Original Article

The effects of regulatory stringency and risk sensitivity on banks

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ABSTRACT The EU's transposition of Basel II into European law has been done through the Capital Requirements Directive. Although the Directive establishes, in general, uniform rules to set capital requirements across European countries, there are some areas where the Directive allows some heterogeneity. In particular, Member States are asked to choose among different possibilities when transposing the Directive, which are called national discretions (ND). The main objective of our research is to use such observed heterogeneity to gather empirical evidence on the effects on European banks of more or less stringency (ST) and more or less risk sensitivity (RS) in capital requirements. Following the approach in Barth *et al*, we build index numbers for groups of ND, and applying the approach in Altunbas *et al* we provide evidence on their effect on banks' risk, capital, efficiency and costs. We show that more ST and more RS in regulation does not always result in a trade-off between efficiency and solvency: the impact depends on the area of ND to which such characteristics apply.

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INTRODUCTION

The EU's transposition of Basel II into European law was done through the Capital Requirements Directive (CRD). Although the Directive establishes, in general, uniform rules to set capital requirements across European countries, there were some areas where the Directive allowed some heterogeneity. In particular, Member States (MS) were asked to choose among different possibilities when transposing the Directive, which are called options and national discretions (ND). MS made use of this possibility, and we observe that different choices were made on the rules to apply. Arguably, these different choices are nothing but a reflection of different regulatory preferences that, in particular, can be qualified in terms of their stringency (ST) and risk sensitivity (RS). If regulation is effective, these choices can also be expected to lead to different bank results.

The theoretical academic literature produces highly mixed predictions regarding the effects of capital regulation on efficiency, asset risk and overall safety and soundness for the banking system as a whole, whereby the issue mainly remains an empirical one. Although there is no consensus on the economic rationality of banking regulation, there is some agreement that capital regulation can be justified on the basis of improving the safety and soundness of the banking sector and minimising the negative externalities associated with bank failure.[1] In fact, regulators' expectations are that tighter capital requirements, if effective, should lead to higher capital and lower risk-taking. The idea is that if banks hold enough capital, they internalise the adverse consequences of gambling and thus will choose to invest prudently. On the other hand, such tightness could lead to higher inefficiency, which could be manifest in lower profits or higher costs, although evidence has also been gathered on the opposite effect.[2] Moreover, a more risk-sensitive capital framework, if effective, should result in more stability, with the possibility of raising costs in terms of efficiency as well.

A fair amount of empirical work has already been done on the impact of banking regulation on banking system stability, whereas there is very little systematic empirical evidence on how regulation affects risk-taking, capital and efficiency at the level of banks and, in particular, whether there is a trade-off between stability and efficiency. This article attempts to address this gap. The extensive cross-country data on bank regulation and supervision that have been gathered in different waves into a database by the World Bank have provided for the analysis of the effects of regulatory and supervisory arrangements on the development of the financial sector and on the stability and efficiency of the banking system.[3–6] Through the construction of regulatory indices, the papers by Barth *et al* found that more ST in capital regulations does not seem to have a statistically significant effect either on banking-system fragility, bank development, efficiency or costs.

The objective of our article is to test whether this lack of an effect holds when we consider more disaggregated information in relation to capital requirements, that is, at the level where many regulatory decisions are taken. In particular, we make use of the heterogeneity provided by the choice of ND in the CRD to gather empirical evidence on the impact on European banks of more or less ST and more or less RS in capital requirements. We focus on the potential effects that these options and discretions may have on the risk, capital, costs and efficiency of individual banks.

By conducting this analysis, we provide evidence on whether there is a trade-off between solvency and efficiency caused by more ST or by more risk-sensitivity in capital requirements. To do so, we assume that the choice of ND made by MS reflects not only the regulator's preferred option, but also that closest to the regulation that each MS already had in place before the CRD was transposed. In this sense, we are not aiming to test the impact of the introduction of ND, but are using them as proxies for different regulatory approaches. The analysis also allows us to provide an estimate of the impact of different choices, within the CRD, as far as risk-sensitivity and ST in capital requirements is concerned and in particular in relation to the initial proposal made by the Committee of European Banking Supervisors (CEBS) in October 2008.

We follow the approach in Barth *et al*,[3–5] and construct indices of ND in bank capital regulation for all 27 EU countries, testing for their relevance to banks' risk, capital and efficiency.

The structure of the article is as follows. The next section reviews the literature concerning the effects of capital regulation on banks' risk, capital and efficiency. The subsequent section describes the data and specifically the construction of the ND indices while the fourth section focuses on the methodological framework. The subsequent section presents the results, and the penultimate section records the simulations. Finally, the last section summarises and concludes. Appendix A contains a table with the

ND, while Appendix B provides the estimates for the efficiency variable and Appendix C records the detailed tables with the estimation results for the capital, risk, cost and efficiency equations.

LITERATURE REVIEW

Although there is extensive theoretical literature on bank capital, that which takes into account the presence of financial regulation is much thinner on the ground (see Van Hoose[7] and Santos[8] for a survey of theories of bank behaviour under capital regulation). And this happens despite the fact that banking is undoubtedly one of the most regulated industries in the world, and the rules on bank capital are one of the most prominent aspects of such regulation (see Berger *et al*[9] and Freixas and Santomero[10] for a theoretical justification of bank capital requirements).

Given that the regulatory requirement depends on the amount of loans granted, a link between bank capital and lending is established. There is widespread agreement in the theoretical literature available that the immediate effects of constraining capital standards are likely to be a reduction in total lending and accompanying increases in market loan rates and substitution away from lending to holding alternative assets.[11]

This literature produces highly mixed predictions, however, regarding the effects of prudential regulation on banks' risk-taking profiles and on overall safety and soundness for the banking system as a whole.[12] In particular, theoretical contributions do not agree on the impact of more risk-sensitive capital requirements on portfolio choices and on efficiency.[53] Although the effects of capital adequacy requirements are usually to decrease risk-taking,[13] the opposite is also possible.[14–21]

The impact of capital requirements on bank capital and credit risk depends on the extent to which such requirements are binding. Some of the empirical research conducted to determine whether this is the case seems to support the view that regulatory capital has an impact on the capital held by banks.[22–24] In fact, the claim that, as most banks already hold capital substantially in excess of the regulatory minimum, any change in it will not have any effect on banks' capital is not substantiated by the results for the United Kingdom in the work by Alfon *et al*[23] and Francis and Osborne,[24,25] the results in Van Roy[26] with data for six G-10 countries (Canada, France, Italy, Japan, the United Kingdom and the United States) or the findings in Rime[27] for Switzerland. As for risk-based capital ratios, they have been shown to lead to significant increases in capital ratios in relation to a non-RS baseline.[28] Furfine[29] finds some evidence that capital regulation during the 1990s materially influenced bank capital ratios. On the other hand, Barrios and Blanco[30] find that the Spanish banks they considered were not at all constrained by capital regulation during the period under study.

