BANK FOR INTERNATIONAL SETTLEMENTS

# BIS Working Papers

No 558

# Why bank capital matters for monetary policy

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Monetary and Economic Department

April 2016

JEL classification: E44; E51; E52

Keywords: Bank capital, book equity, monetary transmission mechanisms, funding, bank lending

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## Abstract

One aim of post-crisis monetary policy has been to ease credit conditions for borrowers by unlocking bank lending. We find that bank equity is an important determinant of both the bank's funding cost and its lending growth. In a cross-country bank-level study, we find that a 1 percentage point increase in the equity-to-total assets ratio is associated with a 4 basis point reduction in debt financing and with a 0.6 percentage point increase in annual loan growth.

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# 1. Introduction

The drying up of the supply of bank credit in the immediate aftermath of the financial crisis has been a key backdrop in the debate on the appropriate post-crisis monetary policy response. Tighter credit supply impairs the transmission of monetary policy to the real economy. Unlocking bank lending to the real economy has therefore been a key objective of monetary policy. For instance, the asset purchase programme of the European Central Bank (ECB) has been explicitly couched in terms of unblocking the transmission of accommodative financial conditions through banks to ultimate borrowers (Coeuré, 2014; Draghi, 2014). The first phase of the Federal Reserve's asset purchase programme (QE1) was similarly couched in terms of channelling credit to the real economy through direct purchases of mortgage-backed securities (Adrian and Shin, 2009; Gagnon et al, 2010).

In parallel, bank capitalisation has received attention from financial supervisors and central banks, but here, the focus has been on the solvency of banks. For instance, the European Banking Authority's (EBA) 2014 asset quality review and stress test exercise for European banks focused on the capital adequacy of banks, where bank capital is viewed as a loss-absorbing buffer that enhances bank solvency in the face of adverse macroeconomic shocks (eg Steffen, 2014).

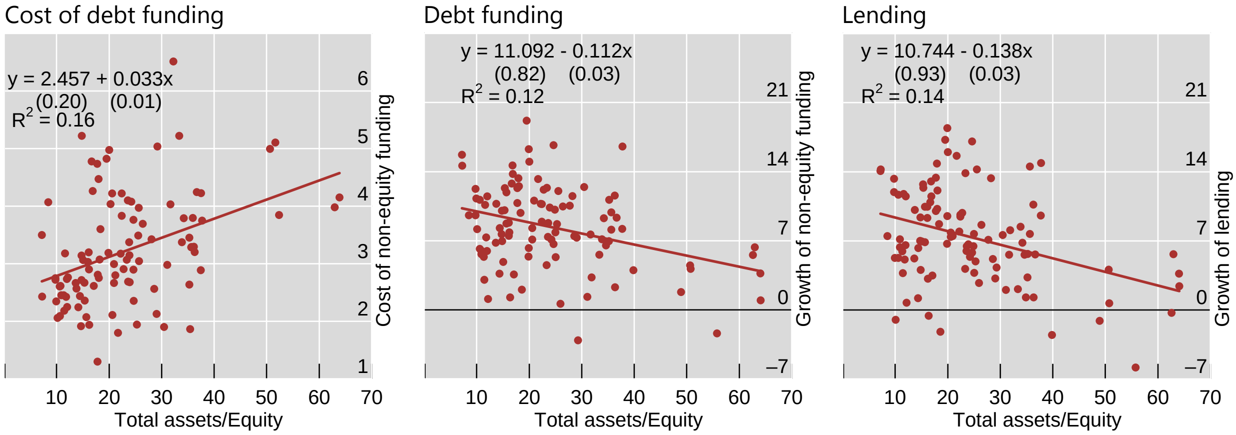
However, solvent banks may nevertheless refuse to lend. Indeed, a weakly capitalised bank may improve its solvency metric by cutting credit exposures. If the banking system as a whole is weakly capitalised, there may even be some apparent tension between the monetary policy imperative of unlocking bank lending (which entails expanding credit) and the supervisory objective of ensuring the soundness of individual banks (which entails cutting back credit). Nevertheless, our main finding is that this tension is more apparent than real; both the macro objective of unlocking bank lending and the supervisory objective of sound banks are better served when bank equity is high.

Our paper revisits the role of bank capital as a determinant of the supply of credit from banks. There is an extensive literature on the relationship between bank capital and lending, which we review below. Our distinctive contribution is to shed light on the mechanism involved in the bank lending channel. A bank is both a lender and a borrower; a bank borrows in order to lend. In this context, bank capital bears on the bank as a borrower, and in turn affects the bank's actions as a lender. Specifically, we find that a higher level of bank capital implies a substantial cost advantage for the bank as a borrower, and in turn induces the bank to increase credit at a faster pace. In particular, we find that a 1 percentage point increase in the equity-to-total-assets ratio is associated with a reduction of approximately 4 basis points in the overall cost of debt funding (deposits, bonds, interbank borrowing, etc.).

This quantitative result represents an important benchmark. Given that debt funding represents around nine-tenths of total liabilities, the effects of bank capital on the overall cost of bank funding is substantial. A back of the envelope calculation indicates that the greater retention of net income by the bank as retained earnings would almost pay for itself through lower cost of debt, even if the cost of equity, typically approximated by the Return on Equity, is presumed to be quite high. More importantly, a bank with a larger equity base can be expected to lend more. Indeed, consistent with this reasoning, we find that banks with higher capital have higher lending growth. A 1 percentage point increase in the equity-to-total-assets ratio is associated with a higher subsequent growth rate in lending, of 0.6 percentage points per year.

Our result adds to the accumulating empirical evidence that higher bank capital is associated with greater lending. A recent study by the European Banking Authority (EBA (2015)) finds substantial beneficial credit supply effects of greater bank capital in a cross-country study of European banks. Michelangeli and Sette (2016) use a novel micro dataset constructed from web-based mortgage brokers to show that better capitalised banks lend more. More generally, empirical evidence shows that in economic systems underpinned by relationship-based lending, adequate bank capital allows financial intermediaries to shield firms from the effects of exogenous shocks (Bolton et al. 2016; Gobbi and Sette; 2015).

Bank capital and loan growth[1] Figure 1




1 The panels represent scatter plots between the average level of leverage for a group of 105 international banks (details to be given below) and some bank-specific indicators: average cost of funding, average growth rate of non-equity financing; average annual growth rate of lending. Standard errors are shown in brackets.

Sources: BankScope; authors' calculations

Figure 1 gives a preview of our main findings. The three panels in Figure 1 are summary plots of the raw data from the empirical database of 105 advanced economy banks used in our empirical analysis. A more detailed description of the dataset follows below. For now, Figure 1 plots the average levels of leverage defined as the ratio of total assets to equity for the 105 banks over the sample period. The three panels show how bank leverage is related to debt funding cost (left panel), growth of debt funding (middle panel) and the growth of lending (right panel).

The scatter plots in Figure 1 overstate the noise in the slope relationships, as the plots are from the raw data without controls; our panel regressions that control for bank and macro variables reveal an even clearer pattern. Nevertheless, even from the noisy scatter charts, we see the key underlying relationships. Lower leverage is associated with lower debt funding costs and a higher growth rate of lending.

Our results highlight the possible tensions between the interests of some bank stakeholders and the wider public interest of maintaining a smoothly functioning banking system that can supply credit in support of economic activity. New equity issuance is not the only way that banks could increase capital ratios. Reducing cash dividends would similarly achieve the aim of raising bank equity through retained earnings. Nevertheless, banks have chosen to pay out substantial cash dividends, even in those regions (such as the euro area) where bank lending has been widely recognised as being inadequate in supporting economic activity. Back-of-the-envelope calculations indicate that the total dividends paid out by euro area banks since 2007 amounts to almost 50 percent of their aggregate end-2013 retained earnings – the core of banks' book equity (Shin (2014)).

Our findings suggest that greater retention of bank earnings, and hence higher bank capital, hold implications for monetary policy transmission, as well as for bank soundness. Indeed, to the extent that credit is an essential ingredient in the transmission of monetary policy to the real economy, our results hold implications for the monetary policy mandate of the central bank, as well as for its mandate as a financial supervisor.

The remainder of the paper is organised as follows. The next section reviews the literature on bank capital and lending behaviour and derives some testable predictions. Section 3 discusses the data and some stylised facts concerning bank capital. Section 4 presents our empirical results and the robustness checks. The last section summarises the main conclusions.

## 2. Bank capital and lending: some testable implications

The effects of bank capital on lending have been extensively debated, especially after the 1988 Basel Capital Accord. A vast empirical literature has examined the impact of capital requirements on bank risk-taking.[2] Initially, attention was paid to the effects of the Basel Accord on banks' risk-taking profiles (eg Dewatripont and Tirole, 1994). The effects of bank capital on lending and monetary policy took on greater prominence with the literature on the "bank lending channel" (Kashyap and Stein, 1995; Jayaratne and Morgan, 2000; Kishan and Opiela, 2000), which found that bank capital can mitigate the effects of any fall in deposits on lending during periods of monetary tightening.

These considerations and the different views on the ways bank capital could affect lending raise some important questions. In particular, what is the link between bank capitalisation and loan supply? Does a greater amount of capital (or lower leverage ratio, defined as total assets over equity) induce banks to lend more? What are the mechanisms at play that explain the negative link between bank leverage and new lending shown in Figure 1? Two possible mechanisms could be at work.

1. "Free" bank capital (capital in excess of minimum capital requirements) could be used by banks to finance consumption or profitable investments (or more generally to protect a lending relationship in the case of a negative shock, such as a monetary tightening). This explanation implies that equity reacts to cycle conditions.

[2] For a more comprehensive review see Martynova, 2015. Boot, 2000, Thakor, 2005, Bolton et al, 2016 point to the importance of relationship lending, while the impact of capital on loan risk is examined by Flannery, 1989, Gennotte and Pyle, 1991, Blum and Hellwig, 1995, Hellman et al, 2000, Kim and Santomero, 1988; Rochet, 1992, Repullo, 2004, De Jonghe, 2010, and Kashyap et al 2010. While the majority of studies link capital with lower risks, Barth et al, 2004 and Demirgüç-Kunt and Detragiache, 2011 find mixed evidence. Capital as a constraint on lending in a downturn is examined by Van den Heuvel, 2002 and Bolton and Freixas, 2006. Dagher et al (2016) assess the benefits of bank capital in terms of its ability to absorb losses.

