIGH (p-value)	0.00	0.82	0.00

This table reports the OLS estimates of a variation of our baseline model (Equation 1) for the full sample that accounts for different income levels of the countries to whom banks belong using the World Bank classification (*LOWMIDDLE* = the country is classified as a low or middle income country; *HIGH* = the country is regarded as high income; such dummy variables interact the capital variables). The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 9 – The relation between capital and profitability (ROA): economic, political and social characteristics

	ECONOMIC FREEDOM			POLITICAL STABILITY			CORRUPTION CONTROL		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TIER1RWA(t-1)×LOW(t-1)	0.0127***	-	-	0.0110***	-	-	0.0139***	-	-
	(8.15)			(6.83)			(9.04)		
TIER1RWA(t-1)×HIGH(t-1)	0.0103***	-	-	0.0125***	-	-	0.0082***	-	-
	(5.65)			(8.74)			(4.51)		
EQAST(t-1)×LOW(t-1)	-	0.0259***	-	-	0.0239***	-	-	0.0275***	-
		(9.14)			(8.37)			(9.69)	
EQAST(t-1)×HIGH(t-1)	-	0.0249***	-	-	0.0289***	-	-	0.0212***	-
		(6.93)			(11.14)			(6.23)	
CAPSURPLUS(t-1)×LOW(t-1)	-	-	0.1033***	-	-	0.0949***	-	-	0.1180***
			(7.62)			(6.52)			(8.79)
CAPSURPLUS(t-1)×HIGH(t-1)	-	-	0.0740***	-	-	0.0845***	-	-	0.0517***
			(4.56)			(7.01)			(3.25)
lnTOTAST(t-1)	-0.0044	0.0015	-0.0070*	-0.0044	0.0019	-0.0071*	-0.0044	0.0012	-0.0070*
	(-1.18)	(0.42)	92	(-1.19)	(0.51)	(-1.94)	(-1.20)	(0.33)	(-1.92)
LIQUIDITY(t-1)	-0.0031***	-0.0032***	-0.0030***	-0.0030***	-0.0031***	-0.0030***	-0.0031***	-0.0032***	-0.0031***
	(-5.93)	(-6.27)	(-5.89	(-5.79)	(-6.17)	(-5.86)	(-6.07)	(-6.36)	(-6.06)
NPLs(t-1)	-0.0298***	-0.0299***	-0.0300***	-0.0297***	-0.0298***	-0.0300***	-0.0301***	-0.0300***	-0.0303***
	(-17.14)	(-17.33)	(-17.22)	(-17.10)	(-17.24)	(-17.27)	(-17.17)	(-17.30)	(-17.30)
LOANAST(t-1)	0.0012**	-0.0006	0.0012**	0.0012**	-0.0006	0.0012**	0.0012**	-0.0006	0.0012**
	(2.18)	(-1.25)	(2.02)	(2.17)	(-1.31)	(2.05)	(2.16)	(-1.16)	(2.00)
COSTREV(t-1)	-0.0276***	-0.0268***	-0.0276***	-0.0277***	-0.0269***	-0.0276***	-0.0275***	-0.0269***	-0.0276***
	(-41.07)	(-40.92)	(-41.09)	(-41.14)	(-40.43)	(-41.16)	(-41.08)	(-40.89)	(-41.12)
NIRTR(t-1)	0.0090***	0.0077***	0.0090***	0.0090***	0.0076***	0.0091***	0.0090***	0.0077***	0.0090***
	(10.52)	(9.31)	(10.54)	(10.46)	(9.13)	(10.57)	(10.43)	(9.28)	(10.49)
GDPGROWTH(t-1)	0.0084**	0.0105**	0.0085**	0.0079*	0.0100**	0.0083**	0.0089**	0.0109***	0.0090**
	(2.03)	(2.54)	(2.05)	(1.91)	(2.43)	(2.00)	(2.14)	(2.63)	(2.16)
CREDITGDP(t-1)	-0.0055***	-0.0055***	-0.0057***	-0.0056***	-0.0054***	-0.0058***	-0.0052***	-0.0053***	-0.0054***
	(-10.15)	(-10.15)	(-10.40)	(-10.33)	(-10.02)	(-10.64)	(-9.39)	(-9.56)	(-9.80)
CRISIS(t)	-0.1622***	-0.1625***	-0.1600***	-0.1587***	-0.1532***	-0.1622***	-0.1845***	-0.1788***	-0.1778***
	(-6.29)	(-6.32)	(-6.20)	(-6.04)	(-5.84)	(-6.22)	(-6.94)	(-6.61)	(-6.80)
N	48,385	48,385	48,385	48,385	48,385	48,385	48,385	48,385	48,385
R^2	0.3673	0.3721	0.3664	0.3673	0.3723	0.3663	0.3678	0.3723	0.3671
CAP×LOW=CAP×HIGH(F-test)	1.80	0.08	2.76*	1.96	7.56***	0.72	11.83***	4.18**	15.86***
CAP×LOW=CAP×HIGH(p-value)	0.18	0.78	0.10	0.16	0.01	0.40	0.00	0.04	0.00