Empirical evidence is provided for the irrelevance of ST in capital regulation for bank development and stability,[3–5] while more stringent capital regulations are negatively linked with non-performing loans.[5] However, much of the evidence on the impact of capital adequacy requirements on financial stability has been obtained under an event-based approach, which identifies crises only when they are severe enough to trigger market events.[31] In contrast, crises successfully contained by corrective policies are neglected, so that estimation suffers from selection bias.[32] Using a Markov switching regression model to deal with this bias, the results in Tchana Tchana show that capital adequacy requirements improve stability and reduce the expected duration of banking crises.[33]

The possible effects on risk-taking arising from regulatory capital pressure has been analysed in some papers. Editz *et al*[22] find no evidence that an increase in the minimum bank-specific capital ratio prevalent in the United Kingdom causes a bank to shift to less risky asset risk buckets. A similar result is obtained in Rime,[27] where it is shown that regulatory pressure does not affect the level of risk in Swiss banks. On the other hand, González[34] provides evidence that banks in countries with stricter regulation have a lower charter value, which increases their incentives to follow risky policies, a similar result to that found by Shrieves and Dahl.[35] The evidence gathered on the impact of RS capital requirements on risk-taking points to a negative relationship with data on the introduction of Basel I,[36] which is also supported by the work of Jacques and Nigro.[28]

Finally, as for the effects of regulation on performance and costs, the results in Demirgüç-Kunt *et al*[6] indicate that tighter regulations on bank entry and on bank activities boost the cost of financial intermediation. In contrast, Berger[2] finds that there is positive Granger causation from capital to bank earnings, through lower interest rates paid on uninsured purchased funds, while the results in Barth *et al*[4,5] do not capture any effect, whereby capital regulation does not impact efficiency.

DATA

Four main sources of data are used for the empirical analysis. We first exploit the data on how each MS has exercised each ND, drawing on the CEBS website.[37] We also use aggregate country data describing several characteristics and reflecting the structure and operation of the national banking system for 2007, which are obtained from the European Central Bank (we use the data contained in both the 2007 European Banking Structures Report and the 2007 Banking Sector Stability Report). We also use the Barth *et al*[5] database to capture institutional features of the regulatory and supervisory framework. And finally, individual bank data for 2007 are obtained from the BankScope database, which is provided by Fitch-IBCA. Data are for all financial institutions (commercial banks, savings banks and cooperatives) with accounting data for 2007 from consolidated accounts if available, and from unconsolidated accounts otherwise.

Our final data set consists of 2089 financial institutions from 27 countries for the year 2007, which comprises 252 commercial banks, 379 savings banks and 1458 cooperatives.

Construction of ND indices

MS have a choice of more than 150 ND and options in the CRD, which may be applied on the basis of national circumstances and which cover a rather wide scope of areas within the Directive.[38]

To perform the empirical analysis, we took 53 of these ND for which we could clearly identify whether adoption implied more or less ST in regulation or more or less RS than the benchmark given by the Directive.[39]

For each country, the CEBS data reflect whether or not the discretion has been exercised (YES/NO answer) by each of the EU countries. Thus, most of the ND can be specified as simple zero/one variables. In general, we assign a value of 1 when the answer reflects a more stringent regulatory treatment or when it implies a more risk-sensitive approach[40] than the benchmark provided by the Directive. We group the responses provided by the MS into aggregate indices that we define below.

We first group ND into two main categories, depending on whether they affect the ST or the RS of regulation. This aggregation allows us to analyse the impact of overall ST and overall RS on banks' risk, capital and efficiency.

Alternatively, we group ND in a more disaggregated form, defined in relation to the regulatory areas they cover. Following CEBS, we distinguish the areas of Own Funds (OF), scope of application (S), credit risk under the standard approach (CRSA), credit risk under the Internal Ratings-based approach (IRB),[41] Counterparty Risk (CPR) and Operational Risk (OR).[42] CRSA, IRB and CPR are, in fact, split into two: one covering ST (XX_ST), and the other risk-sensitivity (XX_RS). The actual number of ND included in each group differs and spans from as little as one in CPR_RS or two in CPR_ST to as much as

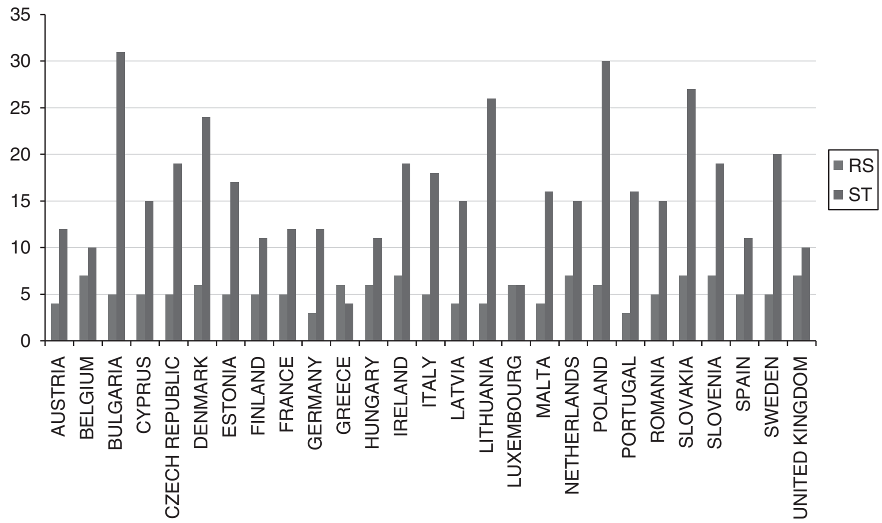

Figure 1: National discretion indices: Risk sensitivity and stringency.

14 in CRSA_ST, as the last line in Table 1 records. The aggregate index ST is obtained from the sum of all the indices that cannot be split plus the ST part of those that can. The aggregate index RS is obtained as the sum of those that have been classified as RS.

Following Barth *et al*,[3] we use two methods to construct the indices for regulatory ST and RS that incorporate the answers to several of the ND. First, we simply add the individual zero/one answers, so that a higher value of the index implies higher ST in the regulation of the area or higher RS, if risk is the issue. The drawback of this method is that it gives equal weight to each of the components in constructing the index. The second method involves calculating the first principal component of the underlying ND, to obtain a principal component with a mean of zero and standard deviation of one. The advantage over the simple aggregation is that no equal weights to the different ND are assumed. The disadvantage is that it does not allow the impact of a change in a specific ND used for the construction of the index to be assessed.

Using the equal-weighted aggregation, we observe (Figure 1) that no MS has chosen a combination of ND that implies either most ST (value of 41) or most RS (value of 10). On the other hand, none has chosen either an overall combination of most lenient treatment or least RS, and only five of the 27 MS present an ST index whose value is over half the maximum and 11 whose value for RS is above half the maximum value. We observe that MS that have joined the EU in recent years, with few exceptions, tend to have chosen more stringent and more risk-sensitive ND than former members.

For the rest of the article, following the approach in the work of Barth *et al*,[3–5] we only report the results obtained with the principal components index.

The simple correlation between the different indices in the different countries is in general low (Table 1), reflecting the fact that the choice made by MS in relation to the ND is rather diverse. Moreover, the area of CPR tends to show a negative correlation with the rest of the areas, which may result from some sort of substitutability between areas. The highest values for the correlations (above 50 per cent) can be found between the areas of Own Funds and Scope, Operational Risk and Scope, Operational Risk and the Standard Approach, and between the two Counterparty Risk indices.

Table 1: Correlations among ND indices

	OF	*S*	*CRSA_ST*	*CRSA_RS*	*CPR_ST*	*CPR_RS*	*IRB_ST*	*IRB_RS*	*OR*
OF	1	—	—	—	—	—	—	—	—
S	0.576	1	—	—	—	—	—	—	—
CRSA_ST	0.310	0.409	1	—	—	—	—	—	—
CRSA_RS	0.007	−0.313	−0.007	1	—	—	—	—	—
CPR_ST	−0.115	−0.348	−0.309	0.238	1	—	—	—	—
CPR_RS	−0.420	−0.341	−0.455	0.143	0.522	1	—	—	—
IRB_ST	0.485	0.443	0.444	−0.198	−0.080	−0.467	1	—	—
IRB_RS	0.302	0.159	0.158	−0.107	0.242	−0.090	0.279	1	—
OR	0.155	0.501	0.527	−0.168	−0.170	0.015	0.416	0.240	1
# ND	4	7	14	4	2	1	12	6	3

METHODOLOGICAL FRAMEWORK

All MS should have transposed the new Directive by the end of 2007, and, therefore, banks should have been operating under the new regulatory framework by that year.[43] On the basis of the assumption that regulation is very persistent over time,[4] so that it takes time for a country to change dramatically its regulatory system, we can also assume that countries exercised, for each ND, the option most similar to the regulation in force before 2007. ND can, thus, be regarded as reflecting current practices in the countries that apply them, as their existence in the Directive is justified on the grounds that they try to accommodate different existing regulatory approaches. In that sense, our analysis is not about the impact of the new regulation but the characteristics of the regulation, defined in terms of ST and RS.

