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Estimating the impact of higher capital requirements on the cost of equity: an empirical study of European banks

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Abstract The new regulatory framework imposes an increase in capital requirements for banks. Although core capital (equity) is more expensive than other liabilities (debt), it strengthens banks' stability and improves its loss-absorbing capacity. In this paper, we investigate the link between high-quality capital requirements and systematic risk. We further analyze the extent to which an improvement in the quality of the banks' balance-sheet will affect the expected return on equity. We show the impact of shifts in funding structure on information asymmetries (especially implicit guarantees) and on the average funding cost. Our results demonstrate that core capital is essential for increasing banks stability and for reducing the average funding cost for banks. Our empirical analysis provides support for the introduction of strengthened prudential requirements defined in Basel III.

Keywords Modigliani-Miller · Banks · Leverage · Regulation · Beta

JEL classification G3 · G21 · G28

1 Introduction and summary

This paper analyzes the implications in terms of risk and cost caused by changes in the funding capital structure. The interest of this study derives from recent issues about the future structure of the banking system as the result of new prudential rules that the Basel Committee imposed recently. The fundamental question behind the debate is about the effects of funding the bank assets with loss-absorbing capital (equity) rather than debt.

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The crisis provided a 'great' experiment to test both the resistance of banks and the regulatory framework. It revealed that the system underestimates the risks associated to banking and financial activities and that the minimum prudential ratios were too high. It is definitely a risk coverage issue, but it also refers to the evolution of banks increasingly interconnected with the capital markets and to 'hidden' incentives to take multiple and a wide range of risks. The way the regulation of bank capital was designed holds an important responsibility in correcting these anomalies and restoring the proper functioning of the banking system.

Banks' capital has been central in the discussions about financial regulation ever since its creation. It recently became even more controversial due to the 2008 financial shock. Since then, regulators, academics and bankers debate on the issue of the impact of these new regulatory measures. The Basel Committee, in playing its role of banking regulator, reviewed the capital framework and introduced new liquidity standards. It imposed an increase in the quantity and an improvement of the quality of banks' core capital in order to strengthen the loss-absorption capacity of banks and the stability of the financial system as a whole.

The 2008 financial shock that hit the markets induced a lack of confidence between banks and financial institutions leading to increased funding rates. Weaker profits were unavoidable for the majority of financial institutions. The majority of financial institutions were affected and public authorities provided bailouts in order to avoid massive bankruptcies. This reaction of public authorities is one of the most debated issues. It also embodies the main motivation for our study.

But the introduction of strengthened regulatory requirements is vital. It was not surprising that bankers complained about these new regulatory requirements saying that they will increase funding costs (IIF (2011), DeAngelo and Stulz (2013)). Moreover, they warn about the adverse effects on credit distribution and economic activity. But consistent counter-arguments were quickly made by academics against bankers' opinions. They sustain that an effective implementation of the Basel III framework results in relatively low costs during the transition period and net profits in the longer term (Kashyap et al. (2010), King (2010), BCE (2011), Miles et al. (2012), BIS (2012), BCBS (2011), BCBS (2010a, b), EBA (2012), Admati and Hellwig (2013)). They demonstrate that banking lobby arguments are not economically justified. With Basel III, the debate experienced even larger dimensions. An increase in both the quantity and the quality of banking capital is essential for the reestablishment of the stability of the financial system (Eliott et al. 2012). They will also have an indirect effect on the reduction of public bailouts and on the improvement of crisis resolution mechanisms.

In this paper we analyze for a sample of 65 large listed European banks the extent to which higher capital requirements will affect banks' funding cost and information asymmetries. We use data on balance-sheets of financial institutions from Bankscope and public data on share prices and market indexes over the period of 1997–2012. We also employ a dataset of banks ratings over the period of 1997–2012 to investigate the effects of information asymmetries on funding cost. We employ simple theoretical concepts in order to analyze the impact of capital structure on the weighted average cost of banking capital. Capital Asset Pricing Model and Modigliani-Miller theories represent finance cornerstone concepts that have already been proved. The first is used to determine a theoretically appropriate required rate of return on banks' equity and the second allows us to test the neutrality effect of capital structure on funding cost.

We empirically test for the consequences of shifts in capital structure on the average cost of capital and the extent to which the release of Modigliani-Miller ideal assumptions impacts on the banks' funding cost. Our results show that for European banks an increase in the amount of equity will ultimately have a positive effect on the weighted average cost of banks. We explain this effect by lower risk premiums due to an improvement in the quality of funding structure which will offset the higher cost of increasing the amount of equity. Our methodology is inspired by Kashyap et al. (2010) and Miles et al. (2012). A part of our empirical findings are in line with their results for samples of US and respectively UK banks. In addition, we analyze the role of implicit guarantees provided by the government on the funding cost. We conclude that they reduce significantly the cost of banking capital and facilitate banks' access to funding. Our results provide support for the new prudential and resolution frameworks.

Our paper is organized as follows: Section 2 provides some background theoretical concepts about funding structure and its determinants. Section 3 describes our dataset. Section 4 reports the empirical methodology and our main results. Section 5 describes an extended analysis on information asymmetries characterizing the banking system. Section 6 concludes.

2 Modigliani-Miller theorem applied to banking sector

The publication of the Basel III text led to intense debates between regulators and (national) supervisory authorities, on one side, and bankers on the other side. Academics and researchers lend support to regulators bringing strong arguments theoretically funded to defend the benefit of the new regulatory framework. The famous theorem of Modigliani-Miller (MM) represents a theoretical benchmark and the main argument against bankers' opinion. It sustains that the value of the firm is independent of changes in the funding structure[1] under a set of assumptions. It stays for the idea that a higher amount of loss-absorbing capital enhances bank's stability and improves its financial capacity. Thus, investors expect a lower return on equity as the amount of risk engaged will be lower. A higher cost of an increased amount of equity will be offset by a reduction in the return on bank capital. Bankers answer back that an increase in the proportion of equity, the most expensive form of capital, will affect funding costs. Moreover, they 'threaten' that this supplementary cost will be transferred to lending activity through higher lending rates. These 'perverse effects' involve an adjustment by credit rationing rather than balance sheets recapitalizations as regulators desired. The economic activity is at the base of both arguments.

In this section we focus only on the funding cost and banks business model. We firstly present the theoretical framework being at the basis for our study and secondly we analyze the limits of the application of financial theories to the banking sector.

2.1 Modigliani-Miller theorem

The theory developed by Franco Modigliani and Merton Miller (Miller and Modigliani (1958)) states that, under certain hypothetical conditions, the value of the firm is

[1] Miller and Modigliani (1958).

independent of the balance-sheet structure. The impact of this theorem left its imprint in the literature and all future releases represent studies of the consequences of a release of the initial assumptions. In our study, we will analyze the set of Modigliani-Miller (MM) initial assumptions and their importance for the application of the MM theorem to the banking system in a new regulatory context. The argument brought by the authors is economically founded and it maintains that the value of the company is independent of the capital structure[2]: naturally, the reduction of the proportion of debt in the firm's balance-sheet allows concentrating the total risk of the firm on a higher number of shares. This involves a lower required return on equity as the risk borne by each unit of equity will be lower. According to this theory the value of the firm will not be affected given that the cost of keeping a higher amount of 'expensive' liabilities in the balance-sheet will be compensated by a reduction in rate of return required by investors. This reasoning is valid only if several conditions are filled: i) no taxes, ii) no bankruptcy costs and no reputation effect if failure of the company, iii) perfectly competitive markets with no information asymmetries. However, these conditions do not characterize the financial reality this is why we propose to quantify the impact of the deviation from the Modigliani-Miller benchmark in terms of average cost of funding.