2. Well-capitalised banks are perceived as "less risky" by depositors and investors and have easier/cheaper access to forms of funding such as bonds or uninsured deposits. This channel implies that debt reacts to cyclical conditions.

Depending on which of these two channels is at work, book equity affects banks' lending in distinct ways. Adrian and Shin (2010) note that banks finance new projects mainly by issuing new debt, and shrink lending by reducing debt, rather than through fluctuations in the use of its own funds – ie its book equity. For this reason, book leverage (defined as the ratio of total assets to the book equity) is procyclical, it tends to increase in a boom and decline in a downturn. In this case, the relevant channel is (2) not (1). On the contrary – given the low incidence of equity to other forms of bank funding (typically in the ratio of one to nine) – if bank capital is used "directly" to finance new investment projects we should observe a high elasticity (more than 1) of bank total assets to equity.

Based on the discussion above, we have the following testable predictions.

If the main channel that explains the negative link between bank leverage and bank lending is (1) we should observe that:

i) Bank equity has an elasticity of greater than one with respect to total assets.

ii) Bank equity is positively correlated with cyclical conditions. It increases in a boom and decreases in a bust.

On the contrary, if banks finance new activities mainly by issuing new debt, and equity facilitates such operations through lower funding costs, then another set of testable predictions may enter the picture. In particular, we examine the following testable predictions:

iii) Less leveraged banks pay less for their debt funding.

iv) Less leveraged banks get more debt funding.

v) Less leveraged banks supply more lending.

vi) The effects of iii)-v) should be less pronounced (not significant) when controlling for market leverage, which is influenced by more volatile financial conditions.

## 3. Data and stylised facts on bank capital

Bank-level data are obtained from BankScope, a commercial database maintained by Fitch and the Bureau van Dijk. We consider consolidated bank statements. Thus, in what follows, the relevant business unit of analysis is the internationally active bank taking decisions on its worldwide consolidated assets and liabilities. Our choice of the unit of analysis is also consistent with the practice of measuring capital adequacy at the group level. Our sample is at an annual frequency and includes major international banks from advanced economies. It covers the 19 years from 1994 to 2012, a period spanning different economic cycles, a wave of consolidation, and the global financial crisis.

The sample of banks covers the major financial institutions from the eleven G10 countries (Belgium, Canada, Switzerland, Germany, France, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States) plus those of Austria, Australia and Spain. To ensure consistently broad coverage, we select banks by country in descending order of size to cover at least 80% of the domestic banking system. With this procedure, we identified in total 105 consolidated banking institutions that hold over 70% of worldwide banking assets as reported in *The Banker* magazine at end-2008.[3] The consolidation of the banking sector during the last two decades makes it important to control for mergers and acquisitions (M&A). Doing so serves to exclude spurious jumps in individual balance sheet positions that reflect only banks' reorganisations. In particular, we adjust for 155 mergers and acquisitions over the sample period by constructing pro-forma entities at the bank holding level.[4]

## Composition of the database

Table 1

| Countries | Assets (2012, bil. USD) | Location of the ultimate borrower: Domestic | Location of the ultimate borrower: (2012, bil. USD) | No. of banks | No. of M&A | No. of banks with some forms of public intervention |
|---|---|---|---|---|---|---|
| *Austria* | 610 | 70.2 | 29.8 | 5 | 5 | 5 |
| *Australia* | 3,073 | 74.2 | 25.8 | 7 | 4 | 0 |
| *Belgium* | 1,169 | 57.9 | 42.1 | 3 | 7 | 3 |
| *Canada* | 3,402 | 68.6 | 31.4 | 6 | 3 | 0 |
| *Switzerland* | 2,569 | 37.0 | 63.0 | 5 | 5 | 1 |
| *Germany* | 5,169 | 77.5 | 22.5 | 13 | 3 | 2 |
| *Spain* | 3,542 | 67.4 | 32.6 | 14 | 14 | 2 |
| *France* | 8,731 | 72.3 | 27.7 | 6 | 13 | 5 |
| *Italy* | 3,177 | 80.8 | 19.2 | 12 | 35 | 6 |
| *Japan* | 3,555 | 82.8 | 17.2 | 5 | 7 | 0 |
| *Netherlands* | 993 | 60.4 | 39.6 | 1 | 0 | 0 |
| *Sweden* | 1,921 | 58.3 | 41.7 | 4 | 5 | 1 |
| *United Kingdom* | 10,730 | 62.7 | 37.3 | 7 | 15 | 3 |
| *United States* | 10,273 | 73.8 | 26.2 | 17 | 39 | 14 |
| *Sum*/average* | 58,914* | 67.4 | 32.6 | 105* | 155* | 42* |

Note: Unweighted averages across banks per country. Average/sum* indicates unweighted averages or sums (*) over countries. Location of the ultimate borrower is estimated by merging BankScope information with data from the BIS international banking statistics. No. of M&A indicates the number of mergers and acquisitions that have been taken into account in the construction of pro-forma banks.

Sources: BankScope; BIS international banking statistics; National central banks' statistics; authors' calculations.

For each country, Table 1 shows the number of banks in our sample that are headquartered in each jurisdiction, along with their combined asset size and location of clients. The columns on the "location of the ultimate borrower"[5] in the table show,

[3] See http://www.thebanker.com/Top-1000-World-Banks.

[4] We construct individual bank histories by drawing on the merger and acquisition dates of large banking institutions provided to us by central banks and complemented by Bureau van Dijk's Zephyr database. Starting with 260 consolidated banking groups, we adjust banks' financial statements backwards by aggregating the reported positions of the acquirer and the target bank prior to the merger or acquisition. The approach used in this paper for the treatment of mergers has been widely used in the literature. See for example Ehrmann et al (2003), Gambacorta and Mistrulli (2004), and De Haas et al (2015).

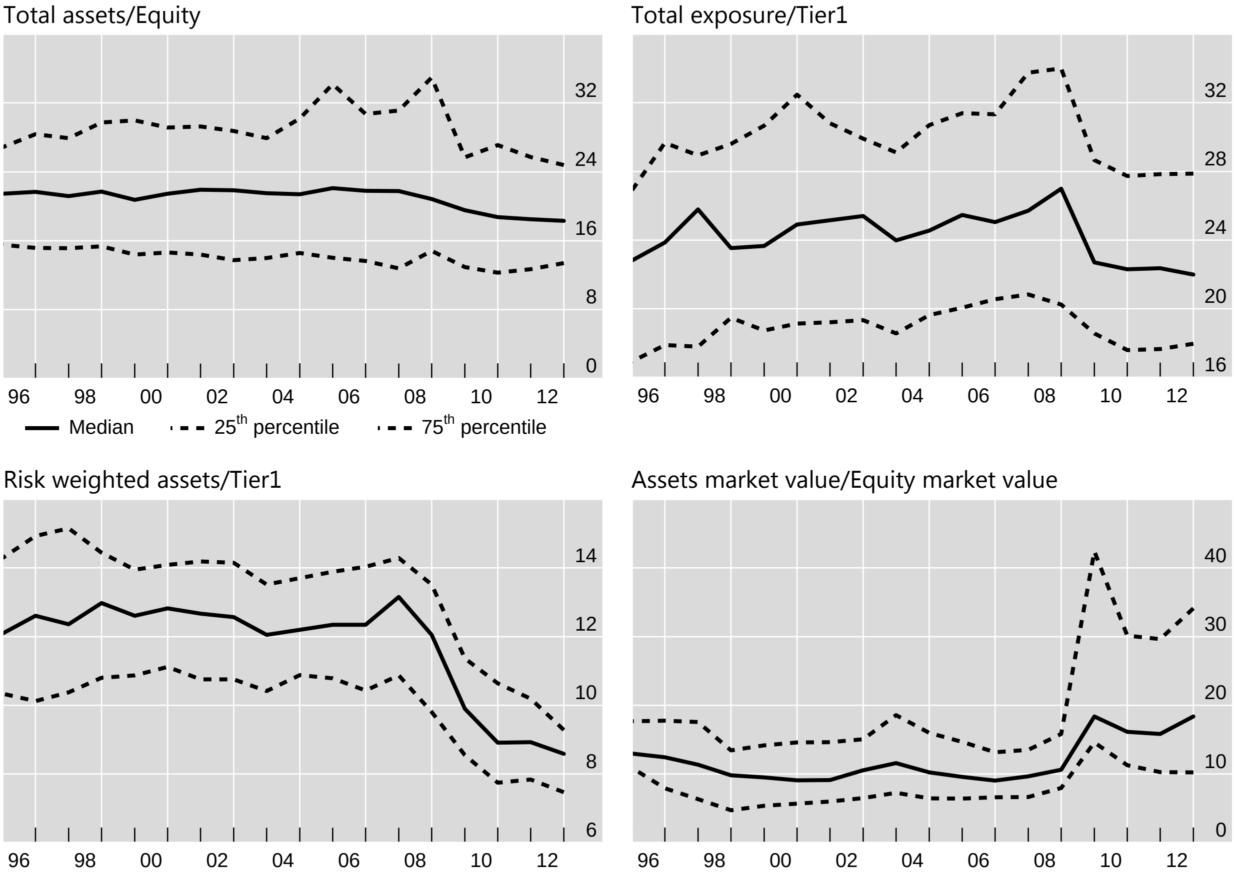
[5] The concept of "ultimate borrower" is based on the country where the ultimate risk or obligor resides, after taking into account risk transfers. The information for the location of the ultimate borrower is not available at the individual bank level and it has been estimated by merging BankScope data with data from the BIS consolidated international banking statistics.

unsurprisingly, that banks headquartered in different countries also differ in the level of international activity and exposure, ranging from less than 20% of claims on borrowers outside their home country for Italian and Japanese banks to more than 60% for Swiss banks. It is thus important to adjust our economic cycle measures for the location of bank assets in the form of a weighted average of the country-specific cyclical variables for locations in which banks operate. Monetary policy measures are weighted averages across the jurisdictions in which each bank gets funding. Finally, a total of 42 banks in our sample received public recapitalisations during the global financial crisis; our econometric analysis therefore has to take into account both the crisis and the public bailouts.