This table reports the OLS estimates of a variation of our baseline model (Equation 1) for the full sample that accounts for economic (Models 1-3), political (Models 4-6) and social (Models 7-9) characteristics of the countries to whom banks belong. *ECONOMIC FREEDOM*, *POLITICAL STABILITY* and *CORRUPTION CONTROL* are measured through the Index of Economic Freedom (Heritage Foundation), the 'Political Stability and Absence of Violence' Index (World Bank) and the 'Corruption control' Index (World Bank), respectively. For each of them we create two dummy variables, *LOW* and *HIGH*, marking each country for which the index is below or above the sample median value, respectively, and interact the capital variables. The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 10 – The relationship between capital and profitability (ROA): robustness estimates

	BANKS WITH AT LEAST 15 OBSERVATIONS OVER 19			*EXCLUDING US BANKS*			*BANKS WITH MODERATE ANNUAL CHANGES IN CAPITAL VARIABLES*		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TIER1RWA(t-1)	0.0174***			0.0115***			0.0111***		
	(3.45)			(8.17)			(6.70)		
EQAST(t-1)		0.0381***			0.0266***			0.0245***	
		(3.80)			(9.44)			(8.38)	
CAPSURPLUS(t-1)			0.1317***			0.0864***			0.0835***
			(3.22)			(7.61)			(6.16)
lnTOTAST(t-1)	-0.0208***	-0.0291***	-0.0262***	-0.0009	0.0123***	-0.0040	-0.0024	-0.0029	-0.0049
	(-2.64)	(-3.89)	(-3.49)	(-0.20)	(2.72)	(-0.90)	(-0.66)	(-0.82)	(-1.29)
LIQUIDITY(t-1)	-0.0053***	-0.0046***	-0.0054***	-0.0035***	-0.0038***	-0.0034***	-0.0029***	-0.0031***	-0.0027***
	(-3.92)	(-3.37)	(-3.99)	(-6.61)	(-7.34)	(-6.54)	(-5.34)	(-5.78)	(-4.49)
NPLs(t-1)	-0.0345***	-0.0331***	-0.0349***	-0.0262***	-0.0264***	-0.0263***	-0.0329***	-0.0302***	-0.0269***
	(-12.19)	(-11.34)	(-12.47)	(-15.79)	(-15.93)	(-15.84)	(-15.49)	(-15.45)	(-12.71)
LOANAST(t-1)	0.0022	-0.0006	0.0019	0.0003	-0.0016***	0.0003	0.0014**	-0.0001	0.0022***
	(1.24)	(-0.51)	(1.04)	(0.57)	(-3.08)	(0.46)	(2.34)	(-0.07)	(3.46)
COSTREV(t-1)	-0.0248***	-0.0243***	-0.0250***	-0.0258***	-0.0250***	-0.0258***	-0.0232***	-0.0230***	-0.0229***
	(-15.76)	(-16.25)	(-15.50)	(-35.07)	(-33.68)	(-35.00)	(-32.42)	(-34.42)	(-32.98)
NIRTR(t-1)	0.0130***	0.0119***	0.0128***	0.0065***	0.0051***	0.0066***	0.0089***	0.0076***	0.0098***
	(5.93)	(5.89)	(5.87)	(7.52)	(5.88)	(7.63)	(8.93)	(8.58)	(10.17)
GDPGROWTH(t-1)	0.0032	0.0059	0.0028	0.0023	0.0047	0.0024	0.0081	0.0127**	0.0030
	(0.57)	(1.08)	(0.48)	(0.54)	(1.10)	(0.55)	(1.56)	(2.57)	(0.53)
CREDITGDP(t-1)	-0.0046***	-0.0035***	-0.0035***	-0.0049***	-0.0049***	-0.0051***	-0.0047***	-0.0060***	-0.0047***
	(-5.22)	(-3.86)	(-5.24)	(-7.94)	(-8.07)	(-8.22)	(-8.30)	(-10.44)	(-6.93)
CRISIS(t)	-0.1418***	-0.1391***	-0.1391***	0.0644	0.0544	0.0699*	-0.1755***	-0.0962***	-0.1767***
	(-4.55)	(-4.49)	(-4.54)	(1.62)	(1.37)	(1.76)	(-5.91)	(-3.52)	(-5.64)
N	11,993	11,993	11,993	34,902	34,902	34,902	28,072	31,299	26,616
R^2	0.4277	0.4324	0.4260	0.3860	0.3921	0.3847	0.4042	0.4108	0.3982