In a first step, the widely used Capital Asset Pricing Model (CAPM) allows us to analyze the total risk of the bank (i.e. the risk of its assets β_{assets}) as the sum of the risk on equity (β_{equity}) and the risk on debt (β_{debt}). This assumption can be written as follows:

$$\beta_{assets,it} = \beta_{equity,it}\frac{E_{it}}{D_{it}+E_{it}} + \beta_{debt,it}\frac{D_{it}}{D_{it}+E_{it}} \tag{1}$$

Where D is the book value of bank's debt for t period and E is the book value of bank's equity. Representing the beta of the economic assets as a weighted average of the betas of stockholders' equity and debt is only for reasons of calculation. In order to determine the relationship between the risk associated with bank's own resources[3] and the level of debt, we will write the above equation as follows:

$$\beta_{equity,it} = \left(\beta_{assets,it} - \beta_{debt}\frac{D_{it}}{D_{it}+E_{it}}\right)\frac{D_{it}+E_{it}}{E_{it}} \tag{2}$$

Let us suppose now that $\beta_{debt,it}=0$,[4] in other words that the debt is riskless. In this context the equity beta becomes:

[2] However, this is a different way of interpreting the theorem. Merton Miller himself acknowledges in his article published in 1988 that the way they have increased the definition of their theorem does not exactly express what they wanted to convey. The use of the term of 'independence of the company's value at the financing structure of the firm' is rather strong, however it sets a benchmark. ("The view that capital structure is literally irrelevant or that 'nothing matters' in corporate finance, though still sometimes attributed to us (and tracing perhaps to the very provocative way we made our point), is far from what we ever actually said about the real world applications of our theoretical propositions. Looking back now, perhaps we should have put more emphasis on the other, more upbeat side of the 'nothing matters' coin: showing what doesn't matter can also show, by implication, what does" (Miller (1988))

[3] Among the determinants of beta we remind the costs structure: variables or fixed costs (if the company has mostly fixed costs, then it is more sensitive to the environment and thus its beta will be higher), the business sector, the growth rate of income and the funding structure.

[4] With this assumption, a part of the volatility of the economic activity, more exactly the part of risk supported by creditors will be neglected. This can be justified by the existence of deposit insurance applied to deposits. For the other liabilities, this hypothesis is also appropriate: the risk under the CAPM is not the default risk but the market risk or the risk of fluctuations in the liabilities' value correlated with the market.

$$\beta_{equity,it} = \beta_{assets,it} \frac{D_{it} + E_{it}}{E_{it}} \tag{3a}$$

Knowing that financial leverage is defined as the ratio between the booking value of assets and the booking value of equity, $\frac{D_{it}+E_{it}}{E_{it}}$, then the systematic risk of equity, i.e. equity beta, can be written as :

$$\beta_{equity,it} = \beta_{assets,it}\ L_{it} \tag{3b}$$

This last equation highlights the link between the CAPM and MM theorem: under the assumption of riskless debt, the risk of equity and the risk premium decrease linearly with leverage.[5] Therefore, if we half leverage (or double the capital ratio), the risk of equity will be halved as well. Hence, if leverage is halved (or capital ratio is doubled) this will lead to a distribution of the total risk of the bank on a twice as high number of shares. Consequently, each unit of core capital will bear half of the risk endured before and β_{equity} will be reduced to half under this theoretical framework. The main consequence is an enhanced stability of the institution. However, this reasoning supposes that there are no immediate interactions between capital structure (described by the leverage or capital ratio) and beta assets (Hamada (1971)).

In a second step, according to the theoretical framework, the capital structure determines the rate of return that investors are ready to accept in order to finance an institution. We employ a linear relationship between the expected yield on stock-holders' equity and the associated level of risk. This relationship is given as:

$$k_{it} = E(R_{it}) = R_f + \beta_{it}\, P_r \tag{4}$$

where the expected return on the capital $E(R_i)$ represents the cost of equity for the bank i, R_f is the risk-free rate, β the systematic risk and P_r the market premium.[6] From (3b) and (4), we can highlight the direct relationship between the capital structure described here by the financial leverage L_{it} and the expected cost of equity.

$$k_{it} = R_f + \beta_{assets,it}\ L_{it}\ \left[E(R_m) - R_f\right] \tag{5}$$

In agreement with this specification, increasing the amount of equity (ie. reducing leverage) reduces beta assets (Eq. 3b) and inherently the expected return on equity, k_{it}. Thus the MM principle is revealed: increase in the cost of capital caused by a higher proportion of stable resources will be offset by a reduction in the expected rate of return

[5] In theory, this relationship has been verified. However, the assumption of the independence of beta assets with respect to the leverage and across time seems to us very strong and this even more in the current context of crisis. This was not the case if it was assumed that the banks 'portfolios contain the majority of medium-and long-term claims, but descriptive statistics show that this represents only half of the banks' balance sheets. The other assets that generate profits (eg. titles and securities) represent about one third of the bank's balance sheet. This is why the issue of fluctuations in the total risk of bank assets from one year to another could depend on the economic environment and market liquidity. The assumption is also questioned from the point of view of the business model of the bank: banks can adopt their investment behavior based on the liability structure while respecting regulatory ratios (VanHoose (2007), Mc Kinsey (2011)).

[6] The market premium P_r is calculated as the difference between the expected market rate of return and the risk-free rate of return ($E(R_m)-R_f$). In our model the expected market rate of return is given by the historical returns on a market portfolio (for example CAC40 returns for French banks, FTSE 100 for English banks etc.). The risk free rate of return used for determining the risk premium is given by the interest rate of government bonds.

as investors anticipate an adjustment of k_{it} relative to a lower risk incurred (Miller and Modigliani (1961).

In a third step, the compensation effect mentioned in the MM theorem will be even better highlighted in the calculation of the weighted average cost of capital (WACC):

$$WACC_{it} = k_{it}\frac{E_{it}}{D_{it}+E_{it}} + R_f\frac{D_{it}}{D_{it}+E_{it}} \quad (6)$$

With k_{it} the cost of equity, R_f the risk-free debt rate,[7] D_{it} the amount of debt and E_{it} the amount of equity. The WACC is calculated as the average cost of equity and debt, weighted by their book value. The approach just outlined indicates that an increase in the proportion of equity, the the most expensive resource, makes the bank balance-sheet more stable reducing at the same time the expected rate of return on equity. A secondary effect appears with respect to the cost of debt which will decrease relative to the risk level of the balance-sheet (Admati et al. (2011)). This is due to a higher capacity of the firm to service its debt, reducing at the same time the credit risk and the risk of default.

Going even further in this theoretical analysis, under the assumption of riskless debt, from (5) and (6) we can present the expression of the weighted average cost of capital as:

$$WACC_{it} = R_f + \beta_{assets,it}\left[E(R_m) - R_f\right] \quad (7)$$

We thus deduct that the weighted average funding cost is insensitive to the capital structure. In accordance to the theoretical framework of MM, the cost of an increase in the proportion of equity should be assumed to be equal or close to zero. Consequently, a change in the financing structure will not impact on the weighted average cost of capital.