Different definitions of leverage[1]

In per cent

Figure 2




[1] The solid line represents the median values of the leverage ratio. The region in between the dotted lines delimits the second and third quartile of the distribution.

Sources: BankScope; authors' calculations.

In the analysis we consider four measures of leverage: i) a standard leverage ratio, given by total bank assets over total common equity; ii) a Basel III measure of leverage, given by total exposure over Tier 1 capital; iii) a risk-weighted leverage, given by risk-weighted assets over Tier 1 and iv) a market measure of leverage, given by the market value of bank assets (market capitalisation of equity plus debt) over market capitalisation (equal to the share price multiplied by the number of shares outstanding).[6]

Figure 2 shows the distribution across individual banks of the four leverage ratios in the sample (median and quartiles). As expected, there is considerable variation across banks and ratios. A few other patterns emerge. First, as expected, the level of the leverage ratio with the exposure measure at the numerator (panel b) is structurally higher than the risk-weighted measure (panel c). This is not surprising, since the exposure measure is not weighted for risk. Second, banks hold on average significant (discretionary) Tier 1 capital in excess of the 25% regulatory maximum of risk-weighted assets (panel c). Only in very few cases did banks report higher leverage ratios than the regulatory maximum. Third, leverage ratios based on accounting measures (first three panels) fell after the Lehman default (September 2008) owing to market discipline effects, public recapitalisations and the announcement of the introduction of the Basel III capital regulation (December 2009). The downward trend in the first three panels of Figure 1 is more pronounced for risk-weighted capital ratios (the shaded area indicates the post-Lehman period). The fact that the risk-based leverage fell more strongly than the other leverage measures in response to the crisis suggests that banks could have invested in assets with lower risk weights, although there is evidence that banks from the advanced economies increased capital through equity issuance, cuts in dividends and increases in retained earnings (Cohen and Scatigna, 2014). As one can see from the last panel of Figure 1 the market-based leverage is much more volatile compared to the other accounting leverage ratios. Finally in the global financial crisis period the market leverage increased, reflecting the low equity valuation levels of many banks, especially in Europe, against the backdrop of difficult economic conditions in their home markets (Gambacorta and van Rixtel, 2013).

Second, leverage ratios vary importantly across regions. The highest ratios are reported by banks headquartered in the euro area and other European countries, while North American banks reported the lowest ratios. However, European banks report lower risk-weights on their assets; the ratio between risk-weighted assets and total assets, the so-called risk density function, is lower for European banks.

Table 2 also presents statistics for two cycle indicators (the annual growth rate of GDP and the stock market growth) and a monetary policy measure (three-month interbank rate). The two cycle measures are calculated as a weighted average across the jurisdictions in which banks are active, using foreign claims data from the BIS consolidated banking statistics. The adjustment is intended to control for both domestic and international macroeconomic conditions so that the cycle indicators can capture the macroeconomic conditions in the major countries in which banks operate. We approximate monetary policy conditions based on the best estimate of the currency composition of the banks' liabilities, weighting the three-month interbank rate correspondingly. As a result of this weighting, each bank in our sample faces different monetary conditions. The average of the weighted level of the short-

[6] Leverage definitions ii) and iii) have different numerators and relate to different concepts of solvency. Definition ii) corresponds to the leverage ratio recently adopted by the Basel Committee on Banking Supervision (BCBS, 2014). A bank's exposure is defined by the sum of the following components: (a) on-balance sheet exposures; (b) derivative exposures; (c) securities financing transaction exposures; and (d) off-balance sheet exposures. Definition (iii) corresponds to the capital to risk-weighted assets ratio and includes at the numerator on-balance sheet and off-balance sheet exposures weighted according to risk based on the regulatory requirements (BCBS, 1988, 2005). For more details see Brei and Gambacorta (2016).

term rates in the individual jurisdictions are, however, quite similar (the range goes from 3.2% to 3.7%) because the banks in our sample get funding in more than one currency and are exposed to similar global financial conditions.

Average bank leverage by macro region

Table 2

| Region | Total assets/ Equity (%) | Total exposure/TIER 1 (%) | Risk weighted assets/TIER 1 (%) | Market value assets/ market value equity (%) | Real GDP growth, adjusted (%) | Stock market growth, adjusted (%) | Three-month interbank rate, adjusted (%) | Total assets (2012, bil. USD) | Number of banks |
|---|---|---|---|---|---|---|---|---|---|
| Asia-Pacific | 24.3 | 22.6 | 12.3 | 14.7 | 2.47 | 2.69 | 3.73 | 6,628 | 12 |
| Euro Area | 27.0 | 27.6 | 12.1 | 23.9 | 1.70 | 6.13 | 3.19 | 19,967 | 54 |
| Other Europe | 24.6 | 33.4 | 11.1 | 16.6 | 2.27 | 7.04 | 3.45 | 14,620 | 16 |
| North America | 15.4 | 22.2 | 10.5 | 9.4 | 2.29 | 6.33 | 3.25 | 13,675 | 23 |
| Average/sum* | 22.8 | 26.5 | 11.5 | 16.1 | 2.18 | 5.55 | 3.40 | 54,890* | 105* |

Note: Unweighted averages across banks per region over the period 1994-2012. Asia-Pacific indicates AU and JP; Euro Area represents AT, BE, DE, ES, FR, IT and NL; North America is CA and US; and Other Europe indicates CH, UK, and SE. "Average/sum*" indicates unweighted averages or sums over countries. "Adjusted" refers to the adjustment of the macroeconomic variables for the location of international claims on a consolidated basis.

Sources: BankScope; BCBS - QIS database; BIS consolidated international banking statistics; Moody's KMV Credit Monitor; authors' calculations.

Table 3 reports some characteristics of low leverage banks (those in the first quartile of the distribution of the total assets-to-total equity ratio) and high leverage banks (those in the last quartile). It appears that low-leveraged banks pay a lower cost of funding, and have a higher annual growth rate in debt financing and lending. It is worthy of note that low-leveraged banks have also a lower level of asset risk (measured by asset volatility) and higher profitability (ROA) than highly leveraged banks.

Summary statistics by bank type

Table 3

| | Low leveraged banks | Highly leveraged banks | Difference | | All banks |
|---|---|---|---|---|---|
| Number of banks | 27 | 26 | | | 105 |
| Observations | 423 | 369 | | | 1,587 |
| Assets (bil. USD) | 268.7 | 676.8 | -408.1 | *** | 402.6 |
| Cost of debt financing | 2.6 | 3.5 | -0.9 | *** | 3.1 |
| Annual growth rate of debt financing | 8.05 | 6.22 | 1.83 | * | 8.56 |
| Annual growth rate of lending | 7.41 | 4.64 | 2.77 | *** | 7.52 |
| Asset Risk | 4.02 | 5 | -1.0 | *** | 4.82 |
| ROA | 0.95 | 0.19 | 0.76 | *** | 0.58 |
| Non-interest income over income | 31.59 | 17.05 | 14.5 | *** | 22.99 |

Note: Unweighted averages over the period 1994-2012. Banks with a low and high leverage have been identified using the first and fourth quartile of the ratio between total assets and common equity. ***, **, * indicate that averages are significantly different across bank groups at the 1%, 5%, and 10% level using a t-test.

Sources: BankScope; Moody's KMV Credit Monitor; authors' calculations.

## Summary statistics of the variables used in the regressions

Table 4

| Variable name | Variable description | Number of observations | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|---|
| | | Endogenous variables | | | | |
| Log Equity | Logarithm of bank equity (in billion dollars) | 1,587 | 2.061 | 1.392 | –2.486 | 5.398 |
| Log Assets | Logarithm of bank total assets (in billion dollars) | 1,587 | 5.078 | 1.475 | 0.483 | 8.245 |
| Equity growth | Growth rate of bank equity | 1,587 | 9.295 | 17.102 | –70.495 | 79.620 |
| Tier1 growth | Growth of Tier 1 bank capital | 1,278 | 0.093 | 0.158 | –0.948 | 1.349 |
| Cost of funding | Average cost for debt funding (percentage points) | 1,587 | 3.107 | 1.599 | 0.008 | 8.924 |
| Funding growth | Growth rate of debt funding | 1,587 | 8.555 | 13.748 | –79.976 | 94.612 |
| Loan growth | Growth rate of lending | 1,587 | 7.516 | 12.020 | –37.582 | 72.616 |
| Total assets/equity | Accountancy leverage measure given by total bank assets over total common equity | 1,587 | 23.553 | 14.786 | 5.033 | 174.116 |
| Exposure measure/Tier1 | Basel III measure of leverage given by total exposure over Tier 1 | 1,331 | 26.542 | 12.700 | 6.996 | 99.589 |
| RWA/TIER1 | Risk-weighted assets over Tier 1 | 1,442 | 11.577 | 3.022 | 2.240 | 22.727 |
| Total Assets market value/ total market value of equity | Market measure for leverage given by the market capitalisation over the market value of equity | 958 | 15.957 | 13.955 | 3.048 | 99.152 |
| | | Bank-specific characteristics | | | | |
| Asset risk | Asset volatility, std. dev, percentage change in market value of assets | 1,587 | 4.764 | 2.772 | 0.174 | 31.724 |
| ROA | Return on assets given by profits before taxes over total assets*100 | 1,587 | 0.579 | 0.640 | –6.002 | 3.704 |
| Rescued | Dummy variable that takes the value of one if a bank had public capital on its balance sheet and 0 elsewhere | 1,587 | 0.395 | 0.489 | 0.000 | 1.000 |
| | | Macro controls(1) | | | | |
| ∆RGDP | Growth rate of real GDP, adjusted | 1,587 | 2.022 | 1.984 | –5.277 | 5.925 |
| ∆Stock market | Stock market growth, adjusted | 1,587 | 5.928 | 18.030 | –35.004 | 54.362 |
| ∆MP | Change in the three-month interbank interest rate, adjusted | 1,587 | –0.269 | 1.158 | –3.867 | 1.767 |
| MP | Level of the three-month interbank interest rate, adjusted | 1,587 | 3.307 | 1.914 | 0.252 | 9.359 |
| | | Other controls | | | | |
| CRISIS | Dummy that takes the value of 1 in the years 2008–12 and 0 otherwise | 1,587 | 0.360 | 0.480 | 0.000 | 1.000 |
| IFRS | Dummy that takes the value of 1 if a bank reported under IFRS and 0 elsewhere | 1,587 | 0.360 | 0.480 | 0.000 | 1.000 |

Note: The sample period goes from 1995 to 2012. (1) The growth rate of real GDP and the stock market capitalisation are weighted according the location of banks' ultimate borrowers; the interbank rate is a weighted averages across the jurisdictions in which each bank gets funding.

