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Drivers of banks' cost of debt and long-term benefits of regulation – an empirical analysis based on EU banks

Abstract

Based on a sample of EU listed banks, we estimate the sensitivity of banks' marginal cost of debt and analyse the potential impact of the post-crisis regulatory package. We build synthetic estimates of risk in banks' books and the macroeconomic environment and argue that regulatory changes alter the transmission of these risks to banks' market funding costs. To circumvent the fact that new regulations are not observable, we also construct indices for each of the new regulatory packages, (1) capital and leverage, (2) liquidity and funding, and (3) banks' structural perimeter (which seeks to separate real economy lending from market activities). Those are based on the variables reported in sample which are most correlated with the regulatory targets.

We find evidence of a dampening effect of banks' capital base on the transmission of risks to market funding costs: a 1 standard deviation increase in the capital and leverage index reduces the transmission of a 1 standard deviation shock to macroeconomic risk by up to 20 basis points (bps). Based on a different sample and obtained from a different methodology, our results for capital are comparable to those of Babihuga and Spaltro (2014). We also find evidence of a dampening effect for funding and liquidity regulations, with a 1 standard deviation increase in the index reducing the transmission of a 1 standard deviation shock to macroeconomic risk by up to 34 bps. However, we do not reach a clear conclusion regarding the impact of structural perimeter regulations.

Non-Technical summary

This paper argues that the long-term impact of the regulatory reforms implemented in the aftermath of the 2008 crisis will be positive, because banks' cost of market debt is negatively influenced (i.e. reduced) by higher capital and liquidity resources – which new regulations seek to improve. Most papers analysing the impact of regulatory changes focus on the short term pain of the adjustment towards more stringent requirements, which materialises through lower credit extension to the real economy or tougher credit standards as banks need to build up capital and liquidity resources. We take a longer-term view to argue that since markets reward higher prudential standards with lower cost of debt issuance, the short-term costs of building up capital and liquidity resources are eventually more than offset.

To do so, our model looks at the relationship between markets' perception of bank risk on the one hand, and banks' idiosyncratic and macro risks on the other hand. This assumes that the way markets perceive bank riskiness is influenced by bank's individual characteristics (e.g. profitability, business model, etc.) as well as the macro environment in which it operates (e.g. its home country's GDP growth). After establishing the relationship, we analyse how differing prudential standards distorts it.

There is however an observation problem as the new regulatory requirements are new. Even if a bank's regulatory target was computed before the new rules, its reporting may not be mandatory. Hence, to overcome this problem, we need to use proxies correlated with the regulatory target we want to study. To do so, we have classified new regulations broadly into three categories: capital/leverage, liquidity/funding, and banks' structural perimeter (market activities versus real economy lending). We then observe how each type of regulatory standard distorts the initial relationship between the way markets perceive a bank's risk and the bank's macro and micro fundamentals.

We have used balance sheet and profit & loss data as well as data on banks' systemic risk contribution for a group of 31 European banks. We have found that banks' funding structure distorts the way markets perceive their fundamental riskiness. As regulations aim to improve banks' capital resources and make their funding structure more stable, they tend to reduce market-perceived bank risk and their cost of market funding for a given level of risk. Our findings suggest capital regulations have a particularly strong impact: a 1 standard deviation increase in the capital and leverage index reduces the transmission of a 1 standard deviation shock to macroeconomic risk by up to 20 basis points (bps). Liquidity and funding regulations also have a strong impact, with a pass-through of a one standard deviation shock to macro risk up to 34 bps lower for banks with one standard deviation higher liquidity index. However, we did not find a clear relationship regarding the impact of regulation on banks' structural perimeter.

These results are comparable to those of Babihuga and Spaltro (2014), but they have broader implications as they seek to encompass a wider array of regulations, which impact not only capital, but also funding/liquidity as well as banks' structural perimeter.

1. Introduction

Since the outbreak of the 2008 financial crisis, the academic and policy debate around the impact of regulation on the financial system has become ever richer. The international overhaul of the global financial system's regulatory structure brought about by the new rules enacted by the Basel Committee on Banking Supervision (BCBS) – the so-called Basel III standards – has been the topic of numerous papers, theoretical or empirical. Those have sought to identify the channels through which financial regulation would impact the real economy.

Most of the quantitative papers on regulatory changes focus on the short-term pain of the adjustment towards more stringent regulatory requirements. A vast strand of the literature has shown that adjusting to higher capital and liquidity requirement was detrimental to the provision of credit to the economy, as banks apply tougher credit standards and/or higher margins on the loans they provide (see King (2010), Maurin and Toivanen (2015), Roger S. J. and Vlček (2011)). Despite the uncertainty around the scale of new regulations' impact, banks will be forced to raise longer-termed, more stable and loss-absorbing funding – which is more expensive and hence will increase their overall funding costs in the short- to medium-term. Conversely, very few papers have shown estimates of the long term gains.[1] This paper aims at contributing to fill this gap.

We analyse the likely impact of key pieces of regulation on banks' funding costs, estimating how they will affect their cost of market funding by reducing markets' perception of bank risk. The regulations considered here are: the Basel III changes to Capital and Leverage ratios, the Liquidity Coverage Ratio (LCR), the Net Stable Funding Ratio (NSFR), and the Liikanen-type changes to banks' structural perimeter (separating trading from real economy activities).[2]

Banks are likely to react in different ways to the regulatory push, depending on their business model. In this context, cross-section regressions can prove very useful. In addition, country aggregates can be misleading as they average indicators across the domestic sample, wrongly implying by construction that a bank which is above the regulatory threshold covers for a bank that is below it. As the requirements constrain banks at the consolidated level, one needs to consider granular data for each bank.

Estimating the combined impact of these regulatory changes on banks' funding is tricky given the data limitations. Indeed, there is an observation problem as most of the new regulatory parameters are new, resulting from changes in definitions or new requirements. Even in the case where a bank's regulatory target was computed before the new regulatory package, its reporting may not have been

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[1] The 2010 BIS Report on the Long-term Economic Impact (LEI) of regulation is one of the few exceptions.

[2] European Commission proposal on Banking Structural Reform (published 29/01/2014).

mandatory. Hence, due to the lack of data, we use proxies correlated with the regulatory target we want to study. We think that proxies which are close enough to the spirit of the new regulatory requirement can be used to infer from their impact based on in sample cross section regularities what could result from the new requirements.

Our key findings are the following. Banks' balance sheet structure modifies the pass-through of micro and macro risks (hereafter "absolute risk") to markets' perception of bank risk (hereafter "relative risk"), and hence their market funding costs. As regulations aim to make banks' balance sheet structure more resilient, they tend to reduce banks' relative risk and their cost of market funding for a given level of absolute risk. We find strong evidence of a dampening effect of the capital base on the transmission of risks to funding costs, with a 1 standard deviation increase in the capital and leverage index reducing the transmission of a 1 standard deviation shock to macroeconomic risk by up to 20 basis points (bps). Our results are comparable to those of Babihuga and Spaltro (2014) (while based on a different sample and obtained from a different methodology) but have broader implications as they seek to encompass a wider array of regulations, which impact not only capital, but also funding/liquidity as well as banks' structural perimeter. In our estimations, increased resilience on the funding and liquidity side also matters, with a 1 standard deviation increase in the index reducing the transmission of a 1 standard deviation shock to macroeconomic risk by up to 34 basis points (bps). Finally, in line with findings in the literature, we do not find a clear relationship regarding the impact of Liikanen-type reforms on banks' structural perimeter. The largest banks, which tend to have larger trading activities, may be shielded by an implicit too-big-to-fail umbrella and therefore take more risk. On the other hand, their larger scope may enable them to better diversify absolute risks in their operations. These opposite forces at play may not be properly disentangled in our framework and hence in our estimates, where banks' funding costs do not share an unconditional significant and clear relationship with indicators of size.