The empirical analysis proposes testing whether bank risk, efficiency, costs and capital are affected by these characteristics of regulation as shown by the choice of ND, taking into account other features of the functioning of the countries. In particular, the following regression model is estimated to capture the impact of ND on bank risk, capital and efficiency:

$$Y_{jn} = \alpha + \beta^{*}\mathrm{ND}_n + \gamma^{*}\mathrm{COUNTRY}_n + \lambda^{*}\mathrm{CONTROL}_{jn} + \varepsilon_{jn}$$

where n indexes country n, and j indexes bank j.

Moreover, Y_{jn} is either RISK_{jn}, the observed value of the measure of risk chosen for the jth bank operating in country n, or $\mathrm{CAPITAL}_{jn}$, the amount of capital that a bank holds, or $\mathrm{INEFFICIENCY}_{jn}$, the observed value of the measure of inefficiency for the jth bank in country n; ND_n is the vector of national discretions; $\mathrm{COUNTRY}_n$ is a vector of country-specific variables, $\mathrm{CONTROL}_{jn}$ is the vector of control variables that are bank-specific and that differ depending on the variable that is being explained; α, β, γ, λ are the regression coefficients and ε_{jn} is the disturbance term. Our focus of attention will be on the sign and statistical significance of the β coefficients. If β has a statistically significant negative sign in the risk equation and/or a positive sign in the capital equation, we can say that the corresponding ND has a positive impact on solvency. Moreover, if β has a statistically significant positive sign in the inefficiency equation, we can say that the corresponding ND has a negative impact on efficiency.

Following Altunbas *et al*,[44] we specify a system of equations and estimate these using Zellner's Seemingly Unrelated Regression approach (SURE). This allows for considering the possibility of correlated errors between the equations – as we are using the same accounting data in all of them – while controlling for relevant variables, whether country or bank-specific.

The dependent variables

We proxy INEFFICIENCY with two variables:

AC_{jn} Average costs obtained as the ratio of total costs (overhead costs + interest expenses) divided by total assets.

$INEFT_{jn}$ cost inefficiency measure. It is obtained as the distance of a firm's observed operating costs to the minimum or 'best practice' efficient cost frontier. It is derived from the estimation of a stochastic cost frontier using a translog specification, whose details can be found in Appendix B. Such an approach followed to capture efficiency, although fairly common in the literature, has its limitations as it assumes that there is only one way to run a bank, and that all banks can therefore have the same cost structure but for their inefficiencies.

As for RISK, we proxy it with:

$LOLPTA_{jn}$ Loan loss provisions over total assets. A similar measure (with reserves) is used by Altunbas *et al.*[44] It is derived from accounting information so that it has the limitations inherent to such kinds of data, of being backward-looking. Higher levels of provisions are suggestive of greater banking risk.

And for CAPITAL we use:

ETA_{jn} the ratio of book value of equity to total assets, where equity includes preferred shares and common equity.

The control variables

As it is crucial to use a variety of control variables and sensitivity checks to mitigate problems while interpreting the findings, we propose including the following.

Bank size

As a measure of size, we use the natural log of total assets for bank j in country n ($SIZE_{jn}$). As pointed out by McAllister and McManus,[45] larger banks have better risk diversification opportunities and thus a lower cost of funding than smaller ones. On the other hand, the 'too-big-to-fail' argument suggests that larger banks would benefit from an implicit guarantee that, other things being equal, decreases their cost of funding and allows them to invest in riskier assets. Previous empirical evidence on this issue produced ambiguous results. We also include bank size squared ($SIZE2_{jn}$) to capture any nonlinearity in the relationship.

Fee income

As a measure of banks' different product mixes, we include the variable $FEES_{jn}$, which equals non-interest-operating income divided by total assets. As banks engage in different non-lending activities, these other activities may influence the pricing of loan products because of cross-subsidisation of bank products. Thus, we include fee income to control cross-bank differences in the products offered by banks.

Bank liquidity

Bank liquidity is proxied with the ratio of liquid assets to customer and short-term deposits for bank j in country n ($LIQUID_{jn}$). We could expect banks with a high level of liquid assets to receive lower interest income than banks with less liquid assets. Moreover, although it need not reflect a more efficient asset allocation, liquidity could affect efficiency.

Bank loans

We use the change in total net loans to total assets as the measure of a bank's lending activity ($TNLTA_{jn}$). Loans might be more profitable than other types of assets such as securities. Loans might be more costly to produce than other types of assets. Moreover, we can expect that the more loans a bank makes to the retail or the corporate sector, the higher the risk tolerance of bank managers.

Shadow banking

We include a proxy for shadow banking as its size may be expected to affect the capacity of the regulatory framework to impact bank performance and results. We proxy it with the ratio of off-balance sheet items divided by off-balance sheet items + total assets, as it reflects the weight of off-balance sheet items in a bank ($OFFBALR_{jn}$).

Return on assets

In the capital equation, we also include a proxy of bank profits ($ROAA_{jn}$), which is the computed return on average assets that is available in the Bankscope data set.

The country variables

We control for the following country variables:

COIRC	Cost-to-income ratio (per cent of total income) to control for banking efficiency.
OEPOAC	Total expenses (per cent of total assets), which should account for production costs in the banking system.
GDP	The national GDP growth rate, which should account for the impact of the economic cycle on bank performance.
HERFINDAHL	The Herfindahl index, which should cover for the competitiveness of the national markets.
DEPOSIT	This is the index Deposit Insurer Power from Barth *et al.*[3,5] It ranges from 1 to 3, with higher values indicating more power.

The ND variables

The ND variables are included in the regression and their relevance tested for different specifications. In particular, we run a regression with the two aggregate indices and a regression for each of the different areas of regulation. More ST, which would be associated with higher values for the indices, might be expected to result in lower risk and higher capital, as a proxy for higher solvency, while negatively affecting efficiency and increasing costs.

Arguably, the choice by a country of more ST or more RS in regulation results from the efficiency and solvency of their banking system. Therefore, the possibility of such inverse causation needs to be addressed.

Owing to the lack of a time series, we test for it with the calculation of the simple correlations between each of the ND indices for RS or ST and the variables that we are analysing (risk, capital, efficiency and costs). We also estimate a univariate regression where each of the indices is explained only by each of the variables, at the country level. As the results in Table 2 show, the correlations are very low (part A) and the coefficients are only statistically significant for the variable of capital in the case of ST and the ND on Scope and for the variable of efficiency in the case of the ND on Scope if AC is used (part B).[46] We interpret both the low correlations and, especially, the lack of statistical significance as a sign of no causation, so that banks' risk, capital and efficiency do not determine the level of ST and RS chosen by MS.

We apply a filter to detect and remove outliers for the control variables (roughly corresponding to the 1st and 99th percentiles of the distribution of the respective variable, distinguishing among banks, savings banks and cooperatives).