Sources: BankScope; National central banks; BCBS - QIS database; BIS consolidated international banking statistics; Moody's KMV Credit Monitor; authors' calculations.

Our results are consistent with the view that well-capitalised banks are perceived as "less risky" by depositors and other bank creditors and have easier access to funding on more favourable terms. However, these indications are only very preliminary because the cost of bank funding, and the dynamics of deposits and lending, are influenced not only by bank capitalisation but also by other factors (macroeconomic and monetary policy conditions, other bank-specific characteristics) for which we are not able to control for in the sample descriptive statistics reported in Table 3. Summary statistics of all the specific variables used in the regressions are reported in Table 4.

## 4. Empirical analysis

### 4.1 Elasticity of bank activity with respect to bank capital

We begin by documenting some stylised facts. First, we look at the long run elasticity between total assets and equity. We run the following OLS regression:

$$Ln(Total\ \text{Assets})_{ijt} = \alpha\ Ln(Common\ \text{Equity})_{ijt} + \varepsilon_{ijt} \tag{1}$$

where $Ln(Total\ \text{Assets})_{ijt}$ denotes the logarithm of total asset balance sheet items, $Ln(Common\ \text{Equity})_{ijt}$ indicates the logarithm of total common equity in period *t* of bank *i* headquartered in country *j*. The sample used goes from 1995 to 2012.[7]

The results reported in the first column of Table 5 indicate that the hypothesis of unit elasticity between the two variables cannot be rejected. Clearly, this regression does not establish any causal link between the two variables; it simply indicates that there is a proportional relationship between equity and total assets.[8] Given the low proportion of equity in bank funding, this means that we cannot expect that an increase in equity translates directly into large increases in lending. Therefore we may rule out channel 1 as being quantitatively important.

To examine the possibility that leverage could depend on banks' objectives, we modify the specification (1) with two additional control variables: i) bank profitability (return on assets, ROA) and ii) asset risk (standard deviation of the annual percentage change in the market value of assets).[9] These control variables are typically used in studies on the determinants of bank capital (Milne and Whalley, 2001; Ayuso et al,

[7] As the variable used in the regression are I(1), we follow Phillips and Moon (1999) and we initially exclude fixed effects in the regression so that coefficient estimates have standard normal distribution.

[8] The presence of a long run relationship between the log of total assets and the log of equity can be verified by checking the stationarity of the residuals $\varepsilon_{ijt}$ of equation (1). The Fisher Test on the residuals using a Phillips-Perron approach reported in Table 5 always reject the null hypothesis of unit root of $\varepsilon_{ijt}$ against the alternative that at least one series in the panel is stationary. Similar results are obtained using the methodology proposed by Pedroni (1999).

[9] For listed banks, we use the asset volatility measure from Moody's KMV Credit Monitor database defined as the standard deviation of the annual percentage change in the market value of a firm's assets (calculated over the last three years). For the 32 non-listed banks in our sample, we have approximated asset volatility by the standard deviation of the annual percentage change in the book value of total assets over a three-year window, using the efficient estimator of standard deviations for small samples (Longford, 2010).

2004; Jokipii and Milne, 2008; Berger et al, 2008; Gropp and Heider, 2010). The results presented in column II of Table 5 remained qualitatively very similar.

Elasticity between total assets and common equity — Table 5

| Variables | Ln (Total assets) (I) | Ln (Total assets) (II) | Ln (Total assets) (III) | Ln (Total assets) (IV) |
|---|---|---|---|---|
| Ln(Common Equity) | 0.9986*** | 0.9908*** | 0.8470*** | 0.6641*** |
| | (0.0092) | (0.0083) | (0.0094) | (0.0176) |
| Bank-specific characteristics (1) | no | yes | yes | yes |
| Bank fixed effects | no | no | yes | yes |
| Time-fixed effects | no | no | no | yes |
| *Ho: Unit root test residual (2):* | *0.000* | *0.000* | *0.000* | *0.000* |
| *Test unit elasticity (Prob > F =)* | *0.875* | *0.267* | *0.000* | *0.000* |
| *Observations* | 1,587 | 1,587 | 1,587 | 1,587 |
| R-*squared* | *0.8785* | *0.9046* | *0.9795* | *0.9829* |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Annual data. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. (1) Bank specific characteristics include: ROA and asset risk. (2) Fisher Test for panel unit root using a Phillips-Perron test (4 lags). P-values are in parenthesis.

Second, we include bank-level fixed effects in the regression (ie by allowing to the constant in the long-term relationship to be different across banks) based on the idea that firms adjust their equity to unobserved bank-specific targets (Lemmon et al, 2008; Gropp and Heider, 2010; Öztekin and Flannery, 2012; De Jonghe and Öztekin, 2015). The elasticity between total assets and equity is equal to 0.847 (s.e. 0.009), significantly lower than 1 (see column III of Table 5). A final specification in column IV of Table 5 also includes time fixed effects that aim at capturing changes in business cycle conditions. The elasticity drops in this case to 0.664 (s.e. 0.014). Similar results (not reported) are obtained considering the total exposures of the bank (that also include off-balance sheet items) instead of total assets ($\alpha$=0.657 s.e=0.018, in the more general specification).

## 4.2 Does equity react to the cycle?

The second testable hypothesis is that equity reacts to changes in cyclical conditions. During booms, banks might find it easier to raise capital or accumulate retained earnings but during recessions they might resort to adjusting their asset portfolios. As equity is non-stationary, we examine a model in growth rates to avoid the problem of spurious regressions. In particular we estimate the following regression:

$$\Delta Ln(Equity)_{ijt} = \alpha_i + \beta \Delta Ln(Equity)_{ijt-1} + \chi Y_{it} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt} \qquad (2)$$

where $\Delta Ln(Equity)_{ijt}$ denotes the annual growth rate of equity in period *t* of bank *i* headquartered in country *j*.[10] The lagged dependent variable ($\Delta Ln(Equity)_{ijt-1}$) captures equity adjustment costs caused by asymmetric information and rigidities in

[10] The model in log differences has been chosen because variables in levels are integrated of order one (this has been verified by an augmented Dickey Fuller test). This approach avoids the problem of spurious correlations.

capital markets that make it difficult to raise capital at short notice in response to negative capital shocks (Myers and Majluf, 1984). The direct costs of remunerating shareholders and the risk profile of banks, which affect banks' optimal capital decisions, are controlled for by means of bank-specific characteristics ( $X_{ijt-1}$ ), lagged one period to mitigate possible endogeneity problems. Finally, we include – one at a time – a cycle indicator $Y_{it}$ to test how banks adjusted their equity to changes in business or financial conditions.

It is important to note that by the inclusion of bank fixed effects we can interpret the coefficient estimates as variation within banks over time.

The vector $X_{ijt-1}$ of bank-specific control variables includes, as in the section above, bank profitability (return on assets, ROA) and asset risk (standard deviation of the annual percentage change in the market value of assets). We also include a dummy variable $IFRS_{ijt}$ that takes the value of one once a bank has adopted International Financial Reporting Standards (IFRS) and 0 elsewhere. This dummy controls for changes in the measurement of certain balance sheet items and other differences in accounting due to the introduction of the new IFRS standards, notably, the rules concerning the offsetting of derivatives on the asset and liability side. Most countries (except Canada, Japan and the United States) changed accounting standards from local Generally Accepted Accounting Practices (GAAP) to IFRS in 2005–06.

The results are presented in Table 6. The models are estimated using the GMM estimator due to Arellano and Bond (1991) which ensures efficiency and consistency provided that the models are not subject to serial correlation of order two and that the instruments used are valid (which is tested for with the Hansen test). The first two columns indicate that the growth rate of equity is not correlated with our cycle indicators: the real GDP growth and stock market growth. This result is in line with Adrian et al (2015) that shows that banks actively smooth book equity by adjusting payouts to achieve a desired trajectory of book equity. They also show that there is an apparent structural break after the 2008 crisis. For this reason we introduce interaction terms between a dummy $C_t$ (that takes the value of one in 2008–12 and 0 elsewhere) and the regression variables, thus allowing for a parameter shift in the estimated response depending on the state of the economy. The dummy $C_t$ aims at capturing not only the effect of the financial crisis but also changes in banks' behaviour due to the Basel III regulatory reform and the anticipation of more stringent capital requirements. The model to be estimated becomes:

$$\begin{aligned}\Delta Ln(Equity)_{ijt} = \alpha_i + \varphi C_t + (\beta + \beta^* C_t)\Delta Ln(Equity)_{ijt-1} + \\ (\chi + \chi^* C_t)Y_{it} + (\delta + \delta^* C_t)X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt}\end{aligned} \quad (2')$$

Interestingly, the finding reported in the third and fourth columns of Table 6 indicate that the growth rate of equity is reduced when the economy is booming and increases in a financial crisis (due possibly to capital injections). These results are consistent with the finding that leverage is procyclical (Adrian and Shin, 2010, 2014; Adrian et al, 2014; Laux and Rauter, 2014). The results do not change if we use Tier 1 instead of common equity as the measure of bank capital (see columns (V) to (VIII) in Table 6) or changing the specification.[11]