This table reports the results of robustness tests that are carried out on subsamples considering: (i) only banks for which at least 75% of observations are available during the sample period (i.e. at least 15 over 19) (Models 1-3); (ii) only non-US banks (Models 4-6); (iii) only banks for which we observe *moderate* annual changes in the capital variables values (between -10% and +10% for *TIER1RWA* and *EQAST*; between 20% and +20% for *CAPSURPLUS*) (Models 7-9). The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level.

Table 11 – The relationship between capital and profitability (ROA): HLM estimates

Variable	(1)	(2)	(3)
Fixed-effects parameters			
TIER1RWA(t-1)	0.0097***		
	(13.29)		
EQAST(t-1)		0.0215***	
		(18.53)	
CAPSURPLUS(t-1)			0.0759***
			(12.33)
lnTOTAST(t-1)	-0.0030	0.0033	-0.0049
	(-0.73)	(0.83)	(-1.22)
LIQUIDITY(t-1)	-0.0038***	-0.0038***	-0.0037***
	(-11.03)	(-11.24)	(-10.99)
NPLs(t-1)	-0.0317***	-0.0315***	-0.0318***
	(-40.81)	(-40.71)	(-40.98)
LOANAST(t-1)	-0.0004	-0.0019***	-0.0004
	(-0.91)	(-4.96)	(-0.96)
COSTREV(t-1)	-0.0196***	-0.0195***	-0.0197***
	(-57.43)	(-57.06)	(-57.47)
NIRTR(t-1)	0.0070***	0.0062***	0.0070***
	(16.05)	(14.21)	(16.19)
GDPGROWTH(t-1)	0.0109***	0.0117***	0.0108***
	(4.76)	(5.13)	(4.73)
CREDITGDP(t-1)	-0.0054***	-0.0053***	-0.0055***
	(-13.52)	(-13.36)	(-13.73)
CRISIS(t)	-0.1855***	-0.1848***	-0.1838***
	(-10.81)	(-10.77)	(-10.71)
Random-effects parameters			
Country-level variance	0.2202	0.1969	0.2307
Standard error	0.0345	0.0314	0.0360
Bank-level variance	0.2793	0.2693	0.2806
Standard error	0.0077	0.0075	0.0077
Residual variance	0.4962	0.4967	0.4961
Standard error	0.0036	0.0036	0.0036
N	48,385	48,385	48,385
Countries	125	125	125
Banks	8,109	8,109	8,109
LR test (estimated model vs. linear model) – χ^2 value	11,483.97***	10,320.79***	11,846.51***