The rest of the paper consists of three sections and concluding remarks. In Section 2 we review the literature on the impact of regulation and we detail the regulatory packages that we consider. In Section 3, we explain the empirical methodology followed together with the data sources used. In Section 4, we analyse the main results. We also add two Appendices to the paper. The first one includes the Tables and Charts commented in the paper and the second one details the VLAB data used in the estimations.

2.   Literature review and overview of regulations considered

a)   Literature review

In the wake of the recent international regulatory overhaul, several studies have been published on the aggregate impact of Basel III, and seek to estimate net gains/losses. The Basel Committee on Banking Standards' (BCBS) official reports argue that although the Basel III requirements are likely to have short-term costs – through lower GDP growth –, the long-term impact will be net positive – through reduced probability and impact of systemic banking crises (BCBS, MAG and LEI Reports, 2010, Thakor 2014). Other official studies (Straughan et al., UK FSA Occasional Paper 42, 2012; IMF Working Paper 12/233; Slovik and Cournède, OECD, 2011) come to similar conclusions.

Since 2008, an important part of the literature on financial regulation has focused on systemic risk, seeking to determine how regulation can reduce systemic risk or its negative impact. In this field, key contributions include Adrian and Brunnermeier's (2011) "CoVaR" and Acharya et al.'s (2010) Systemic Expected Shortfall (SES), which focus on spillovers and feedback effects within the financial system.

Other academics focus on the feedback loops between the financial sector and the real economy to assess the role of bank capital. Low capital can encourage banks to behave pro-cyclically by reducing credit extension in downturns (Acharya, Engle and Pierret 2013; Gertler, Kiyotaki and Queralto 2011). Interconnectedness within the banking system also means that undercapitalised banks impose negative externalities on others (Brunnermeier and Sannikov 2011). Brunnermeier (2008) also analyses how banks naturally have incentives to take on more risk, which regulation ought to address. Our analysis builds on this literature's approach in that it seeks to understand how market/investor perceptions distort bank-specific and economic risks, and hence banks' lending behaviour in relation to households and companies.

The impact of regulation on the real economy depends to a large extent on banks' adjustment strategy (Roger and Vlček 2011), which can often have procyclical effects (Adrian and Shin 2013). Other important drivers of firm behaviour include liquidity (Brunnermeier and Pedersen 2009) and a firm's ownership structure (Jensen and Meckling, 1976; Admati, DeMarzo, Hellwig and Pfleiderer 2012).

The overall complexity of regulation leads Goodhart, Kashyap, Tsomocos and Vardoulakis (2013) to argue that "the more successful package combines regulations that operate via fairly different channels." Indeed, taking an aggregate balance sheet perspective allows accounting for the interactions between different pieces of financial regulation. Others adopt a similar integrated approach to conclude that equity is not expensive (Marcheggiano, Miles, and Yang 2012), thereby invalidating banks' main counter-argument against increases in capital ratios. Maurin and Toivanen

(2015) argue that the impact of banks closing their capital gap (the desired capital ratio minus the required capital ratio) on the economy depends on their asset composition – as they would generally start by shedding riskier assets.

b)   Overview of regulations considered

It is difficult to disentangle the impact of all the factors currently affecting European banks (low interest rates environment, flat economic growth, deleveraging, etc.) and draw specific causality links between regulatory changes and banks' asset and liability management, and even more so as they are all concurrent. Hence, this paper focuses on the following key pieces of regulation: capital/leverage, liquidity/funding and reforms affecting banks' structural perimeter. Regulations affecting the banking sector are very numerous and detailed, hence we decide to focus on these three "channels" rather than specific regulations as, for each channel, different regulations actually impact similar balance sheet items and hence would be subject to the same dynamics we identify in this paper.

The **capital package** refers to the Basel III capital and leverage ratios as defined in CRR-CRD IV at the European level. The rules require banks to hold their Total Capital (post-deductions)/Risk-Weighted Assets ratio at or above 8% (4.5% Common Equity Tier 1; 1.5% Additional Tier 1; 2% Tier 2), and allows national supervisors to set additional buffers to deal with specific risks (countercyclical buffer, sector capital buffers, systemic buffer). The regulatory changes relate to the minimum requirement, which is higher in Basel III, and imposes better-quality capital in the numerator and more conservative risk-weights. The regulation on leverage ratio , on the other hand, requires banks to hold their Tier 1 Capital/Total Exposures (on- and off-balance sheet) ratio at or above a certain threshold (e.g. 3%), in order to prevent them from rigging capital rules through the computation of their risk-weighted assets (RWAs). The minimum leverage ratio can be seen as a backstop according to which banks have to hold a minimal amount of capital in relation to assets regardless of their riskiness. The ratio is especially relevant as it includes both on- and off-balance sheet items (which are brought into the ratio after applying Credit Conversion Factors).

The **liquidity package** aims at strengthening the short-term and long-term resilience of banks' liquidity risk profile. It consists mainly of the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR requires banks to hold at least 100% of 30-day stressed net cash outflows in high quality liquid assets (HQLA), absent a period of financial stress (during which they are authorised to fall below 100%).[3] On the denominator side, net cash outflows are defined as outflows minus inflows (which are capped at 75% of outflows). Weightings are assigned to reflect the

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[3] HQLA include: (a) Level 1: cash, Central Bank reserves, 0% risk-weighted government-issued or -guaranteed securities (under Basel II), (b) Level 2 (i.e. haircuts applied; maximum 40% of HQLAs after haircuts): 20% risk-weighted government bonds (under Basel II; 15% haircut), RMBS and certain corporate debt securities and equities (higher haircuts, depending on rating).

speed of flows. The LCR came into force on 1st January 2015, but will not be fully phased in before 1st January 2019. The NSFR focuses on medium- to long-term resilience and requires banks to hold available stable funding (ASF) higher than their required stable funding (RSF). The underlying rationale is that less liquid assets require more stable funding. The RSF is computed by applying weighing factors to assets according to their maturity and risk profile. On the other side of the balance sheet, the ASF is calculated by weighing liabilities according to their characteristics (maturity, stickiness, likelihood of withdrawal, etc.), with lower weightings attributed to short-term funds that can be withdrawn easily.

Regulations referring to bank's "structural perimeter" were approved in some European countries, such as Germany, France and the United Kingdom. However, there is still no final agreement on the relevant piece of EU legislation (the "Liikanen proposal"), which aims at separating risky trading activities from banks' more traditional business, and ban or limit proprietary trading. If implemented, such proposal would reduce banks' share of profits arising from trading income, an implication which helps us to choose the variable included in the proxy indicator for this regulation.

It should be noted that ideally the analysis of regulatory packages should be understood in a systematic manner, as the layers overlap. For instance, it is likely that when adjusting to comply with LCR, the bank improves its regulatory capital ratio – as it holds safer assets which carry a lower risk-weight. However, in the absence of an encompassing model, we assess the three different layers one by one, bearing in mind that the overall effect cannot be obtained by summing up the components.

3.   Methodology

Our proposal is the following: banks' balance sheet structure alters their resilience to shocks and changes the relationship between absolute risks (in a bank's balance sheet) and relative risk (perceived by a bank's creditor). New regulations should reduce the sensitivity of market-perceived bank risk (and hence market funding costs) to existing micro and macro risks in banks' balance sheet.

The idea behind the model is the following: the way markets perceive and estimate banks' absolute risk depends on the one hand on factors that are specific to the bank (its ability to generate income, overall level of risk…), and on the other hand on the overall macroeconomic environment (GDP growth, aggregate demand, unemployment…). The effects of these micro and macro factors can however be altered by banks' balance sheet structure, which affects their overall robustness and capacity to withstand stress, shocks and losses: their size (e.g. if they are too big to fail), leverage ratio, reliance on short-term debt, share of securities holdings in total assets, etc. Overall, the model

seeks to capture the extent to which such balance sheet structure alters the way markets perceive bank risk, and pushes it away from a "pure" perception of risk as a simple sum of bank-specific and macroeconomic absolute risks.