Therefore, in the present context of new Basel capital requirements, a banking recapitalization should have no (or weak) impact on the average cost of funding.

2.2 Can the MM theorem apply to banks?

In a perfect financial markets framework, the traditional theory on corporate finance states that the weighted average cost of capital is insensitive to the funding structure (the proportion of equity and debt, i.e. the leverage). This is the essence of the Modigliani-Miller theorem that remains a cornerstone in corporate finance.

With respect to the application of the MM theorem to the banking sector several comments should be noted. First, the riskless debt hypothesis is considered as overestimated. Although, with respect to the CAPM, this assumption is not entirely wrong: deposits can be considered a riskless resource thanks to deposit insurance and with regard to the other bank resources, this assumption is not wrong either (Miller 1995). The concept of zero risk doesn't refer to the probability of default, but to the debt value fluctuation risk relative to the market.

Second, fiscal deductions on debt are considered as an advantage relative to equity. In reality, the interests paid on debt are tax-deductible. In turn, this tax

[7] With the assumption of risk-free debt (Eq. 3a), the debt rate R_d is equal to the risk-free rate R_f.

benefit is no longer valid for dividends paid to the investors. This represents an incentive to borrow rather than raise capital. Hence, reducing the proportion of debt could lead to an increase in the average cost of capital. Theoretical counter-arguments were brought to this criticism along with empirical arguments (Miller (1977), Miller (1998), Stephen (1988)). For a 33 % tax rate, a 1 % increase in the ratio of capital seem to impact the average cost of capital by 2 basis points and this effect is considered to be weak.

Third and foremost, there is the nature of banking itself that imposes a violation of initial assumptions of MM. Banks are highly leveraged institutions and their main activity is to collect deposits and to transform them into loans. In general, banks' assets are financed by liabilities; it is this leverage that makes banks more indebted than firms from any other industry. Moreover, the key role of these institutions in the functioning of European economic activity provides supplementary advantages to banks. Awarded as guarantees, more or less explicit and more or less high, these advantages introduce serious distortions in the theoretical framework presented previously.

Implicit subsidies are among the most troublesome distortions characterizing banking institutions. When banks receive public support, a part of the default risk will be transferred towards the public authority. Hence, the risk premium that a bailout bank is supposed to pay to investors will be lower than the one corresponding to the real level of risk. The bank's capacity to insure the repayment of debt could turn out excellent. The 'adverse' effects of massive government bailouts were obvious. The most evident are relative to an increase in both moral hazard and size (Schich and Lindh (2012). The first one, already discussed in the literature by Oxera (2011), Hau et al. (2012), BIS (2012), refers to banks' risk-taking behavior as a consequence of the anticipation of public support provided in case of bankruptcy. The second one refers to the size of the banks' balance sheet. The government's implicit support eases access to funding and favors the increases in bank's capacity to invest leading in the end to an increase of the balance-sheet. A cyclical effect may appear as the size of the bank and the interconnection of financial institutions play a key role in the allocation of government support (BIS (2012)).

The relationship between the debt level, the systematic risk *beta* and the cost of capital will systematically change if we take into account all these asymmetries. The neutrality of the average cost of capital regarding to the funding structure is questioned, the deviation from the theoretical benchmark will be just an empirical question (Admati et al. (2011)).

3 Sample characteristics and data description

Our study is applied to a sample of European commercial, universal and investment banks. For this purpose, a panel of publicly listed banks was constructed. The dataset includes Bankscope balance-sheet annual data on a consolidated basis, spanning the period from 1997 to 2011. After checking the quality of variables included in the database, we eliminated a number of banks because of data availability necessary for the analysis for the period 1997–2011. We use accounting data on balance sheets and income statements on an annual base. We also use public data on stock-exchange prices of bank stocks and stock indices.

Our dataset is an unbalanced panel composed of 65 banks from 17 countries. However, several banks have not been listed since 1997.[8]

We also use Datastream data. Historical series on rates of return on bank debt by rating classes are used in order to compute the weighted-average cost of capital.

3.1 Equity beta

Equity beta is a main variable in our empirical analysis. It measures the sensitivity of the share *i* to market fluctuations being interpreted as the systematic risk of an institution. It is calculated as the covariance between return on market activity and the return for share *i*, divided by the market volatility $\left(\beta_i = \frac{covariance(R_i,R_m)}{\sigma_m^2}\right)$. On our model, equity beta is estimated using traded daily stock market returns together with the returns on national market indexes specifics to each bank. Therefore, it is calculated using daily stock returns over discrete periods of one year. The stock-market return is given by the national market index corresponding to each national banking system.[9]

3.2 Explanatory variables

Our main independent variables – *financial leverage* and *Tier1 capital ratio* – describe bank's capital structure. The first one is calculated as the book value of total assets divided by the book value of equity and it stands for the banks' indebtedness. The Tier1 capital ratio is calculated as the ratio of Tier1capital to the amount of risk-weighted assets as it is in accordance with the regulatory framework (Le Leslé and Avramova (2012)).[10]

3.3 Control variables

We control for a series of characteristics of the bank and country levels. For the most part, we follow Miles et al. (2012). The bank specific control variables include *liquid asset ratio* -standing for banks' capacity to sell assets without incurring sharp drops in their values, *ROA* for the overall profitability of bank's assets, *loan loss reserve ratio* for the probability of incurring future losses on its assets and balance-sheet size as given by the logarithm of total assets (BCE (2011)).

We account also for other factors that can impact the average riskiness of the bank from year to year using time dummies. We notice a common trend for banks within the same country. That is why we include in alternative scenarios country effects (country dummies) in order to control the specificity of each national banking system. The advantage of these two last variables is particularly high in the current time of economic crisis and strong stock-markets fluctuations with heterogeneous evolution within counties.

[8] Several banks went public after 1997. However we keep it in our database as they represent important entities for the banking system and for the economy.

[9] We use CAC40 index for French banks, FTSE100 index for English banks, DAX index for German banks etc. We also estimate beta using a global index (S&P500). Results are similar.

[10] Basel III is focusing on common equity as the capital component with the highest loss-absorbing capacity and on risk weighted assets as the most appropriate measure of balance sheet risk.

Descriptive statistics reported in Appendix B reflect a stronger variation in the capital ratio and in the equity beta from 2007 to 2010. It actually represents the most unstable period of our study. The evolution of the capital ratio shows that the variation of equity was weaker than the variation of assets for the period up to 2007. Therefore, we deduce that banks have used non-core liabilities which are inevitably riskier than equity. Thus, banking and financial system riskiness increased with the increased use of non-core liabilities. Furthermore, our intuition is that the equity beta risk is likely to influence the weighted average cost of capital, however these two variables do not have exactly the same evolution. We assume that other factors could act on the variation of the average cost of banking capital.

4 Empirical analysis and main results

In this section of the analysis we present and discuss the empirical analysis associated with our theoretical study. The analysis follows the simple approach proposed in the literature by Miles et al. (2012) and BCE (2011). The main objective is to test whether a change in the funding structure of banks, as imposed by the new so-called Basel III standards, will affect the systematic risk (equity beta), the return on equity and finally the average funding cost of capital. In a first stage we are going to analyze the relationship between beta and capital structure as described by the Tier1 capital ratio. This last variable is defined as the Tier1 capital to risk weighted assets ratio[11] and it represents the main variable for the bank funding structure. In a second stage, we quantify the impact of a capital ratio increase on the cost of equity, both under a theoretical and an alternative approach (by integrating the economic cycle as BIS (2012)). We finally analyze the extent to which deviations from the MM benchmark, considering explicit and implicit advantages provided by the government, impact upon the weighted average cost of banking capital.