This table reports the results derived from the estimation of our baseline model (Equation 1) for the full sample by means of a hierarchical linear model (HLM), which employs an iterative maximum likelihood algorithm where the fixed effects (i.e. the slope coefficients) and the random effects (i.e. those allowing the intercepts to be random and unique to every bank and country) are estimated simultaneously until the model converges. The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *z*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level. The LR test compares the estimated models with linear regressions. The null hypothesis is that there is no significant difference between the two models (if rejected, we conclude that there is a statistically significant difference between the models which favours the multi-level specification).

Table A1 – Granger-causality estimations and tests between capital and profitability

a) Regression results

	Dependent variables					
	ROA(t)	*TIER1RWA(t)*	*ROA(t)*	*EQAST(t)*	*ROA(t)*	*CAPSURPLUS(t)*
ROA(t-1)	0.4794***	0.0624	0.4479***	-0.0121	0.4613***	-0.0068
	(19.84)	(1.06)	(19.20)	(-0.31)	(19.03)	(-1.00)
ROA(t-2)	0.0418***	-0.1334**	0.0476***	-0.0577	0.0569***	-0.0089
	(2.65)	(-2.36)	(3.44)	(-1.41)	(3.74)	(-1.61)
ROA(t-3)	0.0223**	0.0336	0.0320***	0.0376	0.0226**	0.0040
	(2.34)	(1.07)	(3.60)	(1.53)	(2.39)	(1.06)
TIER1RWA(t-1)	0.0021	0.8358***	-	-	-	-
	(0.74)	(34.95)				
TIER1RWA(t-2)	0.0039	0.0449*	-	-	-	-
	(1.35)	(1.84)				
TIER1RWA(t-3)	-0.0011	0.0175	-	-	-	-
	(-0.56)	(1.27)				
EQAST(t-1)	-	-	0.0073	0.9208***	-	-
			(1.37)	(44.26)		
EQAST(t-2)	-	-	-0.0047	-0.0061	-	-
			(-0.82)	(-0.26)		
EQAST(t-2)	-	-	0.0027	-0.0025	-	-
			(0.83)	(-0.20)		
CAPSURPLUS(t-1)	-	-	-	-	0.0105	0.8760***
					(0.46)	(48.44)
CAPSURPLUS(t-2)	-	-	-	-	0.0369	0.0097
					(1.55)	(0.41)
CAPSURPLUS(t-3)	-	-	-	-	-0.0118	0.0136
					(-0.81)	(0.88)
N	37,303	36,832	39,318	39,254	37,404	37,000
R^2	0.5171	0.8374	0.5032	0.8535	0.5091	0.8409

b) Tests on estimated coefficients

		Dependent variables					
		ROA	*TIER1RWA*	*ROA*	*EQAST*	*ROA*	*CAPSURPLUS*
Lagged regressors	*ROA*	0.5435***	-0.0374	0.5274***	-0.0323	0.5408***	-0.0117*
		(622.93)	(0.44)	(589.70)	(0.72)	(630.72)	(2.85)
	TIER1RWA	0.0049***	0.8982***	-	-	-	-
		(18.86)	(9910.74)				
	EQAST	-	-	0.0053**	0.9122***	-	-
				(5.96)	(14273.34)		
	CAPSURPLUS	-	-	-	-	0.0356***	0.8994***
						(15.57)	(9808.06)

This table reports the results of causality regressions involving our three definitions of capital and the Granger-causality tests on capital and profitability coefficients. Panel a) shows the estimated coefficients of three annual lags of both capital variables and *ROA*. All models include control variables (all lagged by one year, except *CRISIS*: see Table 1 for their definitions), country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level. Panel (b) displays the sum of the estimated coefficients of the three lags of the row variables in regressions where the dependent variables are the column variables (see the table above) and the related significance tests. *t*-values are displayed in parentheses. Significance for the coefficient sums: *** = 1% level; ** = 5% level; * = 10% level.