Bank risk, in absolute terms, can be seen as a mere combination of "micro" risks (banks' ability to generate income, asset quality) and "macro" risks (GDP growth, demand and supply factors):

$$RISK_{it} = \beta_0 MICRO_{it} + \gamma_0 MACRO_{jt} + u_{it} \tag{1}$$

Where the bank is indexed by i, *RISK* refers to time-varying and bank-specific risk indicators which proxy markets' perception of bank risk (i.e. "relative" risk). *MICRO* refers to time-varying, bank-specific characteristics, which illustrate their capacity to generate income and therefore accumulate capital and increase resilience to adverse shocks. *MACRO* refers to time-varying, country-specific indicators of economic activity, related to the country where the bank is located. Both MACRO and MICRO indicate the "absolute" risk of the bank.[4]

In our estimates, the spread between the bank's cost of funding and the safe return, *SPREAD*, is assumed to follow an autoregressive process and to be positively correlated with relative risk, as shown in Equation (2).

$$SPREAD_{it} = \alpha_0 SPREAD_{it-1} + \rho_0 RISK_{it} + u_{it} \tag{2}$$

In Equation (1), the decomposition of absolute risks associated to a bank is independent from its balance sheet structure. It simply reflects the level of absolute risk viewed from an investor's perspective. Indeed, risk in the macro environment is, to some extent, independent from that of the bank.[5] However, banks' balance sheet structure (and hence the regulations that make them more robust) changes their capacity to withstand shocks, and hence alters the transmission of absolute risk to its market pricing.

We combine Equation (1) and Equation (2) in order to derive the relationship between the spread and risk components. In order to better perceive how this new element changes the initial relationship, we use an interactive term composed of the same micro term, and the balance sheet structure element, "BAL", as follows:

$$SPREAD_{it} = \alpha SPREAD_{it-1} + \beta MICRO_{it} + \gamma MACRO_{it} + \theta MICRO_{it}.BAL_{it} + u_{it} \tag{3}$$

For example, the rationale for capital is the following: because banks' capital ratios were influenced by Basel II requirements, defining a robust cross-section relationship between capital ratios and banks' funding costs gives an indication of what the introduction of Basel III requirements will lead to

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[4] MICRO risk relates, for instance to return on equity or return on assets and MACRO risk relates, for instance to GDP growth, the unemployment rate…the list of proxy is detailed below in the paper.

[5] To some extent only as for systemic institutions, risk in the real economy can react to an increase in these banks' risk.

after clearing the impact of other factors. Hence, drawing from the cross-section dimension information about the link between banks' funding costs and the regulatory proxy can help inferring the impact of a regulation.

More precisely, when the spread of a bank's bond over a reference rate is taken as a measure of relative risk, we use individual series to measure micro absolute risk (e.g. Return on Asset, ROA), macro absolute risk (GDP growth, ΔGDP), and the bank's balance sheet (risk-weighted capital ratio), then in this specific case, Equation (3) becomes:

$$SPREAD_{it} = \alpha SPREAD_{it-1} + \beta ROA_{it} + \gamma \Delta GDP_{it} + \theta ROA_{it}.\frac{Capital_{it}}{RWA_{it}} + u_{it} \qquad (4)$$

Assuming θ = -1, α = 0.9, and two banks located in the same country having the same return on asset of 2% in the long-run, if one has a 1 p.p. higher risk-weighted capital ratio, then, the equation would imply that the bank with the higher capital ratio would pay 20 bps less on its market debt than its peer.[6]

One can also estimate Equation (2) in a different form, by including the *MACRO* – instead of the *MICRO* – variable in the interactive term, in order to find out the extent to which the balance sheet structure alters the impact of macroeconomic risks on market-perceived bank risk:

$$SPREAD_{it} = \alpha SPREAD_{it-1} + \beta MICRO_{it} + \gamma MACRO_{it} + \theta MACRO_{it}.BAL_{it} + u_{it} \qquad (5)$$

A key element of the equation is that the regulatory change is expected to increase the bank's resilience to shocks and therefore dampen markets' reaction, i.e. their perception of a bank's vulnerability to the external environment. It is important to note that beyond the direct effect of a regulation, it is the transmission of absolute risks to banks' market funding costs which the regulation is assumed to impact, so that the level impact of the balance sheet structure is absent from Equations (3) and (5).[7]

None of the individual measures of micro or macro absolute risk are immune to critics and each has its pros and cons. Hence, we construct an index to synthetize information on the explanatory variables, both for bank-specific risk and country-specific risk. We do so implementing two methodologies on the individual bank-specific series after they have been de-meaned and standardised. In the first case, we compile the unweighted average of each individual indicator for

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[6] In the long run, in the absence of change in the macro and micro environment, the spread is constant, so that the lagged dependent variable can be passed to the left and the equation can be rewritten $(1-\alpha)$ spread = …+ θ ROA.Capital/RWA so that the elasticity of the spread to the capital ratio is θ / $(1-\alpha)$. ROA_{LT}

[7] The specification was also estimated with the balance sheet indicator both in level and interactive form. The results, not reported in this version, are available upon request.

each block.[8] In the second case, we extract the first common component of the dataset constituted by the set of individual variables, following Stock and Watson (2002). While the first methodology has the advantage of its transparency and simplicity, it imposes one restriction: the identical relevance of each series. This is not imposed by the factor-based approach where the weights for each series are such that they minimise the distance to the projection of each series on the common factor. In that approach, data are let freer to speak.

Concrete data on the direct impact of the various upcoming regulations is still lacking, but as we know how these regulations will alter the different above-mentioned aspects of banks' funding structure, we can derive the potential aggregate impact of new regulations by focusing on how banks' balance sheet structure defines their riskiness – as perceived by markets. After analysing the link between regulations and banks' balance sheet structure, the link between risk and pricing can be estimated.

We focus on balance sheet items that will be impacted by new regulations, split them into the three above-mentioned categories (capital, funding/liquidity, bank perimeter), and estimate their individual impact on markets' perception of bank risk and bank funding cost. It should be noted that the layers are considered independently but their impact should not be added-up as indeed they are linked by construction.

Each layer is considered through balance sheet items that are used as proxies which are correlated to the target regulatory variables which are not yet recorded across time. In the initial phase of this paper, we had estimated this equation structure by using alternatively all possible proxies for each variable, thereby obtaining a large number of equations and a wide range of elasticities. Hence, we have reverted to the same approach as the one implemented for constructing the MICRO and MACRO risk indices. For Equation (3) with the micro absolute risk and Equation (5) with the macro absolute risk, we use two indices to proxy each layer of regulation. One derived from an unweight average and one obtained from the common component of the series retained to proxy the regulation.

Our estimation covers the period from 2005Q1 to 2013Q4. We use balance sheet, P&L and bond issuance data for European banks sourced from their published accounts and accessed through Datastream. We also use consolidated data at the country level for Germany, France, Italy, Spain, Austria, Portugal, United Kingdom, Sweden and Denmark. For each bank, we match data on funding cost (the explained variable), balance sheet (for both bank-specific risk and regulatory targets), and

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[8] For each bank, we have a bunch of series available from 2005:1 to 2013:4, Xi. We compute the mean, Mi, and standard deviation, SIGi for each bank over the entire period. The demeaned and standardised series is (Xi-Mi)/SIGi. We then add them up and divide by the number of series which differs across banks.

macro environment. In the estimations reported in the paper, the series retained enable us to consider 31 banks located in the European Union.[9]

As regards *SPREAD*, our explained variable, we compute two proxies for measuring market-perceived bank risk, based on funding costs defined as the spread between a bank's cost of market funding and, either the Euribor 3-months, or the domestic sovereign yield of the closest maturity.