4.1 Baseline regressions

4.1.1 Bank equity beta and solvency ratio

We are going to test in a first stage the relationship between equity beta and bank's Tier1 capital ratio. From a Modigliani-Miller point of view, a higher capital ratio (ie. lower leverage) will strengthen bank's stability. A higher amount of equity in a bank's balance-sheet allows the spread of risk over a higher number of shares, therefore the risk per unit of equity will be lower (equation 3b). This reasoning is based on the hypothesis that investors assess the risk of the bank according to the proportion of risky resources held by banks in their balance sheet.[12]

[11] The Basel III capital requirements impose a capital ratio based on core capital, Common Equity Tier1 (CET1). Due to a very short historical data for this variable, we will use the Tier 1 capital in the calculation of leverage. This idea was also used in the literature Miles et al. (2012)) being justified by the strong correlation between the CET1 capital and Tier 1 capital.

[12] A reduction in the proportion of debt reduces the covariance between the bank and the stock-market (through investors anticipations considered as reasonable).

Thus, the baseline estimated relationship is given by:

$$\beta_{it} = u_i + \alpha_1 CR_{it} + \alpha_2 X_{it} + \varepsilon_{it} \tag{8}$$

where CR_{it} is the Tier1 capital ratio, X_{it} is a matrix of regressors which include control variables for the assets risk (the beta assets),[13] u_i is a bank specific effect and ε_{it} is the random standard error. The equity risk, β_{it}, counts for the risk of bank i at time t. From Eqs. 3a and 8 we understand that the coefficient on capital ratio represents an estimate of the assets beta. This will be quantified later in our analysis in a log specification.

Table 3 in Appendix shows results from pooled OLS estimates: (1) is a simple estimate of equity beta on capital ratio (equity to assets ratio), (2) introduces control variables for the risk of assets. We notice that taking into account asset characteristics allows us to better explain equity beta variation. We include time dummies in both specifications in order to control for variation across time. At this standard level, capital ratio has a negative and significant effect on shares' risk: the higher the capital ratio is the lower the risk of the bank. These results show a compensation effect between our two main variables (estimate coefficient −0.004 to −0.006), however it is weak.

We employ three alternative estimates of the initial specification using as main independent variable the risk-weighted Tier1 capital ratio instead of a simple equity to total assets ratio. Three estimates are made: a pooled OLS and another two models allowing for bank specific effects, one for fixed effects and another counting for random effects. Choosing between the two models is a question of correlation between individual effects α_i and the other regressors. Table 4 in appendix shows regression results using level data on equity beta and risk weighted Tier1 capital ratio.[14] There are three main comments on the results. First and foremost, the negative association between risk of bank equity and Tier1 capital ratio is stronger and more significant than in the first case when using a pooled OLS specification. Our results are therefore robust to the two alternative models, fixed and random effects. The risk-weighted Tier1 capital ratio is a better explanatory variable for equity beta than ordinary equity to total assets ratio. RWA and core capital Tier1 are more relevant in explaining banks' share correlation to the market and equity beta systematic risk. Estimated coefficients are strongly statistically significant and higher than previously. Second, in the fixed effects regression, capital structure has a greater impact on equity beta with an estimated coefficient of −0.0257. The fixed effects estimator is consistent under both null and alternative hypothesis, we consider this one as the most appropriate as the difference in coefficients is not important (Hausman test conclusion as Chi-square(3)=1.02 and p-value=0.7958). Third, assets characteristics did not appear significant in this level specification.

As we previously stated, the estimated coefficient of capital ratio could describe the assets beta. Table 5 in the appendix shows results of the specification of equity beta and

[13] It is difficult to assess the risk of bank assets. We first introduced assets characteristics as ROA, the liquidity ratio, the provisions for potential losses ratio, however these variables are not statistically significant. An alternative method is the integration of a volatility index of European equities VSTOXX. This asset risk index appears significant for our sample of European banks even when controlling for factors from year to year (Table 8 in appendix)

[14] We use the nomination 'Tier1 capital ratio' in order to simplify the text. However, we refer to the main independent variable, the Tier1 capital to risk-weighted assets ratio.

log capital ratio.[15] With a full Modigliani-Miller effect we would expect an estimated coefficient of capital ratio of −1: doubling capital ratio should half equity beta. Yet, estimated coefficients are strongly statistically significant but lower than 1. This describes a partial Modigliani-Miller compensation effect of about 42 %.

Determining the level of capital ratio could actually be made in accordance with a risk target often imposed by the risk manager. Indeed, there can be the possibility of a causality link between the two variables. In order to avoid this potential endogeneity between our two main variables, the beta will be considered in relation to the lag level of Tier1 capital ratio. Appendix Table 6 shows results of these regressions. Estimated coefficients are still negative and highly significant with similar values than before confirming our previous findings.

While the amount of pure capital is increasing relative to the amount of debt (i.e. the capital ratio increase or leverage decrease), equity beta is decreasing. This explanation relies on the fact that banks' balance-sheet is steadier, beta systematic risk is lower as the bank is less vulnerable to market fluctuations. This intermediate result supports regulators proposals for banks' recapitalization.

Notice that we assumed that rate of return on liabilities doesn't change when the amount of debt varies. However, this might be a strong hypothesis. We will consider for frictions and consequences of capital structure changes further in our study. Clarify this final statement.

4.1.2 Expected return on bank equity and capital ratio

We pursue the analysis and the second step consisting in estimating the extent to which changes in the financing structure determine the required rate of return on equity. According to the Modigliani-Miller theorem described previously, a higher equity share in banks' balance-sheets and implicitly a reduction in leverage will lead to a reduction in the expected return on equity as risk associated to each unit of equity is lower. Expected data for each bank of the sample is not available. In order to obtain a most appropriate measure, we are going to use an 'expected' ROE. We compute this variable as net income to market capitalization. The denominator allows us to account for investors' anticipations as they are already included in shares prices. Thus, we estimate the following model:

$$ROE_t = \delta_1 \, CR_{it-1} + \delta_2 \, X_{it-1} + \varepsilon_{it} \tag{9}$$

where ROE is the dependent variable representing the expected yield offered to bank's lenders in order to pay for a new capital issue. X_{it-1} is a matrix of bank level and country level lagged control variables,[16] ε_{it} is the error term and δ_1 , δ_2 are slope coefficients or vectors of coefficients. In all cases, standard errors are adjusted for clustering on countries. Including individual and time effects allows us to control for factors that impact each bank's average rate of return and respectively for changes in variables from year to year.

[15] We don't consider for log beta as this variable has negative values for certain banks and certain periods.

[16] As regards to macroeconomic control variables we use the economic cycle and the stock-markets return. Concerning banks' specific characteristics, we use lending activity and market activity proportions in the balance-sheet, as well as the liquid assets ratio. These variables allow us to control for assets structure.