How does equity react to changes in the business and financial cycle? | Table 6

| Explanatory variables | Dependent variable: Growth rate of common equity | | | | Dependent variable: Growth rate of TIER1 capital | | | |
|---|---|---|---|---|---|---|---|---|
| | (I) | (II) | (III) | (IV) | (V) | (VI) | (VII) | (VIII) |
| Real GDP growth, adjusted (1) | 0.4100 | | –3.223*** | | –0.0694 | | –1.6221*** | |
| | (0.3405) | | (1.1160) | | (0.2540) | | (0.6021) | |
| Real GDP growth, adjusted * C (1) | | | 4.1825*** | | | | 1.1961* | |
| | | | (1.2893) | | | | (0.7264) | |
| Stock market price growth, adj. (1) | | 0.0838 | | –0.1014** | | 0.0208 | | –0.1026*** |
| | | (0.0810) | | (0.0431) | | (0.0259) | | (0.0310) |
| Stock market price growth, adj. *C (1) | | | | 0.2878*** | | | | 0.1142** |
| | | | | (0.0682) | | | | (0.0544) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank specific characteristics (2) | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Observations | 1,587 | 1,587 | 1,587 | 1,587 | 1,278 | 1,278 | 1,278 | 1,278 |
| Serial correlation test (3) | 0.210 | 0.190 | 0.901 | 0.993 | 0.822 | 0.830 | 0.233 | 0.349 |
| Hansen Test (4) | 0.174 | 0.156 | 0.119 | 0.117 | 0.567 | 0.591 | 0.529 | 0.572 |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel. *** p<0.01, ** p<0.05, * p<0.1. (1) Cycle indicators are weighted according the location of banks' ultimate borrowers. (2) Bank specific characteristics include: ROA, asset risk and IFRS dummy. (3) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (4) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

## 4.3 Impact of bank capitalisation on funding costs

The results described in the two sections above indicate that equity could have a limited role in "directly" financing household consumption or profitable investments (or more generally to protect a lending relationship). If bank's equity has a (less than) unit elasticity with total assets, given its limited size with respect to the bank's total balance sheet, it cannot finance a larger portion of assets. Moreover, bank equity is negatively correlated with business and financial conditions: this means it is not expanded in a boom or decreased in a bust. In this section, we analyse an alternative explanation where bank capitalisation determines the cost of debt funding.

[11] In particular, we have considered two additional robustness checks. First, we have analysed equation (2) and (2') in levels instead than in growth rates. Second, we have run equation (2) and (2') using pooled OLS without the lagged dependent variable and fixed effects. In both cases results (not reported for the sake of brevity) are qualitatively very similar.

Indexing again individual banks with *k*, countries where banks are headquartered with *j* and years with *t*, we carry out the empirical analysis using the following model:

$$\text{Cost\_funds}_{ijt} = \alpha_i + \theta_t + \beta \text{Cost\_funds}_{ijt-1} + \lambda Leverage_{ijt-1} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt} \quad (3)$$

where $\text{Cost\_funds}_{ijt}$ is the average cost of funding given by total interest rate paid over the total level of debt (excluded equity and reserves). One lag of the dependent variable is introduced in order to obtain white noise residuals. The vector $X_{ijt-1}$ includes, together with bank risk and profitability indicators, other bank-specific controls that could affect the cost of funding: i) the share of short-term funding (deposits, money market and other forms of short-term debt) over total debt funding; ii) a diversification ratio, given by non-interest income to total income; iii) a dummy variable that takes the value of 1 if a bank had public capital on its balance sheet in any given year and 0 elsewhere.

Results are presented in Table 7. In the first three columns we use – one at a time – the three different measures of accounting leverage: i) the standard one, given by total bank assets over total common equity; ii) a Basel III measure of leverage, given by total exposure over Tier 1 capital; iii) a risk-weighted leverage, given by risk-weighted assets over Tier 1. In all cases a greater level of capitalisation (lower leverage) in t-1 leads to a lower cost of debt in t. The effects are not only statistically significant but also relevant from an economic point of view. A one standard deviation increase in the equity-to-total assets ratio is associated with a reduction in the average cost of funding that ranges from 2 to 4 basis points for the first two measures up to 8 basis points for the third risk-adjusted measure. Results do not change if we also include in the specification a complete set of macroeconomic controls that includes bank-specific adjusted measures of GDP growth, house price growth and the three-month interbank rate.

The above results are in line with empirical evidence that lower capital levels are associated with higher prices for uninsured liabilities (see, for example, Ellis and Flannery (1992) and Flannery and Sorescu (1996)). Consistently with this earlier literature, our results suggest that more equity reduces banks' costs; additional capital makes both equity and debt funding safer. In particular, Altunbas et al (2014) find that, other things being equal, a bank with an equity to total asset ratio larger by 1 percentage point has an expected default probability which is reduced by 0.4%. In its pure form, the argument echoes the Modigliani-Miller (1958) theorem on the irrelevance of the funding mix to the overall cost of financing. Admati and Hellwig (2016) have pointed out that, if the Modigliani and Miller (MM) theorem holds, the return on equity (ROE) contains a risk premium that must go down if banks have more equity. Thus the weighted average cost of capital remains unchanged as the leverage decreases. However, many other studies find that the strict version of the MM theorem does not hold (Calomiris and Hubbard, 1995; Cornett and Tehranian, 1994; Myers and Majluf, 1984; Stein, 1998).

## Less leveraged banks pay less for their funding

Table 7

| Explanatory variables | Dependent variable: Average cost of funding (percentage points) | | | | | | |
|---|---|---|---|---|---|---|---|
| | (I) | (II) | (III) | (IV) | (V) | (VI) | (VII) |
| (Total assets/Common equity) $_{t-1}$ | 0.0010*** | | | 0.0012*** | | | |
| | (0.0003) | | | (0.0003) | | | |
| (Total exposure/TIER 1) $_{t-1}$ | | 0.0080* | | | 0.0073** | | |
| | | (0.0048) | | | (0.0032) | | |
| (RWA/TIER1) $_{t-1}$ | | | 0.0218** | | | 0.0199** | |
| | | | (0.0110) | | | (0.0082) | |
| ((Equity/Total assets)*100) $_{t-1}$ | | | | | | | –0.042*** |
| | | | | | | | (0.0148) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes |
| Bank specific characteristics (1) | yes | yes | yes | yes | yes | yes | yes |
| Time fixed effects | yes | yes | yes | yes | yes | yes | yes |
| Macroeconomic controls (2) | no | no | no | yes | yes | yes | yes |
| Observations | 1,587 | 1,331 | 1,442 | 1,587 | 1,331 | 1,442 | 1,587 |
| Serial correlation test (3) | 0.779 | 0.180 | 0.341 | 0.989 | 0.092 | 0.739 | 0.382 |
| Hansen Test (4) | 0.174 | 0.479 | 0.134 | 0.325 | 0.180 | 0.940 | 0.129 |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel methodology. *** p<0.01, ** p<0.05, * p<0.1. (1) Bank specific characteristics include: ROA, asset risk, short tern funding ratio, diversification ratio, rescue dummy and IFRS dummy. (2) Macroeconomic controls include GDP growth and stock market growth. These variables are weighted according the location of banks' ultimate borrowers. (3) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (4) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals

Nevertheless, even if the strict version of the MM theorem does not hold, the proposition that higher equity reduces the cost of debt is a more general one. The MM theorem is simply the purest form of this proposition. Our results confirm that this more general statement is, indeed, supported by the evidence. The intuition is that the reduction in debt financing cost due to the decrease in leverage exactly compensates for the higher cost of equity.

Our estimates imply that the true cost of incremental equity to the overall funding mix is some way between the MM calculation and the naïve calculation which holds the cost of debt invariant to the bank's equity.

Quantitatively, the last column of Table 7 suggests that a 1 percentage point increase in the equity-to-total-assets ratio is associated with approximately a 4 basis point reduction in the average cost of debt funding. Taking into account that debt funding represents around nine-tenths of total liabilities, this is a substantial decrease in overall debt financing costs, and mitigates any assumed cost of raising additional equity.

A back-of-the-envelope calculation of the overall funding cost implied by our findings is reported in Table 8. The first panel reports the overall cost of funding for the average bank in the sample. Fix the total balance sheet size at 100 dollars. The liability of this bank consists of 86.4% of debt funding, 5.6% of equity and 8.0% of technical reserves and non-interest bearing liabilities. Further, suppose that the cost of debt funding is set to the average cost over the sample period (3.10%) and that the cost of equity can be approximated by the average ROE (10 %).[12] Then, the overall cost of funding for the average bank is given by 3.24%.

Now, consider how the overall cost of funding changes for a bank if the funding mix is modified so that there is a 1 percentage point increase in equity offset by a 1 percentage point decrease in debt funding (see the second panel of Table 7). Other non-interest bearing liabilities are fixed at 8% in this calculation.

The third panel of Table 8 takes into account the decrease in the cost of debt funding as reported in column VII of Table 7. Given the 6 basis point decline in debt funding cost, the funding cost of debt is reduced to 3.06%. Taking into account the decline in the cost of debt, the overall change in the cost of funding is only 3 basis points.

## Effect of a 1 percentage point increase in the equity to total asset ratio on the cost of funding

Table 8

| | Average bank in the sample | | Bank with 1 p.p. more equity and 1 p.p. less debt funding (Naïve calculation for cost of debt funding) | | Bank with 1 p.p. more equity and 1 p.p. less debt funding (our calculation for debt funding) | |
|---|---|---|---|---|---|---|
| | Liabilities | Cost (%) (2) | Liabilities | Cost (%) (2) | Liabilities | Cost (%) (2) (3) |
| Debt funding | 86.4 | 3.10 | 85.4 | 3.10 | 85.4 | 3.06 |
| Equity | 5.6 | 10.0 | 6.6 | 10.0 | 6.6 | 10.0 |
| Non-interest bearing liabilities (1) | 8.0 | 0.0 | 8.0 | 0.0 | 8.0 | 0.0 |
| Total liabilities | 100.0 | 3.24 | 100.0 | 3.31 | 100.0 | 3.27 |
| Increase in costs with respect to average bank | | | | 0.07 | | 0.03 |

Note: (1) Non-interest bearing liabilities include fair value portion of debt, credit impairment reserves, reserves for pensions, current and deferred tax liabilities, discontinued operations, and insurance liabilities. - (2) The cost of debt funding is calculated as total interest expenses over total debt funding. The cost of equity is approximated by the ROE. Both costs are calculates as an average over the sample period. (3) The cost of debt funding is reduced by 4 basis points based on the evidence reported in column VII of Table 7.