RESULTS

Aggregate results

The information in Table 3 presents the qualitative results obtained through the estimation of

Table 2: Dependency between ND variables and banks' risk, capital, efficiency and costs

	ST	RS	OF	S	CRSA_ST	CRSA_RS	CPR_ST	CPR_RS	IRB_ST	IRB_RS	OR
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
A. Simple correlations[a]											
LOLPTA	−0.029	0.274	0.192	0.139	−0.190	−0.178	0.070	0.106	−0.227	0.195	−0.029
ETA	0.368	0.302	0.166	0.474	0.232	−0.206	−0.112	−0.046	0.218	0.293	0.391
INEFT	−0.123	−0.293	−0.198	−0.130	−0.075	−0.042	0.115	−0.069	0.055	−0.321	−0.037
AC	−0.125	−0.002	−0.197	−0.327	0.082	0.167	0.282	0.126	0.114	0.107	−0.147
B. Univariate regressions of ND on Banks' risk, capital, efficiency and costs[b]											
LOLPTA	−0.008	0.179	0.105	0.636	−0.071	−0.157	0.040	0.079	−0.104	0.135	−0.028
ETA	0.912*	1.780	0.822	1.959**	0.787	−1.632	−0.579	−0.307	0.900	1.823	3.425
INEFT	−0.183	−1.043	−0.591	−0.323	−0.154	−0.200	0.358	−0.278	0.138	−1.204	−0.197
AC	−1.288	−0.048	4.037	−5.597*	1.150	5.509	6.047	3.514	1.956	2.773	−5.328

[a]Simple correlation by country.
[b]Coefficient β in the regression of ND=$\alpha+\beta{\star}Y$, where y is either banks' risk, capital, efficiency or cost averaged by country.
(*) Statistically significant at 10 per cent level of confidence, (**) Statistically significant at 5 per cent level of confidence.

the system of equations in (1), when we have included in the specification, both jointly and individually, the two aggregate ND indices that distinguish between RS and ST. The table summarises whether more solvency is obtained, through either higher capital or lower risk or both and whether higher inefficiency or higher costs or both accompany more ST and more RS. It also reflects whether these results show evidence of a trade-off between solvency and efficiency.

We find no evidence of a trade-off for overall ST, whereas we do for overall RS. In particular, we find evidence that more ST results in higher solvency, but cannot find evidence that it is also associated with higher inefficiency. On the other hand, overall higher RS in capital requirements is associated with higher solvency but also with higher inefficiency, thus resulting in a trade-off between solvency and efficiency.

Table 4 provides the more detailed qualitative results that support the relations summarised above. In particular, Table 4 records the statistical significance and the sign of the coefficient for the ND indices (β coefficients in (1)) on each of the estimated two sets of equations; that is, the set that includes INEF as the inefficiency measure (first line recorded in the table) and the one that includes AC instead (second line). Under Risk, we show the results obtained for the estimation of β in the risk equation (LOLPTA as the dependent variable); under Capital, we record the results for β in the capital equation (ETA) and under Inefficiency

Table 3: Trade-off between solvency and efficiency in capital requirements. Individual and joint results of aggregate stringency and risk sensitivity

	Solvency	*Inefficiency*	*Trade-off*
Individual impact			
Stringency	Y	N	N
Risk sensitivity	Y	Y	Y
Joint impact			
Stringency	Y	N	N
Risk sensitivity	Y	Y	Y

Table 4: Impact of stringency and risk sensitivity in capital requirements on risk, capital, efficiency and costs

	Risk	*Capital*	*Inefficiency*	
			Tech	*Cost*
Individual impact				
Stringency	−**	.	.	—
	−**	.	—	−**
Risk sensitivity	−**	+**	+**	—
	−**	+**	—	.
Joint impact				
Stringency	−**	.	.	—
	−**	.	—	−**
Risk sensitivity	−**	+**	+**	—
	−**	+**	—	+*

(*) Statistically significant at 10 per cent level of confidence, (**) Statistically significant at 5 per cent level of confidence.

the results obtained for this coefficient in the efficiency and cost equation (INEF and AC), respectively. The detailed quantitative results for the joint estimate can be found in Table C1 in Appendix C.

The results show that, in general, the overall ST and the overall RS inherent in the choice of ND have an impact on risk, on capital and on efficiency. We find that both ST and RS in regulation have the desired positive effect on solvency: the more stringent the choice of discretions is and the more their RS, the lower the risk that firms show, as recorded by a negative statistically significant coefficient for the ND indices in the risk equation. Moreover, we also find evidence that more RS is associated with higher capital, as the positive statistically significant coefficient in the capital equation reflects.

As for the undesired effects on efficiency, we find that while higher inefficiency also results from higher RS, higher ST is associated with lower costs, a result that is consistent with Berger's findings.

Therefore, more general regulatory ST in capital requirements seems to result in a positive effect on financial stability as it is associated with lower risk. Moreover, more ST results in lower costs, a finding that could be explained by markets' positively valuing ST and thus generating lower funding costs.

We also find that RS in the choice of ND for capital requirements has a positive impact on stability, both through its positive impact on capital and through its negative one on risk. But this benefit is counterbalanced by its negative impact on efficiency and on higher costs, so that for RS we observe a trade-off between solvency and efficiency.

Disaggregated results by areas of discretion

The aggregate indices can be regarded as reflecting supervisors' general approach to capital regulation. Conceivably, there may be some heterogeneity in the effects that the different areas of discretion may have on solvency and efficiency, not only because their incidence may be heterogeneous, but also because their impact may differ. It could be the case that, despite the fact that regulators have chosen the more stringent option, there are but few institutions under their jurisdiction that are directly affected by the measure. On the other hand, areas such as Own Funds may have a more widespread incidence than other areas where the relationship with capital or risk may be more indirect. Moreover, the isolated effects of a specific area of capital regulation might differ from the rest because of the interaction with other regulatory aspects.

The analysis of the impact of each of the different areas of ND is conducted using two approaches. Under the first, we only include one ND index at a time in the specification, in an attempt to capture its impact independently from the rest of the measures, so as to obtain the individual effect. In fact, this approach is the one that best encompasses the way policymakers usually analyse the effects of each measure. In general, when a policy decision needs to be reached, usually only the effects that might be expected from the specific proposal that the policymakers are analysing are considered, as though the decisions were taken in isolation with respect to the rest of the measures.[54]

Under the second approach, we try to overcome the limitations of the isolated approach by jointly including in the specification to be estimated all the different areas of ND, and then testing for their individual relevance. This approach allows us to capture the potential interactions among them.

We first present the summary results obtained from the individual estimates in relation to the existence of a trade-off between efficiency and stability in the choice of ND (Table 5), before analysing the detailed individual results (Table 6) that give rise to the summary that is recorded in the previous table. We finalise this section presenting these same results when the joint estimates are considered (Tables 7 and 8).

Individual effects by areas of discretion

As recorded in Table 5, we find evidence that for all areas of ND, except the RS component of the Counterparty Risk, the regulators' expected positive relationship between solvency and ST or RS holds. However, we cannot unambiguously establish the sign of this relationship in the areas of Own Funds and the ST component of Counterparty Risk.

As for the effect on efficiency of having more ST in particular areas of ND, we observe mixed results. In particular, in three areas of ND (Scope, the ST component of the Standard Approach and the risk component of the Counterparty Risk), we cannot find evidence of more inefficiency on the basis of this choice. All in all, we only find evidence of a trade-off between efficiency and solvency in the areas of Operational Risk, both components of IRB and the risk component of the Standard Approach.