Estimated results are presented in Appendix Table 8 highlighting some interesting conclusions. First, capital structure described here by the Tier1 ratio represents a significant explanatory factor for the expected return on equity's variation: the higher the core equity ratio, the lower the required return on equity will be. For a one unit increase in risk-weighted capital ratio, the required return on equity is estimated to decrease by about 18 to 25 points of percentage. However, investors also seem to take into account in their anticipations of the expected rate of return the overall profitability of bank's assets (ROA), the probability of incurring future losses on its assets (loan loss reserve ratio) and also balance-sheet size advantages (estimated coefficients are statistically significant). They might seek higher returns from big risky banks (high loss reserve ratio and big balance-sheet size and also with high assets probability – meaning risky assets). The Modigliani-Miller compensation effect is significant at this level, but the theoretical benchmark is not achieved as the estimated coefficient is different and higher than −1.

We test whether bank specific effects could better explain the variation of our dependent variable. We employ r three alternative models using only the economic cycle and bank assets characteristics as control variables: a pooled OLS model and two bank specific effects, fixed and random effects. The estimated coefficient is even stronger than before suggesting that the main explanatory factors for the rate of return on equity are those describing the capital structure and the risk asset structure. When we account for bank specific effects, the national economy is also influencing the rate of return fluctuations (appendix Table 9). Therefore, we can conclude that there are significant bank specific effects concerning the relationship between the expected rate of return on equity and the Tier1 ratio.

The evidence presented in these two subsections supports the existence of a sizeable Modigliani-Miller compensation effect for our sample of European banks during the period from 1997 to 2012. An increase in the Tier1 ratio (so a decrease in leverage) involves a decline in both the riskiness of the bank (the equity beta) and the required return on its equity (net income to market capitalization ratio). Although this neutrality is not complete, bankers claims on higher funding cost repercussion on credit distribution and economic activity might be nothing else than a management decision not a regulatory implementation unavoidable consequence (Hyun and Rhee (2011)).

5 An application of the MM theory to the banking system. Implicit subsidy consequences on funding cost – empirical approach

Hence the initial idealized conditions are no longer valid in reality, the theoretical MM benchmark can be seen as an extreme vision of the compensation effect. Effectively, the main interest in studying these interactions both between capital ratio and equity beta and between capital ratio and the expected return on equity is reflected in the weighted average cost of capital (WACC) estimation. The higher cost of an increase in the equity proportion (the most expensive form of capital) in the balance sheet will be offset by a reduction of the rate of return paid to investors. Theoretically, the WACC should stay unchanged. But in reality, we are facing information asymmetries, as well as several fiscal and cost advantages, so the calculated WACC will deviate from the benchmark. We are further going to estimate information asymmetries' impact on the weighted cost of capital, and more precisely the impact of implicit guarantees as they represents the main limit of the MM theorem application to banks.

We consider that this competitive advantage 'offered' by the public authority is translated into a lower funding rate than the one corresponding to the real risk level of the bank (Oxera (2011), Ueda and di Mauro (2012), Noss and Sowerbutts (2012)). In order to calculate this spread between the two funding rates we'll employ a ratings based approach. Thereby we use different ratings that credit rating agencies issue for the same bank: a traditional credit rating ('*support*' *rating*) and a 'stand-alone' rating[17] ('*Bank Financial Strength rating*') both issued by Moody's. One and the other reflect an external estimation of the probability of default on banks' debt, but only the second one eliminates the influence of the "safety net" inherent in the industry. Our purpose is to compare the actual bank's cost of funding (corresponding to the 'support' rating) with an estimate of a higher funding cost the bank would pay in the absence of a public guarantee (corresponding to 'stand-alone' rating). The rating based approach used in our estimations, compared to a contingent claim approach, relies on rating agency judgment on the failure probability of the bank and the probability of a government bailout. This allows us to take into account the relative risk associated with banks' business models. However, rating agencies judge the banks' probability of default considering its individual circumstances without taking into account the shock that the failure of one bank could have on the entire banking system. This can underestimate the value of implicit subsidy as it was calculated previously.

The spread between the two ratings calculated first in number of notches and secondly in terms of funding cost was called in the recent literature 'credit/rating uplift' (ICB 2011). The average 'rating uplift' is defined as the difference of notches between the 'stand-alone' rating and the 'support' rating is estimated for the banks in our sample of 2 notches and it is illustrated in the graph in appendix D.

The period is divided into two sub-periods: time of relative stability ("before the storm") up to 2008 and crisis time – after 2008. The spread is significantly more important starting with 2008. Implicit subsidy small values for the period up to 2007 are explained by the absence (or weaker) of government intervention as banks could handle themselves to finance their activity. Staring from 2008 until 2010, a more important variation is highlighted on the graph – it could be due to an overall deterioration of financial markets, including banks. As a consequence, public bailouts reached historical values for these last years (appendix D). This significant variation is due foremost to a high probability of government intervention. Indeed, excessive bailouts were provided to banks during this period in order to ensure the continuity of funding activity; however governments were increasingly weakened staring from 2008.

[17] The banks in our sample are large banks (holdings). We thus assume that any support is issued by the government and there will not be a holding support. Moody's issue a 'support' rating corresponding to the traditional rating and a 'stand-alone' rating excluding the government support. The Bank Financial Strength rating reflects how Moody's appreciates the probability of an external intervention in cases of default. This last ration mentioned varies from A to E (A for a stable bank and E for a bank with high probability of future bailout). Starting from 2008 Moody's issues also a 'stand-alone' rating similar to the 'support' rating (ratings from AAA to D). We are taking into account this last rating allows us to make a more meaningful comparison between the two cases.

It is important to be specified that the implicit guarantee is associated to the cost of debt and it will be further highlighted by the funding rate associated to banking debt.

Conducive to the analysis, we are using in our WACC calculations debt funding rates R_d corresponding to different rating classes issued for Moody's between 1997 and 2012 as it follows:

$$WACC_{it}^{support} = k_{it}\frac{E_{it}}{D_{it}+E_{it}} + R_d^{support}\frac{D_{it}}{D_{it}+E_{it}}(1-t_s) \quad (10)$$

This equation estimated the WACC in the case when the bank benefits from a government guarantee and its debt funding rate $R_d^{support}$ will correspond to the rate associated to the 'support' rating. Assuming now that this advantage is lost and the bank should assure by itself the entire default risk associated with its balance-sheet. In this case the debt funding rate will be higher than the previous case as the banks' debt is no longer 'protected' by the government. The WACC is calculated as:

$$WACC_{it}^{stand-alone} = k_{it}\frac{E_{it}}{D_{it}+E_{it}} + R_d^{stand-alone}\frac{D_{it}}{D_{it}+E_{it}}(1-t_s) \quad (11)$$

We are going to take into account in our estimations the implicit guarantees, the most important asymmetry, but also the fiscal advantage associated to banks' debt and described here by (1-t_s).

Knowing that $R_d^{stand-alone} > R_d^{support}$, therefore the weighted average cost of capital in the first case (with the public guarantee) will be lower than in the case without the public support.

The average spread of funding cost (WACC) captures the implicit advantage in terms of the funding rate that some banks (especially systemic banks) receive from public authorities:

$$\Delta WACC_{it} = k_{it}\frac{E_{it}}{D_{it}+E_{it}} + \Delta R_d\frac{D_{it}}{D_{it}+E_{it}}(1-t_s) \quad (12)$$

With the variation in the average cost of banking capital wrote as $\Delta WACC_{it}$= $WACC_{it}^{stand-alone}$− $WACC_{it}^{support}$ and ΔR_d=$R_d^{stand-alone}$−$R_d^{support}$ the spread in debt cost of funding without and with the public protection.