To compute the time-varying bank-specific cost of market funding, we use Dealogic data, whose data coverage is "comprehensive" although they do not guarantee 100%. Private placements are included. We have used a dataset comprising 30,000 bonds issued over the period by parent banks or affiliates. We first consolidate all the issuances at the group level and after removing bonds with complex coupons or no coupons, and banks with too low issuance, we end up with 25,000 bonds issued by 40 different mother banks. We then retain the issuances of the 31 banks for which we have constructed the *MICRO* indicators. We weight the rate of the coupon by the amount issued and pile up the debt securities of different maturity into a single aggregate cost of fund. In parallel, the average maturity at origination is compiled and used to indicate the maturity of the sovereign yield used to compile the spread (at the closest maturity).

There are several caveats associated with the computation of this measure as a proxy for bank funding cost, but this indicator is more encompassing than what could be obtained by monitoring the yield of few debt securities for one institution. One caveat is that the rate is taken at origination and weighted using the issuances across the quarter, independently of their underlying duration. Still, we performed several checks of the estimate and indeed, from one quarter to the other, the pattern in terms of maturity structure and the degree to which the debt it is secured is relatively persistent for each bank. Moreover, we think this indicator is more encompassing than what we could obtain by monitoring the yields of a few debt securities for one institution. The dispersion of these two spreads, with reference to the Euribor 3-months or to the sovereign of the closest maturity, is reported in Chart 1. The results depend to a large extent on the reference rate. When using domestic sovereign yields, the change in banks' cost of debt in the wake of the sovereign debt crisis does not seem at odds with historical regularities as it accompanies the change in sovereign yields. Indeed, in this case, the episode of the sovereign debt crisis cannot be seen as the spread does not increase. However, when using a euro area benchmark, the Euribor 3-months, the spread clearly evolves on an upward trend from the end of 2010 until the end of the sample.

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[9] BANCA CARIGE, BANCA MONTE DEI PASCHI, BANCA POPOLARE DI MILANO, BANCA PPO.EMILIA ROMAGNA, BANCO BPI, BANCO ESPIRITO SANTO, BANCO POPOLARE, BANCO POPULAR ESPANOL, BANCO SANTANDER, BANKINTER, BARCLAYS, BBV.ARGENTARIA, BNP PARIBAS, COMMERZBANK, CREDIT AGRICOLE, DANSKE BANK, DEUTSCHE BANK, ERSTE GROUP BANK, HSBC, JYSKE BANK, KBC ANCORA, LLOYDS BANKING GROUP, MEDIOBANCA BC.FIN, RAIFFEISEN BANK INTL., ROYAL BANK OF SCTL., SEB, SOCIETE GENERALE, STANDARD CHARTERED, SVENSKA HANDBKN., SWEDBANK, UNICREDIT.

INSERT CHART 1

As regards the explanatory variables, we also use data to proxy macroeconomic risk, bank-specific risk and banks' balance sheet structure, the proxy for the regulatory target. In each case, we use an index computed bank-by-bank based on either an unweighted average or the first common component of the underlying dataset referring to the macroeconomic environment or the bank-specific environment. Prior to the computation, each series is de-meaned and standardised (i.e. divided by its variance) over the period.

For the macroeconomic risk, we use indicators of macroeconomic conditions of the country where the bank is domiciled. Given the banks in the sample, we use country-level data for Italy, France, Germany, Spain, Portugal, Austria, as well as the United Kingdom, Sweden and Denmark: annual GDP growth, the unemployment rate, and the annual growth in disposable income all from EUROSTAT national accounts, annual loan growth from the ECB Balance sheet item statistics and, in the case of euro area countries, non-financial corporates' realised loan demand (from the European Central Bank's Bank Lending Survey). The indicator is such that an increase reflects a lower risk or more opportunities for the bank.

Our proxies for bank-specific risk are based on Balance Sheet and Profit & Loss data from Datastream (sourced from banks' published accounts, consolidated at group level). This set of variables consists of return over asset, return over equity, provisioning rate as the flow of provision over the stock of loans and as the flow of provision over total assets, and loan loss reserve over assets. Given missing observations and the presence of outliers in the sample, we use a correction algorithm to correct and/or estimate missing observations in the sample (see Maurin and Toivanen (2015)). On top of the information on listed banks reported in Datastream, we also use two measures of systemic risk data from NYU Stern's Volatility Laboratory (V-LAB), the Systemic Expected Shortfall (SES) and Marginal Expected Shortfall (MES). Those provide information on how banks behave in relation to the market as a whole.[10]

As shown in Chart 2, the differences between the common component and the unweighted average are relatively minor, both for the median and the interquartile range. It does not change drastically whether the index is estimated through an average or as a common component. However, the two indicators of risk, micro and macro, move asymmetrically. This shows the interest of keeping both of them in the regressions. Both the macroeconomic and microeconomic environments were positive to the EU banking sector up to the end of 2007. The situation deteriorated sharply from then and while it recovered shortly for the macroeconomic environment, it remained at depressed level for the microeconomic environment, staying above but relatively close to the low levels reached in 2008.

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[10] See Annex 2 for more information on V-LAB estimates.

After a second period of pronounced deterioration in the macroeconomic environment, from late 2010 until mid-2012, reflecting the sovereign debt crisis, the situation improved on the macroeconomic side. This was however not clearly reflected in the micro risk indicator.

INSERT CHART 2

Finally, the balance sheet indicators are used to portray regulation on capital and leverage, funding and liquidity and bank structural perimeter. For capital and leverage, the index is computed based on Tier 1 capital ratios, total capital ratios and total assets over common equity, a proxy for the leverage ratio. The implementation of new regulations on the capital and leverage ratios should lead to an increase in this indicator. For funding and liquidity, we include total debt over total assets, loans to deposits ratio, short-term debt over cash, and short-term debt over total assets. For the regulation on structural perimeter, we include indicators of bank size and universality: total assets/GPD, risk-weighted assets/GDP, the share of trading assets as a percentage of total assets, and non-interest income over total assets. An increase in the indicator reflects the bank becoming larger and more universal so that the regulation on banks' structural perimeter is expected to push down the indicator. For these three key indices, we have chosen the above-mentioned variables as we believe they are the best proxies for our purposes, in that they constitute a visible way for investors to assess banks' resilience to specific risks, thereby allowing them to determine at which rate they are willing to lend to them or buy their bonds. Nonetheless, these indices may suffer from endogeneity and selection bias: for example, if only safer (i.e. more capitalised) banks regularly access funding from capital markets, the relationship would be distorted. These risks are reduced by the use of instruments in the estimation.

We also conduct analysis in order to comfort the choice of the series used in the factor analysis to construct the indicator as the first common component. We project each of the series of the dataset on the first common component to estimate the extent to which the series share a common component and to check that the relationship is of the expected sign. The results are presented in Table 1. For all but one of the series used in the construction of the structural perimeter, the relationship is positive, as expected. Moreover, each series shares a relatively strong relationship with the indicator. The R-squared of the projection of each series on the common component lies between 49 and 72% for the macro economic indicator, 36 and 74% for the micro indicator, 58 and 89% for the capital indicator, 50 and 66% for the funding indicator and between 34 and 81% for the structural perimeter. The first common component also captures a relatively large share of the variance of the underlying dataset, between 59% for the structural perimeter indicator, and 78% for the capital indicator.

INSERT TABLE 1

As shown in Chart 3, the indicators for capital and leverage are stable from the beginning of 2005 until the end of 2008, then they display a trend increase from the beginning of 2009 until the end of 2013, which implies a more robust balance sheet. The dispersion widens during the first part of the trend increase, from the beginning of 2009 until the end of 2011. As regards funding and liquidity, no clear pattern appears and the indicator appears relatively volatile with a dispersion reduced in the middle of the period, in 2009 and 2010. The many missing observations at the quarterly frequency estimated to build the indicator probably explain this pattern as indeed most of the reporting banks report the indicators annually or twice a year. Another possibility is that over the period, the funding pattern of banks is so different across jurisdictions that the changes across time in the distribution are hidden behind the large structural differences at the EU level.[11] Concerning the indicator for banks' structural perimeter, a rise in the indicator means that banks become bigger and more universal. A similar pattern emerges from the two methods used to compute the indicator. Both the average and the common component share a common rise from the beginning of 2005 until the beginning of 2010. The trend is clearer for the factor based index which also displays a decline from the beginning of 2012.