The detailed results in Table 6 show that in all the areas of ND where we have found evidence of a positive relationship between ST and solvency, this is so owing to either a positive impact on capital (Own Funds, IRB and Counterparty Risk) and/or a negative impact on risk (Scope, Standard Approach, IRB and Operational). However, in the areas of Own Funds and Counterparty Risk, we also obtain a positive impact on risk, under the specification that uses technical inefficiency, thus raising some ambiguity as far as the final relationship is concerned, as it will depend on the relative impact on capital and risk of ST

Table 5: Trade-off between solvency and efficiency in capital requirements. Individual results

	Solvency	*Inefficiency*	*Trade-off*
Specific stringency			
Own Funds	Y(?)	Y(?)	N
Scope	Y	N	N
Standard	Y	N	N
Internal Models	Y	Y(?)	Y
Counterparty	Y(?)	Y	N
Operational	Y	Y	Y
Specific risk			
Standard	Y	Y	Y
Internal Models	Y	Y	Y
Counterparty	N	N	N

Table 6: Impact of stringency and risk sensitivity in areas of national discretion on risk, capital, efficiency and costs. Individual results

ND index	*Risk*	*Capital*	*Inefficiency*	
			Tech	*Cost*
Specific stringency:				
Own Funds	+*	+**	+**	—
	.	+**	—	−**
Scope	−**	.	.	—
	−**	.	—	−**
Standard	−**	.	.	—
	−**	−**	—	.
Internal Models	−**	+**	+**	—
	−**	+**	—	−**
Counterparty	+*	+**	+**	—
	+	+**	—	+
Operational	−**	.	.	.
	−**	.	—	+**
Specific risk				
Standard	.	+**	+**	—
	.	+**	—	+**
Internal Models	−**	+**	+**	—
	−**	+**	—	.
Counterparty	.	.	−*	—
	+**	.	—	−**

(*) Statistically significant at 10 per cent level of confidence, (**) Statistically significant at 5 per cent level of confidence.

in these areas. As for the impact of having more risk-sensitive capital regulation, we find that it increases stability when it is channelled through the ND of both the Standard and the IRB approach, through its positive impact on capital (Standard and IRB) and negative impact on risk (IRB). However, it has the undesired effect of raising risk when it is channelled through the Counterparty Risk.

The effects on efficiency are more mixed. As for ST, we obtain contradictory results for the areas of Own Funds and IRB, depending on which variable is chosen to capture inefficiencies: we obtain a positive relationship with technical inefficiency, but a negative one with cost. Only in the areas of the ST component of Counterparty Risk and Operational Risk does the evidence point clearly to a positive impact on inefficiency. Moreover, in the areas of Scope and the ST component of the Standard Approach, we cannot find a positive relationship with inefficiency: in the latter case, because there is no statistically significant relationship, and in the area of Scope because more ST is associated with lower costs.

Finally, more RS in the areas of the Standard Approach and the IRB approach result in higher inefficiency, a result that does not hold in the area of Counterparty Risk.

Joint effects by areas of discretion

The analysis so far considers the effect of each of the different areas of capital standards on regulation in isolation, as though the other measures were not in place. It can offer us a pointer as to what we can expect if only this regulatory area is implemented. In order to take into account the possibility that decisions are jointly made in different areas and that some interaction takes place, we estimate the set of equations in (1), including as explanatory variables all the ND indices.[47]

The comparison of the results summarised in Table 7 and detailed in Table 8 with those presented in Tables 3 and 4 shows that, as far as the areas of RS are concerned, the same relationships that we have captured hold under the joint analysis. That is to say, more RS in capital requirements results in a trade-off between solvency and efficiency except in the area of counterparty risk.

On the other hand, in the ND areas that reflect ST, the results we obtained when we considered the effects in isolation do not always hold when the joint analysis is performed. In

Table 7: Trade-off between solvency and efficiency in capital requirements. Joint results

	Solvency	*Inefficiency*	*Trade-off*
Specific stringency			
Own Funds	N	N	N
Scope	Y	Y	Y
Standard	Y	Y	Y
Internal Models	Y	Y	N
Counterparty	Y(?)	Y(?)	N
Operational	N	N	N
Specific risk			
Standard	Y	Y	Y
Internal Models	Y	Y	Y
Counterparty	N	N	N

Table 8: Impact of stringency and risk sensitivity in areas of national discretion on risk, capital, efficiency and costs. Joint results

ND index	*Risk*	*Capital*	*Inefficiency*	
			Tech	*Cost*
Own Funds	·	–**	–*	—
	+**	·	—	–**
Scope	·	+**	+**	—
	·	+**	—	·
Standard	–*	+**	+**	—
	–**	·	—	+**
Internal Models	·	+**	·	—
	·	·	—	–**
Counterparty	+**	+**	+**	—
	·	+**	—	–*
Operational	·	–**	–**	—
	·	–**	—	–**
Specific risk				
Standard	·	+**	·	—
	·	+**	—	+**
Internal Models	–**	·	·	—
	–**	·	—	+**
Counterparty	·	·	–**	—
	·	·	—	–**

(*) Statistically significant at 10 per cent level of confidence, (**) Statistically significant at 5 per cent level of confidence.

particular, we observe a trade-off between solvency and efficiency in the areas of Scope and the Standard Approach that we had not observed when the effects were analysed in isolation, while we do not observe such a trade-off for IRB and Operational Risk.

When we consider the joint effects of all ND, we still find in most cases that ST is positively associated with solvency, the exceptions being Own Funds and Operational Risk. On the other hand, the effects on efficiency under the joint analysis seem to provide different results from those obtained under the individual analysis. Under the joint approach, we find that more ST in the areas of Scope, the Standard Approach and Counterparty risk are associated with higher inefficiency, a relationship we only identified under the individual analysis for the latter. On the other hand, we do not observe this relationship in the areas of Own Funds, IRB and Operational Risk, but did so under the individual analysis.

The more detailed results recorded in Table 8 show that we find that more ST in Own Funds and in Operational Risk does not result in higher solvency, as either capital is lower (Own Funds) or risk is higher (Own Funds and Operational Risk). For the rest of the areas, the positive relationship between ST and solvency is evident through higher capital, when under the individual approach it was mainly observable in lower risk. In the case of the Standard Approach, it is reinforced by its negative relationship to risk.

We also find that in the areas where ST is the issue, there is a negative relationship with inefficiency only in the areas of Scope and the Standard Approach. For these areas, we observe that higher ST is associated with higher technical inefficiency, a result not obtained under the isolated analysis. In the area of the Standard Approach, it is also apparent in higher costs. In no other area do we observe a positive relationship between ST and costs, as it is either not statistically significant (Scope) or it is negative (Own Funds, IRB, Counterparty Risk and Operational Risk).

SIMULATION OF DIFFERENT CHOICES

We use the results we have obtained to quantify the effect that different choices of ST and RS in capital regulation would have entailed for risk, capital and efficiency, under a *ceteris paribus* assumption. In particular, we propose analysing the impact on these factors of choosing for all MS the most stringent possible combination of ND (ST_MAX), the least stringent one (ST_MIN), the most risk-sensitive one (RS_MAX) and the least sensitive one (RS_MIN). With the analysis that we have carried out, we cannot estimate the impact of changing the rules chosen in each country, but we can simulate the implicit effect under the estimates we have obtained.

We also present the results obtained under the option chosen by CEBS in its October 2008 advice (ST_CEBS). In particular, CEBS proposed keeping as an option or ND 28 per cent of the 152 provisions covered in its analysis.[48] It should be recalled that the choice made by CEBS involved changes only in ND that we have gathered under the ST index, but it did not propose changing the treatment given to any of the discretions that we have grouped under the RS index. As a result, the impact that we can capture for CEBS' choice is channelled only through the effects of more or less ST on risk, capital and costs.