For each bank in the sample, we estimate the average cost of funding either with or without the respective credit rating uplift. Using our database of European banks for the period of 1997–2007, we map yield spreads to different categories of ratings (as illustrated in appendix D).

The funding cost spread due to implicit guarantees is higher the poorer the banks stand-alone credit rating (i.e. higher numerical value as described in appendix D). Relatively higher implicit guarantee values were recorded during the 2007–2009 periods, highlighting a deterioration of banks balance sheets but also a stronger dependence on public rescue funds. Consequently, banks reported strong implicit benefits during the crisis period relative to the previous period. The situation changed after 2009 when the government safety net was increasingly weakened. The reduction of these implicit guarantees was reflected in funding cost rises of about 80 basis points between 2007 and 2012.

We further ask for the future evolution of these information asymmetries as new regulation is to be implemented. The new prudential rules of the Basel Committee impose strengthened capital requirements.[18] We expect that an increase in banks capital ratio (i.e. a decrease of leverage as debt proportion in the balance-sheet is decreasing) as proposed within the Basel III framework will strengthen banks stability and ease the financing process (Demirguc-Kunt et al. (2010)). Opinions are divided: on the one side regulators and supervisory authorities argue that increasing capital ratios will strengthen banks and the stability of the whole banking system (BIS (2012), Kashyapet al. (2010), King (2010), BCE (2011), Miles et al. (2012), BIS (2012)). But on the other side, bankers, with a more short-term vision, maintain that increasing the amount of the most expensive liability (equity as core capital) will increase the funding cost (IIF (2010), DeAngelo and Stulz (2013)). In our opinion, the debate has more sense from a timeline perspective. In our analysis, we consider a long-time horizon as the Basel III framework implementation should be made until 2019.

Starting from this debate, we are interested in analyzing funding cost sensitivity to capital structure. We compute weighted-average cost of capital for each bank from our sample in two cases described previously: the first one when the bank benefits from implicit guarantees and the second one eliminating this public support and accounting only for bank strength. The calculated ‘uplift’ between the two measures represents the value of the implicit subsidy for each bank examined.

We analyze the elasticity of funding cost with respect to capitalization level. We first impute the logarithm of our two main variables, WACC and Tier1 ratio and then we apply a simple OLS regression. The estimated coefficient of Tier1 ratio represents nothing but the elasticity coefficient and it describes the sensitivity of the dependent variable, the WACC, relative to the capital structure described by the Tier1 ratio. The first important result illustrates a negative elasticity coefficient between log-Tier1 ratio and both log-WACC and log-implicit guarantee (appendix Table 12). The second finding is that banks are less sensitive to changes in capital structure when public support is excluded: the elasticity coefficient is weaker in the case when we exclude implicit guarantees and we account only for bank’s financial strength. The third important result highlights a stronger elasticity coefficient during the crisis period than in normal times. This result is also confirmed by an implicit guarantee - Tier1 ratio elasticity analysis (appendix Table 13): the elasticity coefficient is 3 percentage points higher during the crisis (2007–2012) than in normal times (1997–2007[19]).

Three main results arise from our analysis. First, our results support the Basel III capital framework implementation as we provide evidence on the beneficial consequences of a better capitalization: A higher amount of stable capital reduces banks’ balance-sheet vulnerability to market fluctuations and improves stability, thus investors

[18] In this paper we consider only for capital requirements of the new Basel III framework as defined in European Parliament Directive CRD IV (European Parliament 2011). Our choice could be restrictive for our analysis; however Modigliani-Miller, the main theoretical model used here refers only to capital amount of the balance sheet. In its initial form, it doesn’t take into account liquidity. It allows us to compute for the weighted average cost of capital only from a capital point of view. Our analysis is opposed to DeAngelo and Stulz (2013) affirming that high leverage is optimal for banks as they are discussing on the WACC evolution from a liquidity point of view. As a consequence, Modigliani-Miller theory could not be used in their context.

[19] 2002–2004 periods are not included in our sample of crisis periods as the shock didn’t had a major influence on the banking system or on our sample of European banks.

should require lower rates of return on capital and banks funding cost will be lower than previously. Second, as an implicit guarantee is relied to debt, the value of this public support will decrease with balance-sheet capitalization. We thus induce the importance of strengthening capital requirements in order to reduce asymmetries and comparative advantages for too-big-to-fail banks.

As a result of our empirical analysis, we have three comments. First and foremost, the implicit subsidy provided to banking institutions makes liabilities price more insensitive to the capital structure (i.e. to the amounts of equity and debt). Second, the fact that the public support contributes to liabilities "mispricing" may increase incentives to both risk-taking and activity growth Diamond and Rajan R (2009), Diamond and Rajan (2011), Farhi and Tirole (2012), Hau et al. (2012), IMF (2011)). Third, banks that receive public support have no interest in internalizing bankruptcy costs as these will increase their funding costs. As we could see from our results, the higher the implicit guarantee the lower the cost of liabilities will be.[20] In the same time, as banks are bailed-out by governments, in the end there will be the taxpayers' funds that will support losses of banks' excessive risk-taking and thus the higher the value of the implicit subsidy the greater the impact on taxpayers will be.

In conclusion, imposing higher core capital ratios will enhance stability and will make bankers and shareholders aware of their responsibilities. Hence, moral hazard will be reduced as well as public interventions to rescue banking institutions from bankruptcy (Kwast and Passmore (2000)). We thus provide support for the Basel III capital framework as it could reduce the overall risk in the financial and banking system.

6 Conclusions

The financial crisis has been a 'great' test for banks and regulatory reform. Banks' innovations and the excessive risk-taking proved to be important factors in influencing the financial and banking sector's main objective – that of maximizing the return relative to risk. They are constrained by regulatory claims wishing to control risk default. But the way capital requirements were designed, next to assets and liabilities structure, lead to collective risk-taking and procyclical leverage. These features induced the outbreak of the financial crisis and the main issue for next regulatory reform.

The new regulatory framework imposed a higher core capital level. A higher proportion of equity in the capital structure is associated not only with a reduction in the risk level and in the risk premium, but also in the expected rate of return. Economically founded arguments disclaim industries' concerns about a higher funding cost. Well capitalized banks are essential to better cover the risks and surpass stress periods without requesting for public bailouts. Our findings prove that higher amounts of Tier1 equity improve banks' stability and reduce the expected cost of capital. Our results support the concept of a Modigliani-Miller compensation effect for a sample of

[20] s This can be the result of the fact that depositors and creditors anticipate that they will be bailed out ex-post, so their ex-ante assessment of risk takes into account the existence of this government protection. Moreover, they have few incentives to monitor and supervise the risks banks can take. We could think that junior creditors would have more incentive in monitoring banks activity. But many holders of subordinated debt and even of hybrid products have been bailed out during the subprime crisis which clearly questioned their incentives to monitor.

65 European banks during the period from 1997 to 2012. We provide evidence of a positive relationship between capital structure and the systematic risk of banks on one side and their funding cost on the other side. Better capitalized banks are less dependent on public funds; this also reduces explicit and implicit advantages. This last section of our study is also our main contribution to the literature. We estimate the implicit subsidy effect on banks' average cost of capital: stronger balance-sheet capitalization reduces both the probability of default and the need for public bail-outs. In a longer-term horizon, this reduces the banks' funding cost as they are more stable.