As small as this estimate of 3 basis points is, there are reasons to believe that even this modest number is an overestimate, as we have assumed for simplicity that the cost of equity funding remains fixed at 10%, even as the funding mix shifts toward equity. Overall, the conclusion based on our sample is that a shift in the funding mix toward equity results in an overall change in the funding cost of the bank that is small, and possibly even negligibly small.

[12] This last assumption is often adopted in the literature to quantify the cost of equity (see King (2010)).

## 4.4 Do less leveraged banks get more funding?

The results described above indicate that well-capitalised banks pay less for their funding but it remains to be verified that they also get more funding. In particular we estimate the following regression:

$$\Delta \ln(\text{funds})_{ijt} = \alpha_i + \theta_t + \beta \Delta \ln(\text{funds})_{ijt-1} + \lambda Leverage_{ijt-1} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt} \quad (4)$$

where $\Delta \ln(\text{funds})_{ijt}$ indicates the annual growth rate of debt funding. The model is specified in growth rates to avoid the problem of spurious correlations as the level of funding is non-stationary.

Results are presented in the first three columns of Table 9, which report also in this case – one at a time – the three different accounting measures for leverage. Even in this case, the effects are statistically significant and the effects are particularly sizeable. A one standard deviation decrease in leverage determines an increase in the average annual rate of debt funding between 1.6 and 2.3%, depending on the different definitions. Results do not change if we also include in the specification a complete set of macroeconomic controls (see columns IV to VI). All in all, these results indicate that a larger capital base reduces the financing constraints faced by the bank, lowering not only the cost of debt funding but also allowing banks to raise more debt. Our results are in line with those of Kishan and Opiela (2000) and Admati et al (2010), which indicate that, since higher capital reduces bank risk and creates a buffer against losses, it makes funding with non-insured debt less information-sensitive.

### Less leveraged banks get more funding — Table 9

| | Dependent variable: Growth rate of debt funding | | | | | |
|---|---|---|---|---|---|---|
| Explanatory variables | (I) | (II) | (III) | (IV) | (V) | (VI) |
| (Total assets/Common equity) $_{t-1}$ | –0.1562*** | | | –0.1576*** | | |
| | (0.0594) | | | (0.0600) | | |
| (Total exposure/TIER 1) $_{t-1}$ | | –0.1494*** | | | –0.153*** | |
| | | (0.0406) | | | (0.0392) | |
| (RWA/TIER1) $_{t-1}$ | | | –0.5427*** | | | –0.4678** |
| | | | (0.2058) | | | (0.2063) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Time fixed effects | yes | yes | yes | yes | yes | yes |
| Macroeconomic controls (1) | no | no | no | yes | yes | yes |
| Observations | 1,587 | 1,331 | 1,442 | 1,587 | 1,331 | 1,442 |
| Serial correlation test (2) | 0.580 | 0.668 | 0.152 | 0.563 | 0.575 | 0.150 |
| Hansen Test (3) | 0.205 | 0.207 | 0.108 | 0.132 | 0.187 | 0.111 |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel methodology. We include in all specifications also a rescue dummy and IFRS dummy. *** p<0.01, ** p<0.05, * p<0.1. (1) Macroeconomic controls include GDP growth and stock market growth. These variables are weighted according the location of banks' ultimate borrowers. (2) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (3) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

## 4.5 Do less leveraged banks supply more credit?

The next step of the analysis investigates whether the positive effects of capitalisation on funding are then translated into higher lending to the wider economy. We estimate a dynamic GMM regression of the following type:

$$\Delta \ln(loans)_{ijt} = \alpha_i + \theta_t + \beta \Delta \ln(loans)_{ijt-1} + \lambda Leverage_{ijt-1} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt} \quad (5)$$

where $\Delta \ln(loans)_{ijt}$ indicates the annual growth rate of lending to the non-financial sector (firms and households). Results are presented in the first three columns of Table 10, which report also in this case – one at a time – the three different accounting measures for leverage. Even in this case, the effects are not only statistically significant but also relevant from an economic point of view. The gains are particularly sizeable and do not differ too much across leverage measures. A one standard deviation decrease in the different definitions of leverage determines an increase in the average annual growth rate of between 1.6% and 1.8%. Results do not change if we also include in the specification a complete set of macroeconomic controls (see columns IV to VI). Using a different definition of the leverage for comparison with other studies, the last column of Table 10 suggests that a 1 percentage point increase in the equity-to-total-assets ratio is associated with a 0.6 percentage point increase in total lending

Less leveraged banks supply more lending — Table 10

| | Dependent variable: Growth rate of lending | | | | | | |
|---|---|---|---|---|---|---|---|
| Explanatory variables | (I) | (II) | (III) | (IV) | (V) | (VI) | (VII) |
| (Total assets/Common equity)$_{t-1}$ | –0.1203*** | | | –0.1065* | | | |
| | (0.0458) | | | (0.0550) | | | |
| (Total exposure/TIER 1)$_{t-1}$ | | –0.1337*** | | | –0.1040*** | | |
| | | (0.0474) | | | (0.0337) | | |
| (RWA/TIER1)$_{t-1}$ | | | –0.6162*** | | | –0.6608*** | |
| | | | (0.1097) | | | (0.1566) | |
| ((Equity/Total assets)*100)$_{t-1}$ | | | | | | | 0.5997*** |
| | | | | | | | (0.1734) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes |
| Time fixed effects | yes | yes | yes | yes | yes | yes | yes |
| Macroeconomic controls (1) | no | no | no | yes | yes | yes | yes |
| Observations | 1,587 | 1,331 | 1,442 | 1,587 | 1,331 | 1,442 | 1,587 |
| Serial correlation test (2) | 0.641 | 0.175 | 0.380 | 0.668 | 0.179 | 0.439 | 0.601 |
| Hansen Test (3) | 0.310 | 0.320 | 0.815 | 0.401 | 0.526 | 0.814 | 0.419 |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel methodology. We include in all specifications also rescue dummy and IFRS dummy. *** p<0.01, ** p<0.05, * p<0.1. (1) Macroeconomic controls include GDP growth, house price growth and three-month interbank rate. The first two variables are weighted according the location of banks' ultimate borrowers; the interbank rate is a weighted average across the jurisdictions in which each bank gets funding. (2) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (3) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

growth. These results indicate that a larger capital base reduces the financing constraint faced by the banks allowing them to supply more loans to the economy. Our finding are also in line with Berger and Bouwman (2013), who show that capital helps banks to improve their probability of survival and increase their market share during a banking crisis.

## 4.6 Is it a simple rebalancing effect?

The results in Tables 9 and 10 could be due to the fact that banks readjust their leverage ratio towards an optimal target. In our models, the fixed effect or within estimator implies a transformation of variables to deviations from the mean level. This means that a value of equity growth below the bank's mean implies that the bank could be overcapitalised (with respect to its target) and vice versa. Hence, to get back to target, the bank could lower its equity and/or increase its assets. In Table 10 we find that the bank does indeed expand its size by having a larger loan growth (compared to its mean) if leverage is low (compared to the mean/target). This expansion on the asset side is accomplished through the use of debt funding (Table 9). It remains to verify that such effects are not due simply to a simple rebalancing mechanism toward a constant target leverage level. We estimate the following equation using changes of ln(equity) as the left-hand side variable:

$$\Delta \ln(\text{equity})_{ijt} = \alpha_i + \theta_t + \beta \Delta \ln(\text{equity})_{ijt-1} + \lambda Leverage_{ijt-1} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt} \qquad (6)$$

Automatic rebalancing toward a constant leverage target would imply that equity growth rates should be higher for highly leveraged banks (when controlling for bank fixed effects), hence an opposite sign as in Tables 9 and 10. On the other hand, if the mechanism at work is related to funding costs, then an insignificant or negative sign should be found (cost of equity being higher for riskier banks). The results (not reported for the sake of brevity but available upon request) indicate that there is no significant link between leverage in t-1 and the growth of equity in t ($\lambda \approx 0$).

## 4.7 Market leverage vs accounting leverage

As discussed in Section 3, the market values of assets and equity tend to be more volatile than book values and one may ask whether a market measure of leverage could have a different impact (with respect to an accounting measure) on the cost and quantity of bank funding and on overall bank lending. In particular, Adrian and Shin (2010) suggest that fair value accounting plays an important role in the procyclicality of leverage, while Amel-Zahed et al (2014) take the opposite view. In particular, they claim that, if assets are valued at current market prices and liabilities are booked at face values, then accounting equity will be subject to large fluctuations. In the extreme, ie when the majority of assets are marked-to-market and liabilities are recorded at book values, then the leverage ratio would tend to decrease during booms when asset prices increase.

Adrian and Shin (2014) explain the different interpretation between the two notions of leverage. Book leverage, defined as the ratio of total assets to book equity concerns how much the bank lends. Instead of total assets, one could use the bank's *enterprise value*, defined as the sum of the bank's market capitalisation and its debt. The enterprise value is the total value of the bank as reflected in the value of the various stakes on the bank. The enterprise value leverage is defined as the ratio of the enterprise value to market capitalisation. We calculate the enterprise value leverage using data on 73 listed banks in our sample. The first three columns of Table 11 present the results of the regressions (3)-(5) that use as the dependent variable enterprise value leverage. The main finding is that such a measure is never statistically significant, as opposed to the accounting measures of the leverage ratio. Results do not change if we also include in the specification a complete set of macroeconomic controls (see columns IV to VI). These results are consistent with the findings in Adrian et al (2015). These findings are also consistent with the notion that enterprise value leverage is driven by the stock market discount rate, rather than by the corporate finance decisions of the firms themselves. This contrasts with book leverage, which is pinned down by book equity, which is directly in control of the firms, via retained earnings and net payout.