INSERT CHART 3

It is well known that the cross-section OLS estimates of equations such as Equations (2), (3) and (5), which include a lag of the dependent variable, suffer from the so-called Nickel bias, as the fixed effects are correlated with the regressors due to lags of the dependent variable. Hence, we use the Arellano and Bover (1995) estimator. This estimator implements forward mean-differencing: it removes the mean of all forward future observations available for each bank-quarter. We implement GMM estimation to correct for endogeneity and to correct for contemporaneous correlation among errors, we compute robust standard errors with the white cross-section method.

4. Results obtained

We estimate Equation (6) which summarises in a condensed way Equations (3) and (5):

$$SPREAD_{it} = \alpha SPREAD_{it-1} + \beta MICRO_{it} + \gamma MACRO_{it} + \theta M_{it}.BAL_{it} + u_{it} \tag{6}$$

where i is the bank and t the time period, *SPREAD* are the two measures of spread retained, *MICRO* is the index or microeconomic risk constructed for each bank, *MACRO* is the index of macroeconomic risk associated to the countries where the bank is headquartered, *M* is either *MICRO* or *MACRO* and

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[11] French banks for example are more dependent on market funding at short term frequencies that their German or Italian peers.

BAL is the balance sheet indicator proxying the regulatory target, respectively for capital and leverage regulations, liquidity and funding regulations and banks' structural perimeter regulations.

To facilitate the reading of the results, the explanatory variables have been multiplied by -1 where relevant, to get a negative reaction to the explanatory variables. An increase in any of the variables on the right hand side is expected to lead to a lower cost of market debt. Hence, in Equation (6), we expect β, ϒ, and θ to be negative, while to ensure stationarity α should be below 1.

In order to better illustrate the impact of regulation on funding costs, we compute the long-term elasticity of the explained variable to regressors. As indicated by Equation (7), elasticities for micro and macro terms are computed as the long-run response of the explained variable to a 1-standard deviation change in the micro or macro risk indicator, respectively noted σ_{micro} and σ_{macro}.

$$\varepsilon_{micro} = \frac{\beta}{1-\alpha}\sigma_{micro} \quad and \quad \varepsilon_{macro} = \frac{\gamma}{1-\alpha}\sigma_{macro} \tag{7}$$

As shown in Equation (8), the elasticities for the interactive term are computed as the long-run response of the explained variable to a 1-standard deviation increases in the balance sheet item and risk index, micro or macro.

$$\Omega_{micro} = \frac{\theta}{(1-\alpha)}\sigma_{micro}.\sigma_{Bal} \quad and \quad \Omega_{macro} = \frac{\theta}{(1-\alpha)}\sigma_{macro}.\sigma_{Bal} \tag{8}$$

The results are presented in Tables 2, 3 and 4 in Appendix 1. The share of the variance explained by the equation varies between 11% and 27% for capital and leverage, 10% and 25% for funding and liquidity and 8% and 25% for banks' structural perimeter. It is always higher in the case where the Euribor 3-month is used as a reference rate to compute the spread. This may reflect the fact that the macroeconomic environment also impacts banks' funding costs through its impact on the local sovereign yield while a large part of the spread between banks' bond rate and the Euribor consists of a spread between the local sovereign yield and the Euribor. Indeed, the macroeconomic environment is not significant in the case where the local sovereign is used as a reference rate. As the models are estimated with 7 instruments[12], they are over identified. We test the validity of these over-identifying restrictions using the Sargan J-test.[13] In all the cases, the p-values are above 50% and suggests that the null that the over identifying restrictions are valid cannot be rejected at the standard level of 5%.

All the estimated equations entail a significant coefficient on the lagged dependent variable which evolves in a narrow range, between 0.73 and 0.86. This suggests that funding costs adjust rapidly to changes in the riskiness of banks' environment, with most of the adjustment to the long-run

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[12] The second lag of the spread, and the second and third lags of each explanatory variable.

[13] Under the null of no over identification, the statistic is distributed as a Chi-squared with a degree of freedom equal to the number of instruments minus the number of estimated parameters.

relationship taking place within one quarter. The result is consistent with empirical evidence which shows that price adjustments in capital markets are very quick.

The results broadly support the view that changes in macro and micro absolute risks are associated with increases in banks' funding costs, with higher risk resulting in higher costs. Importantly, the results are broadly comparable in terms of quantitative impact, after controlling for the specific index used, and despite the fact that the right hand side variables change across equations due to the change in the interactive term. Looking closely at the latter, the estimations provide strong support for the impact of capital regulation, some support for the impact of liquidity and funding regulation and are inconclusive for the impact of structural perimeter regulation.

The results are in line with expectations for the indicator of macro risk. First the coefficient is always correctly signed (except in 2 cases) and significant at the 5% confidence level most of the time when using the spread to the Euribor 3-months and less-so when using the local sovereign. This may reflect the fact that the macroeconomic environment of each bank does not entirely coincide with that of the local economy where the mother bank is located. Indeed, in our sample which consists mainly of large banks, several institutions are global and an important part of their revenues comes from abroad. A one standard deviation increase in the macro risk indicator raises the spread by up to 47 basis points (bps) when measured with reference to the sovereign yield of the closest maturity and by 68 to 116 bps when measured with reference to the Euribor 3-months. Averaging across equations, a one standard deviation increase in the macro risk raises the spread to the Euribor 3-months by 95 bps and the spread to the sovereign of the closest maturity by 22 bps.

Turning to the indicator of micro risk, it is always correctly signed, which entails that an increase in bank's absolute risk results in an increase in its funding costs. Despite differences in the coefficient depending on the index used and the interactive term included in the equation, the scaled long-run responses are always negative and appear to vary in a relatively narrow range across the 24 equations. The results are very similar across the two measures of the spreads, a result that reflects that our indicator is not un-correlated to the macroeconomic environment which correlates to the spread between the Euribor and the sovereign rate. A one standard deviation increase in the micro risk raises the spread by up to 50 bps when measured with reference to the sovereign yield of the closest maturity and by up to 51 bps when measured with reference to the Euribor 3-months. Averaging across equations, a one standard deviation increase in the micro risk raises the spread to the Euribor 3-months by 29 bps and the spread to the sovereign of the closest maturity by 23 bps.

Turning to the results on the regulatory impact, we find strong support for the dampening role of more capitalised or less leveraged balance sheet on the transmission of absolute risk to banks' funding costs, as the coefficients on the interactive term built using an index of capital and leverage are negative in all cases (see Table 2).

Following a macro risk shock of one standard deviation, the spread increase is lower for banks which have a higher index, by between 6 and 16 bps when measured with reference to the sovereign and by 18 to 20 bps when measured with reference to the Euribor 3-months, for a one standard deviation in the index. Averaging across equations, the spread increase is dampened by 15 bps. The pass-through of a one standard deviation micro risk shock of banks with a one standard deviation higher index of capital and leverage is reduced by 51 to 73 bps when the spread is measured with respect to the local sovereign, and by 24 to 40 bps when measured with respect to the Euribor 3-months. Averaging across equations, the spread increase is dampened by 47 bps. It is important to note that the dampening role of capital is obtained after conditioning on absolute risks. Indeed, looking at the data, since the beginning of the financial crisis, banks have increased the resilience of their capital structure, partly owing to regulation (see Chart 3). This rise has been accompanied by a rise in funding spreads, especially when measured with respect to the Euribor 3-months. The latter is explained by the deterioration in banks' absolute risks in our estimates and would have been stronger in the absence of a stronger capital structure (see Chart 2).