Capital requirements could have important effects on banks' business models, although it is absolutely unavoidable for strengthening the stability of the banking system. Imposing higher capital requirements without controlling for banks performance and risk-taking incentives might prove useless.

Appendix

Appendix A

Table 1 Description of variables

Variables	Definition
Leverage	Book value of total assets to book value of equity (source: Bankscope; author's calculations).
Capital ratio	Ratio of Tier1 capital to total assets (non-risk weighted value of total assets).(source: Bankscope)
T1/RWA	The solvency ratio as defined within Basel III. It is computed as the amount of Tier1 capital divided by the total amount of assets (source: Bankscope)
Liquid assets ratio	The ratio of liquid assets as provided by Bankscope divided to the amount of total assets.
Size	Logarithm of total assets (source: Bankscope).
ROA	The average rate of return on assets (source: Bankscope).
Loan loss reserve ratio	The estimated losses on loans due to defaults and nonpayment divided by the amount of total assets (source: Bankscope).
VSTOXX	Volatility indice that measures the level of risk and incertainty in equity markets in Europe. The calculation of VSTOXX is based on EURO STOXX 50 realtime options prices
Rm	Market rate of return. Its computation is based on national market indices.
Economic cycle	Describes upward and downward movements of GDP. It is computed using a Hodrick-Prescott (HP) filter using data on GDP growth.
Stand-alone rating	Bank Financial Strength rating, BFSR, corresponds to the intrinsic risk of the bank. It excludes all external support (source: Moody's BFSR)
Support rating	Also called "all-in" rating, it accounts for the global strength of the bank including the expected ponctual support for the government (source: Moody's Long-term Rating (in foreign currency))

Appendix B

Table 2 Descriptive statistics main variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Equity beta	880	.62	.59	−.004	2.59
Leverage	1118	19.37	11.07	−46.62	128.98
T1 ratio	835	9.09	2.77	−6.7	20.3
Leverage RWA/T1	835	11.65	3.71	−27.03	49.50
ROA	1118	.65	1.42	−16.79	21.45
1997–2007					
Variable	Obs	Mean	Std. Dev.	Min	Max
Equity beta	510	.48	.48	−.004	1.88
Leverage	530	19.65	7.55	1.035	47.67
T1 ratio	423	8.24	2.19	4.42	20
Leverage RWA/T1	423	12.79	2.67	5	22.62
ROA	530	.9	1.10	−.17	21.45
2007–2012					
Variable	Obs	Mean	Std. Dev.	Min	Max
Equity beta	370	.80	.6759	−.004	2.58
Leverage	588	19.06	13.92	−46.61	128.98
T1 ratio	412	9.95	3.03	−6.7	20.3
Leverage RWA/T1	412	10.48	4.24	−27.03	49.5
ROA	588	.38	1.65	−16.79	9.78

Appendix C

Table 3 Equity beta and capital ratio. Pooled OLS regression

Variables	(1)	(2)
Capital ratio	−0.00446**	−0.00633***
	(−2.334)	(−3.051)
Size		0.0471***
		(3.210)
ROA		0.0122
		(0.812)
Liquid asset ratio		0.0212
		(0.110)
Loan loss reserves ratio		0.0140
		(1.042)
Constant	0.768***	0.438**
	(16.78)	(2.548)

Table 3 (continued)

Variables	(1)	(2)
Observations	721	721
R-squared	0.008	0.099
r2_a	0.00614	0.0761
F	5.449	4.295

Robust t-statistics in parentheses ****p*<0.01, ***p*<0.05, **p*<0.1

All specifications include time dummies. Equity beta as dependent variable. Capital ratio is calculated as the book value of equity to total assets ratio

Table 4 Bank equity beta and Tier1 capital ratio, 3 models: pooled OLS, fixed effects (*FE*) and random effects (*RE*). Level specification

	(1)	(2)	(3)
Variables	OLS	FE	RE
Tier1/RWA ratio	−0.0221***	−0.0259***	−0.0257***
	(−3.533)	(−4.782)	(−7.289)
Size	0.0201	−0.00229	0.00145
	(1.283)	(−0.0668)	(0.105)
Liquid asset ratio	0.0429	−0.345	−0.345**
	(0.209)	(−1.259)	(−2.512)
ROA	0.00579		
	(0.255)		
Constant	0.657***	1.050**	1.032***
	(3.250)	(2.559)	(5.557)
Observations	721	721	721
R-squared	0.025	0.096	
r2_a	0.0182	0.0917	.
F	3.896	7.942	.

Robust t-statistics in parentheses ****p*<0.01, ***p*<0.05, **p*<0.1

The dependent variable is equity beta. Second column illustrates results for fixed effects model where fixed effects are accounting for bank specific characteristics. The reported constant represents the average of such estimated effects. Fixed effects regression is run for the sample of 65 banks. Third column reports results for random effect model. In all three regressions, standard errors are robust to clustering effects at the bank level. A Hausman test is applied in order to compare FE et RE estimators. The null hypothesis of this test is that the differences in coefficients are not systematic. Chi-square(3)=1.02 and *p*-value=0.7958. We cannot reject the null hypothesis that the differences in coefficients are not significant, so FE model is better than RE model

Table 5 Bank equity beta and Tier1 capital ratio, 3 models: pooled OLS, fixed effects (*FE*) and random effects (*RE*). Log specification

	(1)	(2)	(3)
Variables	OLS	FE	RE
Tier1/RWA ratio	−0.251***	−0.426***	−0.418***
	(−2.751)	(−4.732)	(−7.474)
Size	0.0213	−0.00253	0.00117
	(1.357)	(−0.0756)	(0.0851)
Liquid asset ratio	0.0461	−0.390	−0.387***
	(0.224)	(−1.412)	(−2.820)
ROA	0.00989		
	(0.348)		
Constant	0.988***	1.794***	1.758***
	(3.266)	(4.108)	(7.589)
Observations	721	721	721
R-squared	0.017	0.099	
r2_a	0.0106	0.0950	.
F	2.665	7.611	.

Robust t-statistics in parentheses ***$p<0.01$, **$p<0.05$, *$p<0.1$

Regression of equity beta on log capital ratio, measured as Tier1 capital to risk-weighted assets ratio. In this case a Hausman test is used to compare the two alternative models, fixed and random effects. Chi-square(3)=1.70 and p-value=0.6362. FE estimator is consistent both under null and alternative hypothesis. We count 65 banks

Table 6 Bank equity beta and Tier1 capital ratio, 3 models: pooled OLS, fixed effects (*FE*) and random effects (*RE*). Level specification with lagged capital ratio

	(1)	(2)	(3)
Variables	OLS	FE	RE
Lagged Tier1/RWA ratio	−0.0210***	−0.0193***	−0.0191***
	(−6.352)	(−4.031)	(−5.831)
Size	−0.000993	0.00323	0.00535
	(−0.0806)	(0.116)	(0.436)
Liquid asset ratio	−0.430***	−0.496*	−0.503***
	(−3.183)	(−1.797)	(−3.749)
ROA	−0.0265***		
	(−3.197)		
Constant	1.054***	0.969***	0.956***
	(6.509)	(3.126)	(5.978)
Observations	721	721	721
R−squared		0.072	
r2_a	.	0.0676	.
F	.	7.271	.