Effects of market leverage are not significant

Table 11

| | Dependent variables | | | | | |
|---|---|---|---|---|---|---|
| | Average cost of funding | Growth rate of debt financing | Growth rate of lending | Average cost of funding | Growth rate of debt financing | Growth rate of lending |
| Explanatory variables | (I) | (II) | (III) | (IV) | (V) | (VI) |
| (Market value of bank assets/market value of bank's equity) $_{t-1}$ (1) | 0.0002 | –0.0013 | –0.0706 | 0.0012 | –0.0004 | –0.0484 |
| | (0.0016) | (0.0016) | (0.0772) | (0.0020) | (0.0015) | (0.0492) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Time fixed effects | yes | yes | yes | yes | yes | yes |
| Macroeconomic controls (2) | no | no | no | yes | yes | yes |
| Observations | 958 | 958 | 958 | 958 | 958 | 958 |
| Serial correlation test (3) | 0.191 | 0.275 | 0.507 | 0.346 | 0.207 | 0.538 |
| Hansen Test (4) | 0.862 | 0.602 | 0.992 | 0.871 | 0.514 | 0.997 |

Note: The sample includes annual data of 75 international banks operating in 14 advanced economies over the period 1995-2012. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel methodology. We include in all specifications also rescue dummy and IFRS dummy. *** p<0.01, ** p<0.05, * p<0.1. (1) The market value of banks' equity is given by the share price multiplied by the number of shares outstanding. (2) Macroeconomic controls include GDP growth, house price growth and three-month interbank rate. The first two variables are weighted according the location of banks' ultimate borrowers; the interbank rate is a weighted average across the jurisdictions in which each bank gets funding. (3) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (4) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

## 4.8 The effect of bank capital in the monetary transmission mechanism

The aim of this section is to discuss how bank leverage can influence the reaction of bank lending to monetary policy shocks. According to the “bank lending channel” thesis, a monetary tightening affects bank lending because the drop in reservable deposits cannot be completely offset by issuing non-reservable liabilities (or liquidating some assets). Since the market for bank debt is not frictionless and non-reservable liabilities are typically not insured, a “lemon’s premium” has to be paid to investors. In this case, bank capital has an important role because it affects banks’ external ratings and provides the investors with a signal about their creditworthiness.

The cost of non-reservable funding (i.e. bonds or CDs) would be higher for low-capitalised banks if they are perceived as more risky by the market. Low-capitalised banks are therefore more exposed to asymmetric information problems and have less capacity to shield their credit relationships (Jayaratne and Morgan, 2000; Kishan and Opiela, 2000). Only if banks had the possibility to issue unlimited amounts of CDs or bonds, which are not subject to reserve requirements, would the "bank lending channel" be ineffective.[13]

The empirical specification, based on Ehrmann et al (2003) and Gambacorta and Mistrulli (2004), is designed to test whether banks with different leverage ratios react differently to a monetary policy shock. In particular the empirical model is given by the following equation, which includes interaction terms that are the product of the leverage measure with the monetary policy indicator; all bank-specific characteristics refer to *t*-1 to avoid an endogeneity bias (see Kashyap and Stein, 1995; 2000):

$$\begin{aligned}\Delta \ln(\text{loans})_{ijt} = \alpha_i + \theta_t + \beta \Delta \ln(\text{loans})_{ijt-1} + \lambda Leverage_{ijt-1} + \\ + \kappa \Delta MP_{it} Leverage_{ijt-1} + \delta X_{ijt-1} + \gamma IFRS_{ijt} + \varepsilon_{ijt}\end{aligned} \quad (7)$$

The interest rate taken as the monetary policy indicator is the three-month interbank rate, as it represents the cost of banks' refinancing. As banks operate in different countries, monetary policy measures are weighted averages across the jurisdictions in which each bank gets funding. The use of GMM mitigates the endogeneity issue. In addition, other considerations suggest that the endogeneity problem may not be as serious, owing to the characteristics of our sample. While aggregate banking conditions could influence monetary policy, the supply of loans of any given bank is less likely to affect central bank decisions. In addition, the fact that banks operate in several jurisdictions, and need not be that large in several of them, reduces this risk further. For example, we can presume that the conditions of the Swiss banking industry are important for macroeconomic conditions in Switzerland but that they do not influence the US economy in the same way.

The results are summarised in Table 12. The first three rows of the table confirm the result of Section 5.6: the average effect of leverage on lending is always significant and negative, in other words well-capitalised banks are less constrained by capital requirements and have more opportunities to expand their loan portfolio.

The additional three rows provide an indication of the response of bank lending to a monetary policy shock depending on the level of bank leverage. Testing the null hypothesis that monetary policy effects are equal among banks with different leverage ratios is identical to testing the significance of the coefficient of the interaction term between leverage and the monetary policy indicator ($\Delta MP_{it} Leverage_{ijt-1}$). As predicted by the "bank lending channel" hypothesis, the effects of a monetary tightening are smaller for banks with higher capitalisation, which have easier access to uninsured financing. For example, a 1 percent increase in the interbank rate determines a decrease in the growth rate of lending that is significantly larger (between -1.1% and -1.7%) for highly leveraged banks (those in the last quartile of the distribution) with respect to low-leveraged banks (those in the first quartile of the distribution). This effect is comparable to that detected by Gambacorta and Mistrulli (2004) for a sample of Italian banks and half those in Jimenez et al (2012) for Spanish banks.

13 This is the point of the Romer and Romer (1990) critique.

Lending portfolio of low leveraged banks react by less to monetary policy changes

Table 12

| Explanatory variables | Dependent variable: Growth rate of lending | | | | | |
|---|---|---|---|---|---|---|
| | (I) | (II) | (III) | (IV) | (V) | (VI) |
| (Total assets/Common equity) $_{t-1}$ | –0.123** | | | –0.1317* | | |
| | (0.0618) | | | (0.0777) | | |
| (Total exposure/TIER 1) $_{t-1}$ | | –0.152*** | | | –0.123*** | |
| | | (0.0374) | | | (0.0373) | |
| (RWA/TIER1) $_{t-1}$ | | | –0.744*** | | | –0.5742*** |
| | | | (0.1283) | | | (0.1422) |
| (Total assets/Common equity) $_{t-1}$*$\Delta MP_t$ | –0.0569* | | | –0.061** | | |
| | (0.0339) | | | (0.0274) | | |
| (Total exposure/TIER 1) $_{t-1}$*$\Delta MP_t$ | | –0.0408** | | | –0.0357* | |
| | | (0.0184) | | | (0.0196) | |
| (RWA/TIER1) $_{t-1}$*$\Delta MP_t$ | | | –0.244*** | | | –0.2344** |
| | | | (0.0817) | | | (0.1031) |
| Lagged dependent variable | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Time fixed effects | yes | yes | yes | yes | yes | yes |
| Macroeconomic controls (1) | no | no | no | yes | yes | yes |
| Bank-specific characteristics (2) | no | no | no | yes | yes | yes |
| Observations | 1,667 | 1,317 | 1,598 | 1,667 | 1,317 | 1,598 |
| Serial correlation test (3) | 0.612 | 0.464 | 0.398 | 0.723 | 0.522 | 0.420 |
| Hansen Test (4) | 0.174 | 0.678 | 0.264 | 0.206 | 0.746 | 0.234 |

Note: The sample includes annual data of 105 international banks operating in 14 advanced economies over the period 1995-2012. Monetary policy measures are weighted averages across the jurisdictions in which each bank gets funding. Standard errors in parentheses. The model is estimated using the dynamic Generalised Method of Moments (GMM) panel methodology. *** p<0.01, ** p<0.05, * p<0.1. (1) Macroeconomic controls include GDP growth, house price growth and three-month interbank rate. The first two variables are weighted according the location of banks' ultimate borrowers; the interbank rate is a weighted average across the jurisdictions in which each bank gets funding. (2) Controls include ROA, bank asset risk and rescue dummy. We include in all specifications also IFRS dummy (3) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (4) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

## 5. Conclusions

Bank capitalisation has been central in the policy debate in the aftermath of the financial crisis. While most of the attention from financial supervisors has been on solvency issues, solvent banks may still refuse to lend. Indeed, if the banking system as a whole is weakly capitalised, there may even be some apparent tension between the monetary policy imperative of unlocking bank lending (which entails expanding credit) and the supervisory objective of ensuring the soundness of individual banks (which entails cutting back credit). Nevertheless, our main finding is that this tension is more apparent than real; both the macro objective of unlocking bank lending and the supervisory objective of sound banks are better served when bank equity is high.

Our focus has been on the relationship between bank capital and credit, and thereby on macroeconomic conditions more broadly. In a bank-level study with time and firm fixed effects, we have found that higher bank capital is associated with greater lending, and that the mechanism involved in this channel is the lower funding costs associated with better capitalised banks.

The cost advantage of a well-capitalised bank is found to be substantial. A 1 percentage point increase in the equity-to-total-assets ratio is associated with a 4 basis point reduction in the cost of debt financing. This effect reduces to around one third the estimate of the cost of equity in total funding as typically calculated by the literature. We also find that such a reduction in overall funding cost translates into greater bank lending. A 1 percentage point increase in the equity-to-total-assets ratio is associated with 0.6 percentage point increase in annual credit growth.

To the extent that increased credit is an essential ingredient in the transmission of monetary policy to the real economy, our results shed light on the importance of bank capital for the monetary policy mandate of the central bank, as well as to its mandate as the financial supervisor.

## References


Admati, A.R., P.M. DeMarzo, M.F. Hellwig, P.C. Pfleiderer, 2010. Fallacies, irrelevant facts and myths in the discussion of capital regulation: Why bank equity is not expensive, Stanford GSB Research Paper 2065.

Admati, A.R., M.F. Hellwig, 2010. The bankers' new clothes: What's wrong with banking and what to do about It, Princeton, University Press.

Adrian T., H.S. Shin, 2009. Prices and Quantities in the Monetary Policy Transmission Mechanism, *International Journal of Central Banking*, 5 (4), 131-142.

Adrian T., H.S. Shin, 2010. Liquidity and Leverage, *Journal of Financial Intermediation*, 19, 418-37.

Adrian, T., H.S. Shin, 2014. Procyclical leverage and value-at-risk, *Review of Financial Studies*, 27(2), 373–403.

Adrian, T., E. Moench, H.S. Shin, 2014. Dynamic leverage asset pricing, Federal Reserve Bank of New York staff report 625.

Adrian, T, N. Boyarchenko, H. Shin, 2015. The cyclicality of leverage and uncertainty, mimeo.

Altunbas, Y., L. Gambacorta, D. Marqués, 2014. Does Monetary Policy Affect Bank Risk?, *International Journal of Central Banking*, 10 (1), 95-135.