Table A2 – The relationship between capital and profitability (ROA): IV-GMM estimates

Variable	(1)	(2)	(3)
TIER1RWA(t-1)	0.0159*** (7.43)	-	-
EQAST(t-1)	-	0.0195*** (6.56)	-
CAPSURPLUS(t-1)	-	-	0.0854*** (5.79)
lnTOTAST(t-1)	0.0021 (0.51)	-0.0016 (-0.40)	-0.0037 (-0.95)
LIQUIDITY(t-1)	-0.0029*** (-4.98)	-0.0034*** (-6.38)	-0.0033*** (-6.03)
NPLs(t-1)	-0.0325*** (-16.20)	-0.0321*** (-17.42)	-0.0317*** (-17.11)
LOANAST(t-1)	0.0016** (2.31)	-0.0007 (-1.44)	0.0009 (1.38)
COSTREV(t-1)	-0.0264*** (-35.38)	-0.0270*** (-39.05)	-0.0276*** (-38.68)
NIRTR(t-1)	0.0094*** (9.65)	0.0080*** (9.20)	0.0089*** (9.56)
GDPGROWTH(t-1)	0.0078* (1.70)	0.0110** (2.55)	0.0080* (1.83)
CREDITGDP(t-1)	-0.0055*** (-9.21)	-0.0058*** (-10.49)	-0.0059*** (-10.42)
CRISIS(t)	-0.1707*** (-6.17)	-0.1479*** (-5.62)	-0.1476*** (-5.58)
N	37,411	43,989	42,810
R^2	0.2144	0.2162	0.2089
# lags of the capital variable included as instruments	2	1	1
J statistic	0.0762 (0.7825)	-	-

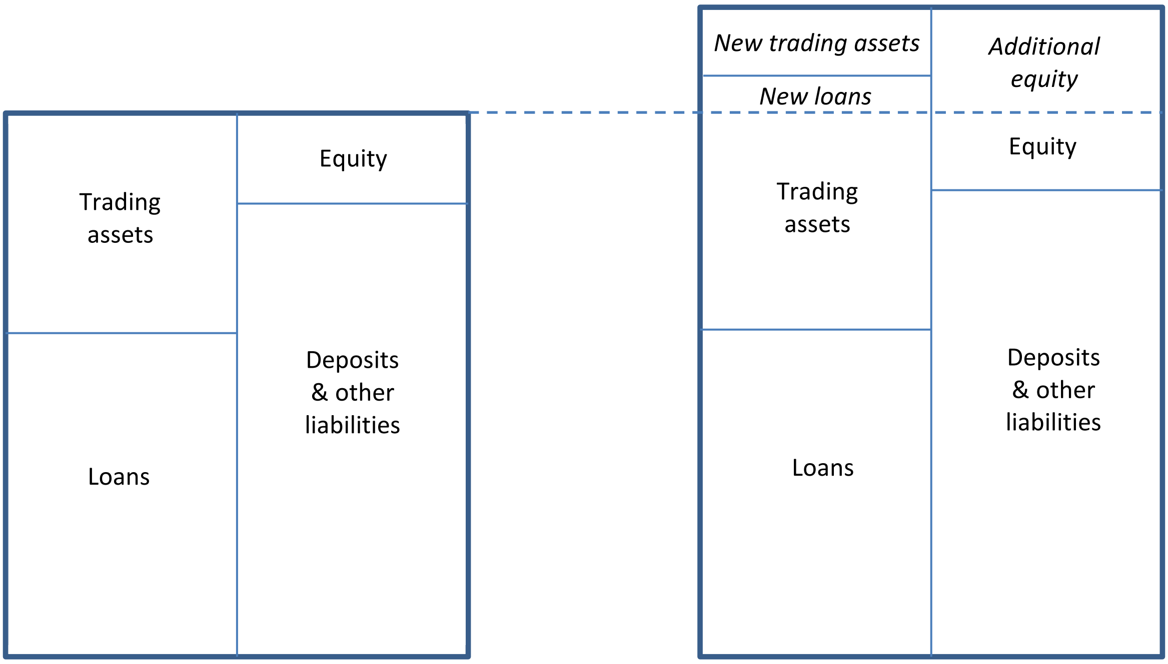
This table reports the IV-GMM estimates of our baseline model (Equation 1). The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *z*-values are displayed in parentheses. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level. The *n*-order lagged capital variables to be inserted as instruments have been assessed by means of the redundancy test by Hall and Peixe (2003). The null hypothesis of the Sargan-Hansen *J* test of overidentifying restrictions is that the instruments are valid instruments (i.e., uncorrelated with the error term) and that the excluded instruments are correctly excluded from the estimated equation (*p*-value in parentheses).