We present in Table 9 the quantitative results obtained from the estimation of the model that had *AC* as the efficiency measure and when the equal-weighted indices were used[49] (Table C3 in Appendix C). We apply the coefficients that we have estimated to the difference between the observed index and the corresponding index that we would obtain if the choice of ND had been each of the above-mentioned combinations. When the coefficient is not statistically significant, we assume the effect to be nil. The values in the table reflect the changes in the mean risk, capital and cost variable that each choice would imply in each country.

Table 9: Simulation of impact on average risk, capital and costs of different proposals on the level of stringency and rist sensitivity by country[a]

Country	*Risk*					*Capital*		*Costs*				
	ST_CEBS	*ST_MAX*	*ST_MIN*	*RS_MAX*	*RS_MIN*	*RS_MAX*	*RS_MIN*	*ST_CEBS*	*ST_MAX*	*ST_MIN*	*RS_MAX*	*RS_MIN*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
AUSTRIA	0.067	−0.974	0.403	−0.926	0.618	0.474	−0.316	0.018	−0.260	0.108	0.508	−0.339
BELGIUM	−1.753	−54.349	17.532	−24.173	56.404	0.309	−0.721	−0.008	−0.245	0.079	0.224	−0.523
BULGARIA	−0.160	−0.441	1.203	−0.921	0.921	0.370	−0.370	−0.039	−0.107	0.291	0.458	−0.458
CYPRUS	0.000	−0.517	0.298	−0.457	0.457	0.513	−0.513	0.000	−0.159	0.092	0.290	−0.290
CZECH REP	0.000	−0.690	0.596	−0.720	0.720	0.350	−0.350	0.000	−0.250	0.215	0.535	−0.535
DENMARK	−4.153	−17.649	24.916	−19.086	28.629	0.230	−0.344	−0.036	−0.153	0.215	0.339	−0.509
ESTONIA	−0.008	−0.181	0.128	−0.173	0.173	0.248	−0.248	−0.007	−0.162	0.115	0.319	−0.319
FINLAND	−0.842	−25.259	9.262	−19.349	19.349	0.616	−0.616	−0.009	−0.271	0.099	0.427	−0.427
FRANCE	0.000	−1.396	0.578	−1.106	1.106	0.292	−0.292	0.000	−0.229	0.095	0.372	−0.372
GERMANY	0.029	−0.831	0.344	−0.922	0.395	0.751	−0.322	0.009	−0.251	0.104	0.573	−0.246
GREECE	0.069	−1.270	0.137	−0.631	0.947	0.383	−0.575	0.019	−0.354	0.038	0.361	−0.541
HUNGARY	0.022	−0.657	0.241	−0.402	0.604	0.181	−0.272	0.005	−0.138	0.051	0.174	−0.261
IRELAND	−0.295	−6.487	5.603	−4.066	9.487	0.162	−0.378	−0.007	−0.154	0.133	0.198	−0.463
ITALY	0.000	−0.907	0.710	−0.906	0.906	0.330	−0.330	0.000	−0.224	0.175	0.459	−0.459
LATVIA	0.000	−2.446	1.411	−2.594	1.729	0.294	−0.196	0.000	−0.209	0.120	0.455	−0.303
LITHUANIA	−0.131	−0.656	1.137	−1.206	0.804	0.464	−0.310	−0.027	−0.133	0.230	0.501	−0.334
LUXEMBOURG	0.036	−1.289	0.179	−0.659	0.988	0.497	−0.746	0.007	−0.255	0.035	0.267	−0.401
MALTA	0.000	−3.973	2.543	−4.382	2.921	0.449	−0.299	0.000	−0.259	0.166	0.588	−0.392
NETHERLANDS	0.000	−7.327	4.227	−3.885	9.066	0.235	−0.549	0.000	−0.018	0.010	0.019	−0.045
POLAND	−0.733	−2.199	5.313	−3.368	5.053	0.289	−0.434	−0.030	−0.090	0.216	0.282	−0.423
PORTUGAL	0.000	−0.809	0.518	−1.041	0.446	0.552	−0.236	0.000	−0.213	0.136	0.563	−0.241
ROMANIA	0.017	−0.445	0.257	−0.394	0.394	0.363	−0.363	0.006	−0.143	0.083	0.260	−0.260
SLOVAKIA	−0.024	−0.359	0.622	−0.330	0.770	0.182	−0.426	−0.010	−0.149	0.259	0.282	−0.658
SLOVENIA	−0.024	−0.537	0.464	−0.449	0.673	0.295	−0.442	−0.011	−0.232	0.200	0.398	−0.597
SPAIN	0.033	−1.038	0.335	−0.770	0.770	0.506	−0.506	0.012	−0.367	0.118	0.558	−0.558
SWEDEN	−0.242	−2.666	2.302	−2.784	2.784	0.260	−0.260	−0.021	−0.235	0.203	0.505	−0.505
UNITED KINGDOM	0.000	−0.938	0.303	−0.417	0.974	0.220	−0.513	0.000	−0.180	0.058	0.165	−0.385

[a]Obtained from the results of the estimation presented in col. 1 in Tables C1 to C3. Under CEBS, MAX_ST, MIN_ST it is recorded the change in the variables under the CEBS, the maximum and minimum stringency option, respectively. Under MAX_RS and MIN_RS it is recorded the change in the variables under the maximum and minimum risk sensitivity option, respectively.

The results presented in Table 9 show that the CEBS option does have rather sizable effects on the risk ratio in most countries (col. (1)), especially if we compare them with the effects on average costs (col. (8)). We might see both rises and declines in risk depending on whether the country reduces its ST under the option proposed by CEBS (a rise in risk) or increases it (a decline in risk). In fact, the biggest impacts are obtained in reductions in risk, suggesting that the CEBS proposal entails bigger movements towards more ST, rather than making countries less stringent. From our calculations, the risk ratio could increase at most 6 per cent in some countries, while the reductions could be as much as nearly five times the initial ratio. On the other hand, from our calculations the impact of the CEBS proposal on costs also shows both signs (col. (8)), which depend on the country. If the adoption of the CEBS proposal entails an increase in ST in a given country, we can expect to see reductions in costs. By the same token, for those countries where ST will be reduced, we can expect to observe increases in cost. Our estimates show that we can expect increases of at most 1 per cent and declines of at most 2 per cent on average costs, resulting from the CEBS option.[50] Finally, because of a lack of statistical significance of the coefficient, we assume that we cannot observe any effect on capital.

The choice of maximum (minimum) ST would result in much higher effects on the average country risk and costs in absolute terms than those we would obtain under the CEBS option, but they would always have the same negative (positive) sign in all countries.

In absolute terms, moving towards maximum ST would result in higher changes in risk than moving towards minimum ST in most countries, the exceptions being Bulgaria, Denmark, Lithuania, Poland and Slovakia. The opposite would be the case when comparing maximum and minimum RS, as the move towards the minimum would imply the biggest changes in most countries, with the exceptions of Austria, Germany and Poland. We also find that changing to maximum ST has in absolute values a higher impact than changing towards minimum RS in most countries.

The effects in absolute values of choosing a maximum RS capital framework on the capital ratio are lower than those we would obtain from moving towards a minimum RS regulation in terms of ND. Namely, in most countries, the choice of the least risk-sensitive combination of ND would result in declines in capital that would be much bigger than the corresponding increases that would arise if the choice of maximum RS were taken.

Finally, the increase in costs resulting from the minimum ST option would in absolute values be lower than the decline in average costs as a result of a maximum ST choice in most countries. As with risk, the opposite would occur when the choice was made between maximum and minimum RS, as in this case the decline in costs from choosing minimum RS would be greater than the increase if the opposing option were chosen.