It is likely that the estimates would be even more supportive of this relationship when implemented since the crisis. Prior to the crisis, the risk of bankruptcy was not highly priced. As shown clearly in the case of the euro area sovereign debt crisis, sovereign bond yields were relatively independent from public indebtedness, despite the fact that it is an indication of the likelihood of default, and a sudden re-pricing resulted during the sovereign debt crisis. The phenomenon was not as strong in the wholesale bank debt market after Lehman Brothers' bankruptcy but following this and other bank liquidations, the market started to pay more attention to the soundness of banks' balance sheet. Indeed, Babihuga and Spaltro (2014) show that the sensitivity of international banks' funding costs (proxied by CDS premia) to capital resources has increased since the crisis (see also Calomiris and Nissim, 2014). The authors find that although increases in total capital have a positive impact on aggregate funding costs (i.e. higher costs) in the short run, in the long run the impact is clearly negative and across all regions (US, UK, Euro area, Nordics): "a 1pp increase in total bank capital reduces funding costs by 26 bps".

INSERT TABLE 2

The estimates shown in Table 3 also provide some support for the dampening role of stronger funding and liquidity position, as all but one of the coefficients for the interactive terms are negative: enhanced funding structure reduces the spillovers of a shock to banks' funding costs. However, none of the results are significant at the 5% level, which may be due to the construction of the index, as it is relatively stable and displays strong dispersion (see chart 3).

When hit by a one standard deviation shock, banks which have a stronger liquidity and funding structure, by one standard deviation, are estimated to experience a lower increase in their funding

cost, of up to 40 bps in reaction to a micro risk shock and up to 34 bps in reaction to a macro risk. Averaging across equations, the spread increase is dampened by 9 bps and 15 bps for respectively a one standard deviation shock in macro risk and micro risk. The reaction to micro and macro risks is stronger when the spread is computed as a common factor, compared to the unweighted average, and somewhat stronger when measured with reference to the local sovereign. The results suggest that markets pay a lot of attention to banks' funding structure and will likely penalise banks with too short-term and unstable liabilities with higher refinancing rates. However, the results here are less robust than for capital and leverage, so that we would be inclined to argue that regulations which affect bank's funding structure and liquidity reserves have less impact on the way markets perceive bank risk. This is consistent with the view that strong loss-absorbing capital is widely considered as the highest standard of bank safety.

INSERT TABLE 3

Turning to results for the third package of regulations we consider in this paper, banks' structural perimeter, all but one of the coefficients are positive (Table 4). Hence, more universal banks do not seem to be rewarded with lower funding costs due to their ability to diversify risks away, as often found in the literature (Calomiris 1995). However, by mixing indicators of size with indicators of universality, the index may wrongly assume a symmetric impact of each: we have included total securities/total assets in the index, as well as indicators of bank size, and these may have opposite effects. The results would indicate that banks with high trading activities as a share of total assets are "penalised" with higher funding costs, as they may be perceived as riskier, ie. the "higher riskiness due to market exposures" dominates the "lower riskiness due to diversification" effect. However, the premium may also not be constant over the period, having increased in the first wake of the crisis and then diminished as national and EU regulations sought to reduce it. In addition, the impact of bank structural perimeter may depend to a large extent on jurisdictions, with the too-big-to-fail (TBTF) premium unevenly distributed across the European Union (EU). Overall, the impact of such factor on relative bank risks is not straightforward and the net effect is probably strongly time-dependent.)

INSERT TABLE 4

5.   Concluding remarks

Our estimations support the view that banks' funding costs, measured as a spread to a safer reference rate, is determined by both their idiosyncratic characteristics and the macroeconomic environment in which they operate. The results are robust and the magnitude is comparable across several equations and methodologies applied to build the indices used as explanatory variables. We then focus on the

long-term impact of regulatory changes. After conditioning on macro and micro absolute risks, banks' balance sheet structure can alter the pass-through of these absolute risks to their funding costs in the long run as banks are made safer. As new banking regulations increase banks' capacity to withstand shocks in several dimensions (capital, funding/liquidity and structural perimeter), they should lower their funding costs for a given level of absolute risk in the long-run. Indeed, we find strong support in favour of this effect for the capital and leverage package: when hit by a 1-standard deviation macro shock, banks which have a 1-standard deviation stronger index of capitalisation, face a funding spread increase which is 18 to 20 bps lower when referenced to Euribor, and 6 to 16 bps lower when referenced to the domestic sovereign. Hence, a 1 standard deviation increase in the capital and leverage index reduces the transmission of a 1 standard deviation shock to macroeconomic risk by up to 20 basis points (bps). For micro shocks, the increase is 51 to 73 bps for the spread to the local sovereign and 24 to 40 bps lower for the spread to Euribor 3-month. Given the magnitude of the shocks observed during the sovereign debt crisis, of around two standard deviations, a bank with a 1-standard deviation stronger capital structure would have experienced a lower increase in funding costs of twice these estimates. We also find some evidence on the funding and liquidity side, with a stronger dampening effect on the transmission of micro risk, lowered by up to 34 bps for banks with a one standard deviation stronger index, and 15 bps on average. Finally, our estimates do not enable us to draw conclusions on the impact of the structural perimeter.

Our results are subject to several caveats. Importantly, as most of the regulatory targets are unprecedented, the estimated impact relies on the quality of the proxy retained to measure them in sample. Furthermore, it is worth mentioning that the results of our estimates using capital, liquidity/funding and structural perimeter factors are not additive, as there are probably some common components in the three effects. Hence, one cannot simply add the positive impact of the three types of regulations to derive the aggregate impact on funding costs. Moreover, banks' balance sheets are endogenous. They respond to the micro and macro environments of banks, and are affected by market pressures as well as the regulatory framework. In our analysis, we want to isolate the impact of the regulatory framework. This implies conditioning on the macro economy, and on market conditions, but there is an identification problem in that one cannot distinguish how much of banks' reaction is due to market discipline versus new regulations. Further research could seek to disentangle these two constraints – for example through the use of time-varying coefficients: market pressure on banks to increase capital may intuitively be smaller in boom times. Finally, we do not take into account the possible spillovers from bank to bank. However, because of banks' interconnectedness, increasing the soundness of one bank mechanically improves that of other banks as banks become less of a source of systemic risk to one another. Estimating these second-round effects is left open for further research.

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Annex 1: Tables and Charts reported in the text

CHART 1 – CROSS SECCTION DISTRIBUTION OF SPREADS (% per annum, de-meaned)

a) – between the average coupon and the domestic sovereign yield of the closest maturity

**b)** – between the average coupon and the Euribor 3-months
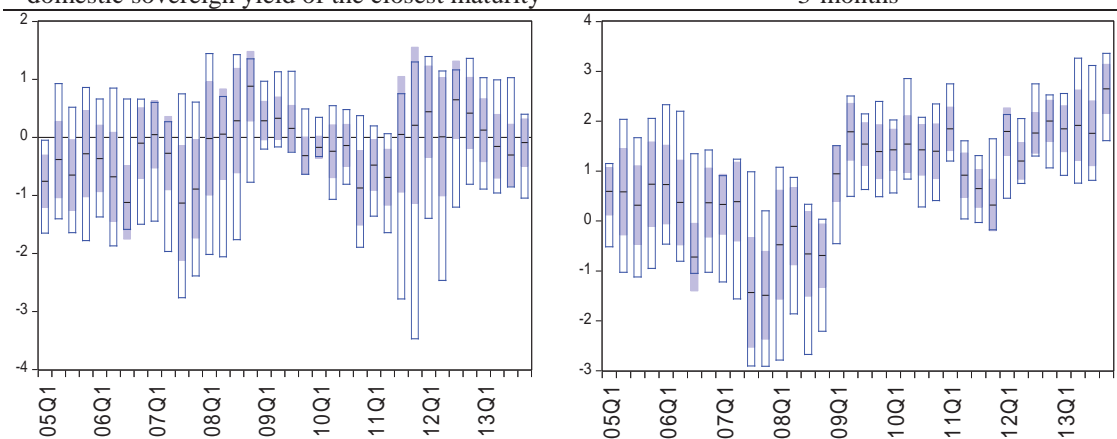
Note: The horizontal line in the bars represents the median of the distribution and the blue area the 95% interval confidence. The limits of the boxplots indicate the first and the third quartile of the distribution.