Amel-Zadeh, A., M.E. Barth, W.R. Landsman, 2014. Procyclical Leverage: Bank Regulation or Fair Value Accounting?, Rock Center for Corporate Governance, Working Paper 147.

Arellano, M., Bond, S.R., 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *The Review of Economic Studies*, 58, 277-297.

Ayuso, J., D. Pérez, J. Saurina, 2004. Are capital buffers pro-cyclical? Evidence from Spanish panel data, *Journal of Financial Intermediation*, 13, 249–64.

Barth, J.R., G. Caprio Jr., R. Levine, 2004. Banking regulation and supervision: what works best?, *Journal of Financial Intermediation*, 13, 205-248.

Basel Committee on Banking Supervision, 1988. International convergence of capital measurement and capital standards. July, www.bis.org/publ/bcbs04a.pdf.

Basel Committee on Banking Supervision, 2005. International convergence of capital measurement and capital standards: A revised framework. November, www.bis.org/publ/bcbs118a.pdf.

Basel Committee on Banking Supervision, 2014. Basel III leverage ratio framework and disclosure requirements. December, www.bis.org/publ/bcbs270.pdf.

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

Berger, A., R. DeYoung, M. J. Flannery, D. Lee, Ö. Öztekin, 2008. How Do Large Banking Organizations Manage Their Capital Ratios?, *Journal of Financial Services Research*, 34(2), 123-149.

Blum, J., M. Hellwig, 1995. The macroeconomic implications of capital adequacy requirements for banks, *European Economic Review*, 39, 739-749.

Bolton, P., X. Freixas, 2006. Corporate Finance and the Monetary Transmission Mechanism, *Review of Financial Studies*, 3, 829-870.

Bolton, P., X. Freixas, L. Gambacorta, P.E. Mistrulli, 2016. Relationship and Transaction Lending in a Crisis, *Review of Financial Studies*, forthcoming.

Boot, A., 2000. Relationship Banking: What Do We Know?, *Journal of Financial Intermediation*, 9, 7-25.

Brei, M., L. Gambacorta, 2016. Are bank capital ratios pro-cyclical? New evidence and perspectives, *Economic Policy*, forthcoming.

Calomiris, C. W., Hubbard, G.R., 1995. Internal Finance and Investment: Evidence from the Undistributed Profit Tax of 1936-37, *Journal of Business,* 68, 443-482

Coeure, B., 2014. Monetary Policy Transmission and Bank Deleveraging. The Future of Banking Summit, Paris, 13 March, available at http://www.ecb.europa.eu.

Cohen, B., M. Scatigna, 2014. Banks and capital requirements: channels of adjustment. BIS Working Papers, 443.

Cornett, M.M., H. Tehranian, 1994. An Examination of Voluntary versus Involuntary Security Issuances by Commercial Banks: The Impact of Capital Regulations on Common Stock Returns, *Journal of Financial Economics*, 35, 99-122.

Dagher, J., G. Dell'Ariccia, L. Laeven, L. Ratvnoski, H. Tong, 2016. Benefits and costs of bank capital, IMF Staff Discussion Note, 16.

De Haas, R., Y. Korniyenko, A. Pivovarsky, T. Tsankova, 2015. Taming the herd? Foreign banks, the Vienna Initiative and crisis transmission, *Journal of Financial Intermediation*, 24 (3), 325-55.

De Jonghe, O., Ö. Öztekin, 2015. Bank capital management: International evidence, *Journal of Financial Intermediation*, 24(2), 154-77.

De Jonghe, O., 2010. Back to the basics of banking? A micro analysis of banking system stability, *Journal of Financial Intermediation*, 19, 387-417.

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

Dewatripont, M., J. Tirole, 1994. The Prudential Regulation of Banks, Cambridge, Massachusetts, MIT Press.

Draghi, M., 2014. Monetary policy in a prolonged period of low inflation, in "Monetary Policy in a changing financial landscape", Conference Proceedings, 25-27 May Penha Longa, Sintra Portugal.

European Banking Authority, 2015. 2015 EU-wide transparency exercise results, EBA, London.

Ehrmann, M., L. Gambacorta, J. Martinez Pagés, P. Sevestre, A. Worms, 2003. Financial Systems and the Role of Banks in Monetary Policy Transmission in the Euro Area, in Angeloni I., A. Kashyap, B. Mojon (eds.), Monetary Policy Transmission in the Euro Area. Cambridge, Cambridge University Press, 235-269.

Ellis, D.M., M.J. Flannery, 1992. Risk Premia in Large CD Rates: Time Series Evidence on Market Discipline, *Journal of Monetary Economics*, 30, 481-502.

Flannery, M.J., 1989. Capital Regulation and Insured Banks' Choice of Individual Loan Default Risks, *Journal of Monetary Economics*, 24, 235-258.

Flannery, M.J., S.M. Sorescu, 1996. Evidence of Market Discipline in Subordinated Debenture Yields: 1983-1991, *Journal of Finance*, 51, 1347-1377.

Gagnon, J., M. Raskin, J. Remache, B. Sack, 2010. Large-Scale Asset Purchases by the Federal Reserve: Did They Work?, FRBNY Staff Reports, 441.

Gambacorta, L., P.E. Mistrulli, 2004. Does bank capital affect lending behavior?, *Journal of Financial Intermediation*, 13, 436-457.

Gambacorta, L., A. van Rixtel, 2013. Structural bank regulation initiatives: approaches and implications, *BIS Working paper*, no 412.

Gennotte, G., Pyle, D., 1991. Capital Controls and Bank Risk, Journal of Banking and Finance 15, 805-824.

Gobbi, G., E. Sette, 2015, Relationship Lending during a Financial Crisis, *Journal of European Economic Association*, 13(3), 453-481.

Gropp, R., F. Heider, 2010. The determinants of bank capital structure, *Review of Finance*, 14, 587–622.

Hellman, T., Murdock, K., Stiglitz, J., 2000. Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirement Enough?, *American Economic Review*, 90, 147-165.

Jayaratne, J., Morgan, D.P., 2000. Capital Markets Frictions and Deposit Constraints at Banks, *Journal of Money, Credit and Banking*, 32, 74-92.

Jiménez, G., S. Ongena, J.L. Peydró, J. Saurina, 2012. Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications, *American Economic Review,* 102(5), 2301-2326.

Jokipii, J., A. Milne, 2008. The cyclical behaviour of European bank capital buffers, *Journal of Banking and Finance*, 32, 1440–51.

Kashyap, A.K, Stein, J.C., 1995. The Impact of Monetary Policy on Bank Balance Sheets, *Carnegie-Rochester Conference Series on Public Policy*, 42, 151-195.

Kashyap, A.K., Stein, J.C., 2000. What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?, *American Economic Review*, 90, 407-428.

Kashyap, A., J. Stein, S. Hanson, 2010. An analysis of the impact of "Substantially heightened" capital requirements on large financial institutions, *Journal of Economic Perspectives*, 25, 3-28.

Kim, D., Santomero, A.M., 1988. Risk in Banking and Capital Regulation, *Journal of Finance*, 43, 1219-1233.

King, M.R., 2010. Mapping capital and liquidity requirements to bank lending spreads, BIS Working paper series 324.

Kishan, R. P., Opiela, T. P., 2000. Bank Size, Bank Capital and the Bank Lending Channel, *Journal of Money, Credit and Banking*, 32, 121-141.

Laux, C., T. Rauter, 2014. Procyclicality of US Bank Leverage, mimeo.

Lemmon, M., M. Roberts, J. Zender, 2008. Back to the beginning: Persistence and the cross-section of corporate capital structure, *Journal of Finance*, 63(4), 1575–608.

Longford, N.T., 2010. Small sample inference about variance and its transformations, SORT, 34.

Martynova, N., 2015. Effect of bank capital requirements on economic growth: a survey, DNB Working Paper 467.

Michelangeli, V., E. Sette, "How does bank capital affect the supply of mortgages? Evidence from a randomized experiment", BIS Working Papers, 2016, forthcoming.

Miles, D., J. Yang, G. Marcheggiano, 2012. Optimal Bank Capital, *The Economic Journal*, 123, 1–37.

Milne, A., A. Whalley, 2001. Bank capital regulation and incentives for risk-taking, Cass Business School Research Paper.

Modigliani, F., M., Miller, 1958. The Cost of Capital, Corporation Finance, and the Theory of Investment, *American Economic Review*, 48, 261-297.

Myers, S.C., N.S. Majluf, 1984. Corporate Finance and Investment Decisions when Firms Have Information that Investors Do Not Have, *Journal of Financial Economics,* 13, 187-221.

Öztekin, Ö., M.J. Flannery, 2012. Institutional determinants of capital structure adjustment speeds, *Journal of Financial Economics*, 103(1), 88-112.

Pedroni, P., 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, Oxford Bulletin of Economics and Statistics, 61, 653-70.

Phillips, P.C.B., R.H. Moon, 2000. Linear Regression Limit Theory for Nonstationary Panel Data, *Econometrica*, 67, 1057–1111.

Repullo, R., 2004. Capital requirements, market power, and risk-taking in banking, *Journal of Financial Intermediation*, 13, 156-182.

Rochet, J.C., 1992. Capital Requirements and the Behavior of Commercial Banks, *European Economic Review*, 36, 733-762.

Romer, C.D., Romer, D.H., 1990. New Evidence on the Monetary Transmission Mechanism, *Brookings Papers on Economic Activity*, 1, 149-213.

Shin, H.S., 2014. Bank capital and monetary policy transmission, ECB Forum on Central Banking, Monetary policy in a changing financial landscape, 25-27 May, 2014, Sintra.

Stein, J. C., 1998. An Adverse-Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy, RAND *Journal of Economics*, 29, 466-486.

Steffen, S., 2014. Robustness, validity and significance of the ECB's asset quality review and stress test exercise, Economic and Monetary Affairs Committee Study IP/A/ECON-ED/IC/2014-055.

Thakor, A.V., 2005. Do Loan Commitments Cause Overlending?, *Journal of Money, Credit, and Banking*, 37, 1067-1100.

Van den Heuvel, S., 2002. Does bank capital matter for monetary transmission?, *Economic Policy Review*, Federal Reserve Bank of New York, 1-7.