Table A3 – The relationship between capital and profitability (ROA): system GMM estimates

Variable	(1)	(2)	(3)
TIER1RWA(t-1)	0.0139***	-	-
	(3.60)		
EQAST(t-1)	-	0.0316***	-
		(4.79)	
CAPSURPLUS(t-1)	-	-	0.1030***
			(3.49)
ROA(t-1)	0.2768***	0.2887***	0.3107***
	(14.69)	(15.75)	(15.58)
lnTOTAST(t-1)	-0.0596***	-0.0519***	-0.0548***
	(-3.83)	(-3.40)	(-3.58)
LIQUIDITY(t-1)	-0.0044***	-0.0039***	-0.0045***
	(-4.68)	(-4.12)	(-4.53)
NPLs(t-1)	-0.0426***	-0.0419***	-0.0402***
	(-11.74)	(-11.27)	(-11.02)
LOANAST(t-1)	-0.0009	-0.0030***	-0.0007
	(-0.57)	(-1.99)	(-0.43)
COSTREV(t-1)	-0.0113***	-0.0109***	-0.0093***
	(-10.91)	(-9.81)	(-7.84)
NIRTR(t-1)	-0.0062***	-0.0082***	-0.0054***
	(-4.42)	(-5.06)	(-3.05)
GDPGROWTH(t-1)	-0.0034	-0.0017	-0.0033
	(-1.09)	(-0.44)	(-0.87)
CREDITGDP(t-1)	-0.0036***	-0.0038***	-0.0034***
	(-7.76)	(-8.38)	(-6.73)
CRISIS(t)	-0.1289***	-0.1128***	-0.1349***
	(-7.11)	(-5.89)	(-6.40)
N	47,541	48,277	47,723
AR(1)	-14.97	-15.77	-15.22
AR(1) (p-value)	0.00	0.00	0.00
AR(2)	0.18	0.46	0.71
AR(2) (p-value)	0.86	0.64	0.48
Hansen J test	756.72	733.71	688.50
Hansen J test (p-value)	0.00	0.00	0.00

This table reports the system GMM estimates of our baseline model (Equation 1). The dependent variable is *ROA*. Variables definitions are provided in Table 1. Independent variables are lagged by one year, except *CRISIS*. Capital variables are treated as endogenous; bank variables are treated as predetermined; country-level variables, time dummies and country dummies are treated as exogenous. Regressors have been instrumented by their second to fifth lags order lags. All regressions include country and time fixed effects (coefficients are not reported). Standard errors are clustered at bank level. *t*-values are displayed in parentheses and are based on two-step standard errors clustered by bank and incorporating the Windmeijer correction. Significance for the parameter estimates: *** = 1% level; ** = 5% level; * = 10% level. The AR(1) and AR(2) tests check for the presence of first-order and second-order serial correlation in the residuals of the estimated equations, respectively. The Hansen *J* statistic tests the instruments' joint validity.

Figure 1 – Asset expansion as a response to increased capital requirement



This figure shows a hypothetical example where, because of increased capital requirements, a bank expands its balance sheet by raising additional equity capital and using the proceeds to acquire new assets.
Source: Adapted from Admati et al. (2013).