CHART 2 - CROSS SECCTION DISTRIBUTION OF THE RISK INDICES

a) – Estimated as an unweighted average

b) – Estimated as a factor

Macro risk

Micro risk
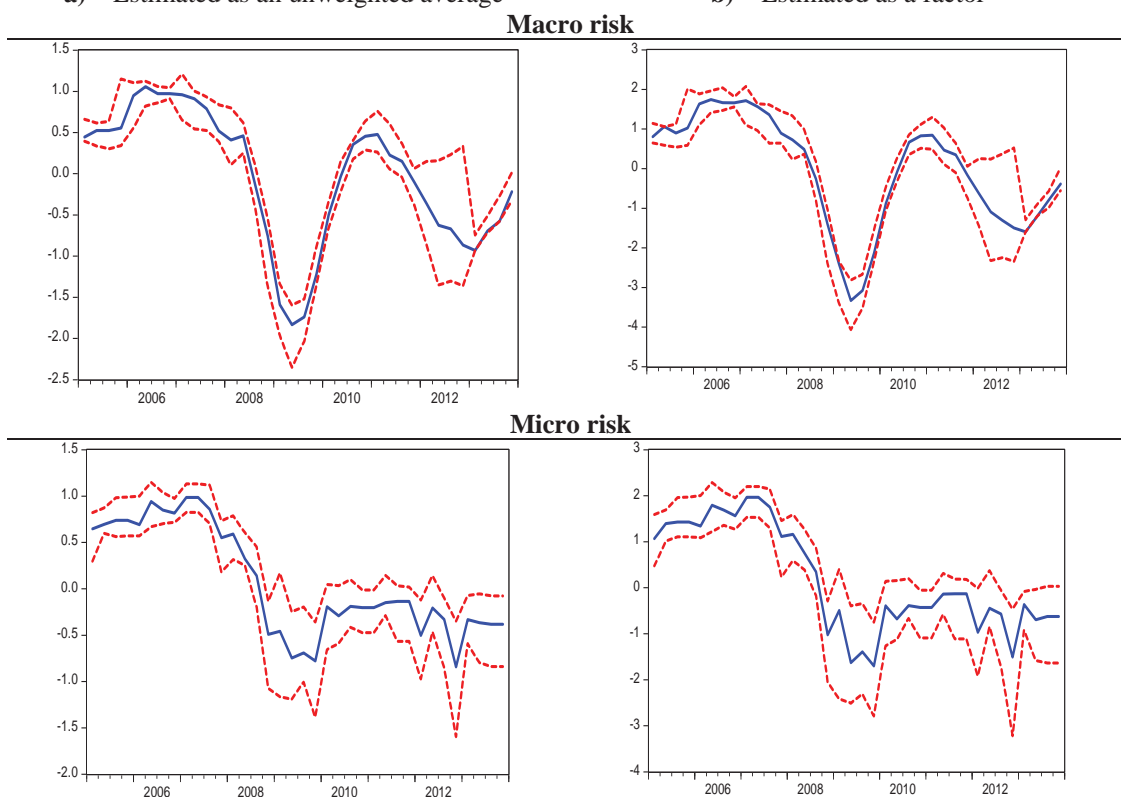
Note: Series are first de-meaned and standardised. The blue line inside the red ones portrays the median of the indicator across the sample of banks while the two red dotted lines represent the 25% and 75% quartiles.

CHART 3 – CROSS SECTION DISTRIBUTION OF THE REGULATORY PROXIES

a) – Estimated as an unweighted average   **b)** – Estimated as a factor

Capital and Leverage

Funding and Liquidity

Structural perimeter

Note: The blue line inside the red ones portray the median of the indicator across the sample of banks while the two red dotted lines represent the 25% and 75% quartiles.

TABLE 1 – RESULTS OF THE PCA ANALYSIS

		Loading	R2 (%)	Share of the variance explained by the first common component (%)
MACRO	GDP (an. growth)	0.52	78.2	
	(-) Unemployment rate	0.51	78.8	
	Loans to the non-financial private sector (an. growth)	0.35	48.8	69.7
	Disposable income (ann. growth)	0.47	68.1	
	Loan demand from NFC (BLS, realised)	0.43	61.6	
MICRO	Return on assets	0.34	58.9	
	Return on equity	0.39	65.6	
	(-) Flows of provisions/Total Assets	0.4	73.3	
	(-) Flows of provisions/Loans	0.41	73.8	60.6
	(-) Loan loss reserve/Net loans	0.13	44.2	
	(-) Systemic Expected Shortfall/Total Assets (SES)	0.38	62.7	
	(-) Marginal Expected Shortfall (MES)	0.19	36	
CAPITAL	Tier 1 Capital ratio	0.55	88.8	
	Capital ratio	0.58	81.6	77.6
	(-) Total assets/Common equity	0.37	58	
FUNDING	(-) Total debt over total assets	0.19	66	
	(-) loans to deposits	0.05	49.5	59.6
	(-) Short-term debt/Cash	0.22	56.9	
	(-) Short-term debt/Total assets	0.15	65.4	
STRUCTURAL PERIMETER	Total Assets/GDP	0.51	80.6	
	Risk-weighted assets/GDP	0.47	70.6	58.4
	Total investments/Total assets	0.2	48.1	
	Non-interest income/Total assets	-0.21	33.7	

Note: Results obtained block by block and based on the dataset of 31 banks apart for the macro block which is based on the dataset of 10 countries (Belgium, Germany, Spain, France, Italy, Austria, Portugal, Sweden, United Kingdom and Denmark). Each series is de-meaned and standardised. As explained in the text, some of the series are inverted so that an increase reflects lower risk or stronger resilience of banks in the case of the three regulatory layers. The columns loading and R-squared indicate the results of the projection of the series on the first common component.

TABLE 2 – IMPACT OF CAPITAL AND LEVERAGE REGULATIONS

	Y(t-1)	β (micro)	ϒ (macro)	Θ (micro)	Θ (macro)	Scaled long-term response (bps)				Reg. diagnostics	
						ε(micro)	ε(macro)	Ω(micro)	Ω(macro)	R2 (%)	Jstat (%)
Spread to the local sovereign of the closest maturity											
Unweighted average	0.783 [0.07]**	-0.176 [0.1]*	0 [0.06]	-0.303 [0.12]**		-50	0	-73		12.4	32.1
Common component	0.771 [0.07]**	-0.026 [0.02]	-0.031 [0.02]	-0.038 [0.02]**		-23	-24	-51		13.3	14.9
Unweighted average	0.81 [0.07]**	-0.084 [0.11]	-0.019 [0.06]		-0.043 [0.09]	-27	-8		-16	12	26.9
Common component	0.793 [0.07]**	-0.009 [0.02]	-0.038 [0.02]*		-0.005 [0.02]	-8	-32		-6	12.2	12.5
Spread to the Euribor 3-months											
Unweighted average	0.713 [0.04]**	-0.239 [0.09]**	-0.235 [0.04]**	-0.217 [0.15]		-51	-68	-40		25.7	47.9
Common component	0.744 [0.05]**	-0.032 [0.02]	-0.147 [0.02]**	-0.02 [0.02]		-26	-100	-24		25.6	41.6
Unweighted average	0.753 [0.04]**	-0.082 [0.09]	-0.272 [0.04]**		-0.071 [0.09]	-20	-92		-20	24.1	14.5
Common component	0.773 [0.05]**	-0.006 [0.02]	-0.151 [0.02]**		-0.015 [0.02]	-6	-116		-18	24	28.7

Note: see note Table 4. The standard deviation of the synthetic indicator for capital and leverage is 0.938 and 1.327 when computed as an unweighted average and common component respectively.