SUMMARY AND CONCLUSIONS

This article conducts an empirical analysis of the effects on financial institutions of the choice by regulators of more or less ST and more or less RS in capital requirements, using the so-called ND and options that feature in the CRD. In particular, after controlling for individual firm characteristics and country-specific aspects, we test for systematic impact of different characteristics in terms of ST and RS of ND on the risk, capital, efficiency and costs of banks, using individual data for financial institutions operating in 2007 in the 27 European Union countries, by means of the estimation by SURE of a system of equations. In this connection, and for each country, we have constructed different indices that group together the ND, and whose value is positively associated with ST or RS. The first group comprises two aggregate indices that reflect either ST or RS in the choice of discretions, and which are assumed to reflect overall ST and overall RS in capital regulation. The second group comprises nine indices that group together discretions that deal with a specific area of capital requirements regulation and whose value is also positively associated with ST or RS. Such disaggregation allows us to test whether different areas of regulation have a different impact on financial institutions.

Our results show that more ST and more RS in capital requirements usually have the desired impact on solvency. That is to say, in general, more ST or more RS in regulation results in financial institutions having either lower risk and/or higher capital. This relationship is obtained both when the overall ST and RS and the specific areas of the regulatory capital framework are considered. However, in the case of ND dealing with Own Funds and Counterparty Risk, we also find evidence that more ST could similarly be associated with more risk-taking. The fact that we cannot take into account the quality of capital may be one of the factors explaining this result.

We also found that, in general, there is no trade-off between ST and efficiency. The areas of Operational Risk and IRB may be the exception, when taken in isolation, while the areas of Scope and the Standard Approach exhibit that relationship when the effects of all the ND are jointly analysed. In all these cases, we gathered evidence of a positive relationship with inefficiency. The ambiguity as regards the effect on solvency in the areas of Own Funds and Counterparty Risk does not allow us to conclude that for these areas there is a trade-off.

In the case of more RS in capital standards, we find evidence of a trade-off, so that by choosing more RS in regulation we can expect higher solvency, but also higher inefficiencies and/or costs. The exception is again in the area of Counterparty Risk, where we could not only not find a positive impact on solvency, but also found a positive impact on efficiency.

This study also provides empirical evidence of the limitations inherent in an isolated analysis of the impact of different measures, which are, in fact, jointly adopted. Although in the areas of RS the overall effects under the joint consideration do not differ from those obtained under the individual approach, different results are obtained in some of the areas of ST. In particular, we obtain the same positive impact on solvency through higher capital or lower risk in all areas of ND except in Own Funds and Operational Risk. In the case of Own Funds, we already observed higher risk under the individual approach, but not for Operational Risk. The effects on efficiency are those that vary most from one approach to the other. Although we observed a trade-off in IRB and Operational Risk under the individual approach, under the joint consideration the trade-off is captured for the areas of Scope and the Standard Approach.

From the estimated coefficients, we have computed the expected effects of different levels of ST and RS in capital requirements that could be channelled through the choice of ND. Our results show that, in absolute terms, moving towards maximum ST would result in higher changes in risk than moving towards minimum ST in most countries, while the opposite would be the case when comparing maximum and minimum RS, as the move towards the minimum would entail the biggest changes in most countries. The effects in absolute values on the capital ratio or on the cost ratio of choosing highest RS are lower than those we would obtain from moving towards a minimum RS regulation in terms of ND. Finally, the increase in costs resulting from the minimum ST option would be lower in absolute values in most countries than the decline in average costs as a result of a maximum ST choice.

These results have some relevant policy implications. On the one hand, we can conclude that even small variations in capital standards policy, such as those embedded in ND, have effects on firms. However, whenever a measure is taken jointly with other measures, the whole package needs to be taken into consideration when analysing the effects. While individual considerations may show the desired effects, when they are jointly taken, they may generate counterbalancing reactions resulting potentially in no benefits or excessively high costs. In particular, we found that more ST in the areas of Own Funds and Counterparty Risk may have the undesired effects of raising risk and reducing capital (Own Funds). Finally, there is always a need to consider the trade-off between efficiency and solvency that we have shown may arise whenever RS is increased in the regulatory framework or when we increase ST in specific areas of the capital requirements.

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33 Tchana Tchana, F. (2008) The Empirics of Banking Regulation. Munich Personal RePEc Archive, MPRA Paper No. 9299.

34 González, F. (2005) Bank regulation and risk-taking incentives: An international comparison of bank risk. *Journal of Banking and Finance* 29: 1153–1184.

35 Shrieves, R. and Dahl, D. (1992) The relationship between risk and capital in commercial banks. *Journal of Banking and Finance* 16: 439–457.

36 Thakor, A.V. (1996) Capital requirements, monetary policy and aggregate bank lending: Theory and empirical evidence. *Journal of Finance* 51(1): 279–324.

37 http://www.c-ebs.org/Publications/Consultation-Papers/All-consultations/CP11-CP20/CP18.aspx.

38 See Argimon, I. and Ruiz, J. (2010) The Effects of National Discretions on Banks. Banco de España Working Paper 1029; for a short description of the National Discretions included in the empirical part.

39 There are 11 transitional discretions that could also be classified, but because of their temporary nature have not been included in the analysis.

40 More risk sensitivity does not necessarily mean greater stringency in terms of capital requirements, as this will depend on the financial institution's risk profile.

41 To measure its credit risk for regulatory purposes, the bank can use three approaches: the standardised approach, the foundation IRB, and the advanced IRB approach: (i) the standardised approach uses only a predetermined risk weight for different types of loans; (ii) the model underlying the IRB approach is the one-factor Gaussian copula model of time to default.

42 The equal weighted indices for each country are recorded in Table A1 in Appendix A.

43 The only exceptions were Malta, Spain and Greece, which transposed the directive a year later.

44 Altunbas, Y., Carbo, S., Gardener, E.P.M. and Molyneux, P. (2007) Examining the relationship between capital, risk and efficiency in European banking. *European Financial Management* 13(1): 49–70.

45 McAllister, P.H. and McManus, D.A. (1993) Resolving the scale efficiency puzzle in banking. *Journal of Banking and Finance* 17: 389–405.

46 The main differences in relation to the equal-weighted indices arise in relation to the Operational Risk area, where the sign differs. In particular, under the simple index the relationship is positive with LOLPTA and INEFT. LOLPTA is also statistically significant for CRSA, and RS for AC.

47 See Table C2 in Appendix C.

48 In particular following the Call for Advice CEBS classified the options and national discretions into three categories: (i) options discretions that might be subject to mutual recognition; (ii) possible legitimate options discretions; and (iii) options discretions that should be deleted. We can only take into consideration (ii) and (iii). In April 2009, the Commission requested further technical advice on several national discretions, which was delivered in June. Further work is expected within the near future.

49 We cannot use the Principal Component Indices in this part as we want to estimate the differential impact. See Table C3 in Appendix C.

50 We need to establish the equivalence between a unit of risk over total assets and one unit of costs over total assets in order to determine whether the CEBS option, or any policy option, produces a net benefit.

51 Maudos, J., Pastor, J.M., Pérez, F. and Quesada, J. (2002) Cost and profit efficiency in European banks. *Journal of International Financial Markets, Institutions and Money* 12: 33–58.

52 The density function of an exponential distribution variable u_i is: $f(ui)=1/\eta \exp(-u_i/\eta)$, $u_i>=0$; where the mean and the standard deviation of u_i are both equal to $\eta>0$.

53 Zhu, H. (2008) Capital regulation and banks' financial decisions. *International Journal of Central Banking* 4(1): 165–211, Developing a dynamic equilibrium model, the author concludes that a risk-based capital regime strikes a better balance between safety and efficiency and causes fewer distortions in loan decisions.