Robust z-statistics in parentheses ***$p<0.01$, ** $p<0.05$, * $p<0.1$. The dependent variable is equity beta

Table 7 Robustness check. Dependent variable: VSTOXX index

	(1)
Variables	
Tier1/RWA ratio	−0.0119*
	(−1.690)
VSTOXX	−0.0115*
	(−1.663)
Constant	1.289***
	(4.756)
Observations	721
R-squared	0.075
r2_a	0.0523
F	3.269

Robust t-statistics in parentheses ***$p<0.01$, **$p<0.05$, *$p<0.1$. The dependent variable is equity beta. VSTOXX is the equivalent of VIX index on US stock exchange market. It is computed for Eurostoxx market

Table 8 Expected return on bank equity and Tier1 capital ratio, 3 models: pooled OLS, fixed effects (*FE*) and random effects (*RE*). Level specification

	(1)	(2)	(3)	(4)
Variables				
Tier1/RWA $ratio_{t-1}$	−0.185**	−0.254*	−0.672***	−0.305**
	(−1.965)	(−1.877)	(−3.178)	(−2.101)
Economic cycle		−0.219	−1.501	−0.511
		(−0.794)	(−1.357)	(−0.840)
Rm_{t-1}			6.689	3.698
			(1.278)	(1.236)
Size			1.473***	1.029**
			(3.368)	(2.585)
Liquid asset $ratio_{t-1}$			−2.366	−4.360
			(−0.405)	(−1.048)
Loan loss reserve $ratio_{t-1}$			1.348***	0.774**
			(3.066)	(2.353)
ROA_{t-1}			4.319***	2.091***
			(5.433)	(3.993)
Constant	3.724***	4.806***	−20.63**	−14.14*
	(3.141)	(2.787)	(−2.445)	(−1.884)
Observations	721	721	721	721
R-squared	0.005	0.008	0.113	0.774
r2_a	0.00405	0.00422	0.0677	0.732
F	3.862	2.088	2.506	18.42

Robust t-statistics in parentheses ***$p<0.01$, **$p<0.05$, *$p<0.1$ The dependent variable is expected return on equity. All regressions include time dummies. We tested Fama and French factors HML (value factor) and SMB (size factors), but they are are not significant explanatory variables for the expected return on equity. The other macroeconomic factors don't appear as significant for our sample of European banks either. So in the following estimates we are not focusing on these variables

Table 9 Expected return on bank equity and Tier1 capital ratio. Level specification. OLS pooled regressions

	(1)	(2)	(3)
Variables	OLS	FE	RE
Tier1/RWA ratio$_{t-1}$	−0.645***	−0.302**	−0.329***
	(−3.424)	(−2.388)	(−2.643)
Economic cycle	−0.709	−0.979**	−0.924**
	(−1.081)	(−2.211)	(−2.134)
Size	1.331***	0.826**	0.909***
	(3.424)	(2.344)	(2.671)
Liquid asset ratio $_{t-1}$	−0.203	−2.304	−2.149
	(−0.0385)	(−0.612)	(−0.580)
Loan loss reserve ratio $_{t-1}$	1.092***	0.655**	0.683**
	(2.925)	(2.395)	(2.543)
ROA$_{t-1}$	4.001***	2.032***	2.160***
	(5.606)	(4.380)	(4.730)
Constant	−12.68**	−10.24	−4.345
	(−2.060)	(−1.288)	(−0.930)
Observations	721	721	721
R-squared	0.102	0.089	0.113
r2_a	0.0620	0.0489	0.0677
F	2.550	0.623	2.506

Robust t-statistics in parentheses.***$p<0.01$,**$p<0.05$,*$p<0.1$. The dependent variable is expected return on equity

Appendix D

Table 10 Support rating and the associated numerical value

S&P	Moody's	Fitch	Numerical value
AAA	Aaa	AAA	1
AA+	Aa1	AA+	2
AA	Aa2	AA	3
AA−	Aa3	AA−	4
A+	A1	A+	5
A	A2	A	6
A−	A3	A−	7
BBB+	Baa1	BBB+	8
BBB	Baa2	BBB	9
BBB−	Baa3	BBB−	10
BB+	Ba1	BB+	11
BB	Ba2	BB	12
BB−	Ba3	BB−	13
B+	B1	B+	14
B	B2	B	15
B−	B3	B−	16
CCC+	Caa1	CCC+	17

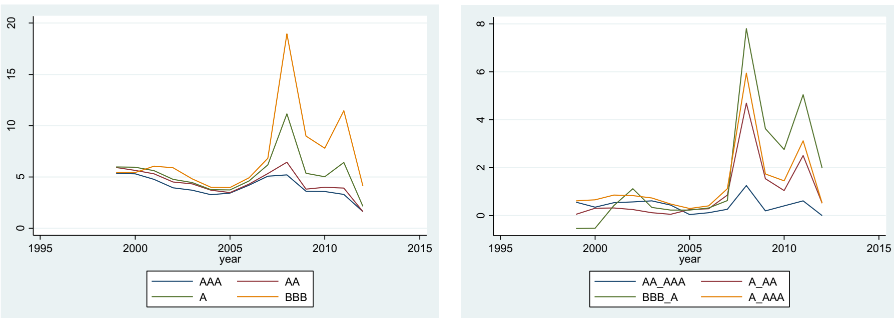
Table 10 (continued)

S&P	Moody's	Fitch	Numerical value
CCC	Caa2	CCC	18
CCC−	Caa3	CCC−	19
CC+	Ca1	CC+	20
CC	Ca2	CC	21
CC−	Ca3	CC−	22
C+	C1	C+	23
C	C2	C	24
C−	C3	C−	25

In our analyze we used only Moody's ratings

Table 11 Rating for banking stability (Moody's Bank Financial Strength Rating)

MBFS	Numerical value
A	1
A−	2
B+	3
B	4
B−	5
C+	6
C	7
C−	8
D+	9
D	10
D−	11
E+	12
E	13
E−	14



Source: Datastream, author's calculations

Source: Datastream, author's calculations

Fig. 1 The funding rate associated to different rating classes in % (*left*). Rate spreads associated with rating spreads in % (*right*)

Appendix E

Table 12 Elasticity WACC and leverage

	WACC - Leverage		
	With implicit subsidy	Without implicit subsidy	Without implicit subsidy – crisis period
Elasticity	0.449***	0.464***	0.543***
	(8.257)	(10.11)	(9.426)
Variables	Funding cost as weighted average cost of banking capital (WACC)		
	Leverage as equity to total assets ratio.		

Table 13 Elasticity WACC and risk-weighted Tier 1 ratio

	WACC – risk-weighted Tier1 ratio		
	With implicit subsidy	Without implicit subsidy	Without implicit subsidy – crisis period
Elasticity	−0.705***	−0.324***	−0.519***
	(−7.119)	(−3.687)	(−5.812)

Variablesl: Funding cost as weighted average cost of banking capital (WACC)

Risk-weighted Tier1 ratio calculated as Tier1/RWA

Model: The estimation method is based on a simple regression and therefore easily implemented on a spreadsheet. We first apply logarithm to our main variables and thus the coefficient of regression will describe the elasticity coefficient. It represents the ratio of logarithmic derivatives of the two variables

Table 14 Elasticity implicit subsidy and risk-weighted Tier 1 ratio

	Implicit subsidy – risk-weighted Tier1 ratio	
	All periods	Crisis period
Elasticity	−0.720**	−0.750**
	(−2.255)	(−2.176)

Implicit subsidy is computed as a funding cost spread. It represents the difference between the WACC with public guarantee and the WACC excluding this support

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