TABLE 3 – IMPACT OF LIQUIDITY AND FUNDING REGULATIONS

	Y(t-1)	β (micro)	Υ (macro)	Θ (micro)	Θ (macro)	Scaled long-term response (bps)				Reg. diagnostics	
						ε(micro)	ε(macro)	Ω (micro)	Ω (macro)	R2 (%)	Jstat (%)
Spread to the local sovereign of the closest maturity											
Unweighted average	0.811 [0.06]**	-0.132 [0.1]	0.014 [0.06]	-0.083 [0.44]		-43	6	-8		11.8	13.6
Common component	0.798 [0.06]**	-0.019 [0.02]	-0.036 [0.02]*	-0.026 [0.02]*		-18	-31	-40		11.6	14.3
Unweighted average	0.835 [0.07]**	-0.096 [0.11]	-0.004 [0.05]		0.058 [0.35]	-36	-2		8	10.3	29.5
Common component	0.807 [0.06]**	-0.015 [0.02]	-0.037 [0.02]*		-0.025 [0.02]*	-16	-33		-34	11.5	13.6
Spread to the Euribor 3-months											
Unweighted average	0.734 [0.04]**	-0.201 [0.09]**	-0.229 [0.04]**	-0.01 [0.45]		-46	-72	-1		25.4	23.9
Common component	0.755 [0.04]**	-0.025 [0.02]	-0.152 [0.02]**	-0.01 [0.03]		-21	-108	-12		25	53.1
Unweighted average	0.749 [0.04]**	-0.186 [0.09]**	-0.229 [0.04]**		-0.043 [0.025]*	-46	-76		-4	24.8	28.8
Common component	0.765 [0.05]**	-0.019 [0.02]	-0.152 [0.02]**		-0.007 [0.02]	-17	-113		-8	24.7	54.7

Note: See note Table 4. The standard deviation of the synthetic indicator for capital and leverage is 0.285 and 1.536 when computed as an unweighted average and common component respectively.

TABLE 4 – IMPACT OF BANK STRUCTURAL PERIMETER REGULATIONS

	Y(t-1)	β (micro)	Υ (macro)	Θ (micro)	Θ (macro)	Scaled long-term response (bps)				Reg. diagnostics	
						ε(micro)	ε(macro)	Ω (micro)	Ω (macro)	R2 (%)	Jstat (%)
Spread to the local sovereign of the closest maturity											
Unweighted average	0.864 [0.07]**	-0.05 [0.11]	-0.041 [0.06]	0.275 [0.21]		-23	-25	68		7.8	14.6
Common component	0.804 [0.06]**	-0.016 [0.02]	-0.036 [0.02]*	0.005 [0.01]		-16	-32	8		11.6	18.9
Unweighted average	0.841 [0.06]**	-0.018 [0.11]	-0.086 [0.06]		0.3 [0.12]**	-7	-45		85	9	59.1
Common component	0.821 [0.06]**	-0.002 [0.02]	-0.048 [0.02]**		0.026 [0.01]**	-3	-47		37	10.7	26.7
Spread to the Euribor 3-months											
Unweighted average	0.744 [0.04]**	-0.155 [0.09]*	-0.257 [0.05]**	0.096 [0.22]		-37	-84	13		24.6	24.7
Common component	0.76 [0.05]**	-0.027 [0.03]	-0.148 [0.02]**	-0.01 [0.01]		-23	-107	-13		25	31.9
Unweighted average	0.727 [0.04]**	-0.154 [0.08]*	-0.304 [0.05]**		0.308 [0.1]**	-35	-93		51	24.4	65.7
Common component	0.769 [0.05]**	-0.019 [0.03]	-0.152 [0.02]**		0.014 [0.01]	-17	-115		15	24.5	48.5

Note: Estimation of Eq. 6 over 2005Q1-2013Q4 with Arenallo-Bover (1995) estimator. The standard deviation of the estimates is reported below in parenthesis and one (two) asterisk denotes significance at 10% (5%). Robust asymptotic standard errors reported in parentheses are clustered at the bank level. J-stat reports the result of the Sargan test of over-identification. The long-run responses are computed as indicated in Eq. 7 and 8. When computed as an unweighted average and common component respectively, the standard deviation of the synthetic micro risk is 0.612 and 2.013, that of the synthetic macro risk is 0.965 and 1.679, and that of the synthetic indicator for capital and leverage is 0.542 and 1.475.

Annex 2: Presentation of the VLAB data

In Acharya, Pedersen, Philippon and Richardson (2010), the authors elaborate a new methodology to measure systemic risk. The methodology assumes that a banking failure becomes a source of systemic risk only when the banking system as a whole is undercapitalised (e.g. no systemic impact of the failure of Barings Bank in the UK in 1995). Hence, individual firms' contribution to systemic risk can be calculated as the amount by which their capital resources fall below a certain threshold, conditional upon the system as a whole being undercapitalised, or in the authors' words, their "Systemic Expected Shortfall" (SES).

Banks' SES is determined by their Marginal Expected Shortfall (MES) and their quasi-leverage ratio. The former refers to a bank's average equity price change when the stock market as a whole experiences its 5% worst trading days. The latter is calculated as follows: (Book value of assets – Book value of equity + Market value of equity)/Market value of equity. The authors show that MES and the quasi-leverage ratio "seem to capture quite well" the SCAP-estimated percentage losses, realised stock returns and total realised return on CDS spreads during the crisis. The authors also compare the predictive power of these metrics versus the usual idiosyncratic (Expected Shortfall, volatility of returns) and systemic (Beta) measures of risk and find that MES and Leverage perform better at explaining banks' negative returns during the crisis.

The NYU Stern's Volatility Laboratory ("VLAB") computes Acharya et al.'s systemic risk metrics on a daily basis for most financial firms across the world. We have obtained data from VLAB on the key metrics for 414 European banks on a daily basis for June 2000 to December 2013 (where available). The data uses a capital ratio threshold of 8% and is easily updatable. Beyond the two indicators we use, Marginal Expected Shortfall (MES), using the MSCI World Index as reference and SRISK, which represents firms' Systemic Expected Shortfall (SES), other series are available over a long period, for each bank.

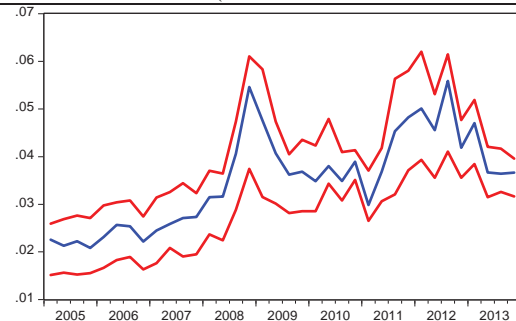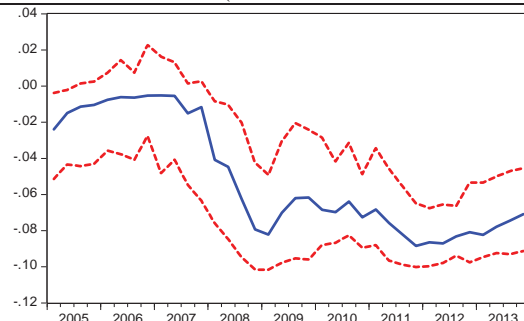**CHART A** – SES (as a ratio to total bank asset)   **CHART B** – MES (as a ratio to total bank asset)

Source: Authors compilation based on data are available on http://vlab.stern.nyu.edu/analysis/RISK.WORLDFIN-MR.GMES, explained in Acharya et al. (2010) paper at http://vlab.stern.nyu.edu/public/static/SR-v3.pdf. Note: The blue line inside the red ones portray the median of the indicator across the sample of banks while the two red dotted lines represent the 25% and 75% quartiles.

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