54 In general, the task forces or working groups that are being created to discuss policy decisions look at each area of regulation in isolation.

APPENDIX A

Table A1: National discretion indices

	RS	*ST*	*OF*	*S*	*CRSA_ST*	*CRSA_RS*	*IRB_ST*	*IRB_RS*	*CPR_ST*	*CPR_RS*	*OR*
AUSTRIA	4	12	0	4	4	2	3	1	1	1	0
BELGIUM	8	7	0	1	7	2	0	4	2	1	0
BULGARIA	5	21	3	6	11	2	9	3	1	0	1
CYPRUS	6	11	1	2	5	1	4	4	2	0	1
CZECH REPUBLIC	6	14	2	6	6	2	3	2	2	1	0
DENMARK	6	20	0	6	10	2	4	3	2	1	2
ESTONIA	6	9	1	4	6	0	3	4	2	1	1
FINLAND	6	6	1	2	5	1	1	3	2	1	0
FRANCE	6	10	0	1	5	1	4	3	1	1	1
GERMANY	3	11	0	0	7	2	3	0	2	1	0
GREECE	7	0	0	0	3	2	0	3	1	1	0
HUNGARY	6	10	2	4	2	2	2	3	1	1	0
IRELAND	8	13	0	3	9	2	5	4	1	1	1
ITALY	6	16	1	5	4	1	6	3	1	1	1
LATVIA	5	9	0	3	7	1	4	3	1	0	0
LITHUANIA	5	19	2	4	11	1	7	3	1	0	1
LUXEMBOURG	7	5	0	1	4	1	1	4	0	1	0
MALTA	5	12	1	4	7	2	3	2	1	0	0
NETHERLANDS	8	10	0	1	8	2	5	4	1	1	0
POLAND	6	24	3	4	12	3	9	3	1	0	1
PORTUGAL	4	13	1	3	7	1	3	1	1	1	1
ROMANIA	6	9	3	4	4	2	3	2	1	1	0
SLOVAKIA	7	22	4	6	8	3	7	4	1	0	1
SLOVENIA	7	15	2	3	8	3	3	3	2	1	1
SPAIN	6	6	1	1	3	1	5	3	1	1	0
SWEDEN	6	16	2	3	10	1	4	3	1	1	0
UNITED KINGDOM	8	5	1	1	5	2	2	4	1	1	0
TOTAL	10	41	4	7	14	4	12	6	2	1	3

Source: Own calculations from CEBS.

APPENDIX B

Estimation of bank inefficiency

We follow most recent studies that derive banks' cost inefficiency from stochastic cost frontier estimates.

For the definition and measurement of output, we follow the intermediation approach as in Maudos *et al*,[51] considering balance-sheet items as good indicators of output. The following three outputs are used from Bank-scope profit and loss account data:

Q_1 = loans
Q_2 = other earning assets
Q_3 = deposits and other short-term funding

The prices of productive factors are proxied by:

P_1 = Cost of loanable funds, computed by dividing financial costs (interest paid) by their corresponding liabilities (deposit, money market funding and other funding)
P_2 = Cost of labour. It is proxied by overhead costs over total assets.
P_3 = Cost of physical capital, obtained as the ratio of other non-interest expenses, which proxies expenditure on plant and equipment, to average assets.

We estimate a translog frontier cost function by firm type, distinguishing among commercial, savings and cooperative banks, and include country dummy variables except for the specification corresponding to commercial banks.

In particular, the specification we estimate is the following:

$$\ln TC = \alpha_0 + \sum_{i=1}^{3} \beta_i \ln Q_i + \sum_{h=1}^{3} \gamma_h \ln P_h + 1/2\left[\sum_{i=1}^{3}\sum_{j=1}^{3} \varphi_{ij} \ln Q_i \ln Q_j + \sum_{h}^{3}\sum_{m}^{3} \delta_{hm} \ln P_h \ln P_m\right] + \sum_{i=1}^{3}\sum_{m=1}^{3} \phi_{im} \ln Q_i \ln P_m + \ln v + \ln u$$

where ln records natural logarithm and TC is total costs, proxied as the sum of overhead costs and interest expense. The restrictions of symmetry and linear homogeneity have been imposed on input prices.

We assume an exponential distribution to model the efficiency variable u.[52] The characteristics of this distribution are that the probability is highest near the zero values of u, meaning that the probability of firms being close to full efficiency is highest. This is appropriate for a competitive market such as the banking system in Europe. If firms are homogeneous, there will foreseeably be fewer firms that are highly inefficient. On the other hand, if firms are heterogeneous, one might find some firms that are highly inefficient, meaning that the tail of the distribution is long. That would be indicated by a large value for the variance parameter. The results are presented in Table B1.

Table B1: Estimation of stochastic cost function

	Commercial banks		*Saving banks*[a]		*Cooperatives*[a]	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*	*Coef.*	*Std. err.*
lq1	0.384	0.020	0.269	0.027	0.313	0.010
lq2	0.438	0.027	0.138	0.021	0.279	0.007
lq3	0.170	0.037	0.612	0.049	0.411	0.013
lnp1	0.687	0.025	0.659	0.015	0.621	0.009
lnp3	0.017	0.015	0.019	0.007	0.019	0.002
c_lnp1_p1	0.129	0.010	0.205	0.008	0.187	0.007
c_lnp3_p1	0.001	0.007	0.004	0.004	−0.011	0.004
c_lq1_p1	0.062	0.021	0.262	0.016	0.184	0.009
c_lq2_p1	0.016	0.023	0.136	0.009	0.087	0.007
c_lq3_p1	−0.115	0.035	−0.400	0.023	−0.283	0.014
c_lnp3_p3	0.006	0.003	0.006	0.001	0.002	0.001
c_lq1_p3	0.014	0.007	−0.012	0.006	−0.015	0.004
c_lq2_p3	0.016	0.008	−0.010	0.004	0.009	0.003
c_lq3_p3	−0.022	0.013	0.024	0.009	0.006	0.005
c_lq1_q1	0.049	0.004	0.161	0.010	0.142	0.006
c_lq2_q1	−0.174	0.017	−0.136	0.019	−0.132	0.009
c_lq3_q1	0.035	0.018	−0.181	0.041	−0.165	0.017
c_lq2_q2	0.036	0.004	0.052	0.006	0.088	0.002
c_lq3_q2	0.041	0.019	0.043	0.032	−0.048	0.011
c_lq3_q3	0.013	0.016	0.059	0.038	0.113	0.013
Observations	370	—	450	—	1698	—

[a]Includes country dummies.

APPENDIX C

Table C1: Estimation of risk, capital and efficiency equations with aggregated ND indices

	1. INEFT as the efficiency variable			*2. AC as the efficiency variable*		
	LOLPTA	*ETA*	*INEFT*	*LOLPTA*	*ETA*	*AC*
ETA	−0.009**	—	−0.178**	0.002	—	−0.070**
INEFT	−0.049**	−1.067**	—	—	—	—
AC	—	—	—	0.023**	0.031	—
LOLPTA	—	−1.084**	−1.359**	—	0.796**	0.237**
TNLTA	−0.004**	−0.113**	−0.023**	−0.003*	−0.108**	−0.021**
SIZE	0.065**	−0.721**	0.212**	0.047**	−1.435**	−0.065
$SIZE^2$	−0.005**	−0.026	−0.036**	−0.003**	0.032*	−0.004
LIQUID	−0.002**	−0.035**	−0.020**	0.002**	0.142**	−0.010**
OFFBARL	0.008**	0.072**	−0.022**	0.012**	0.127**	0.003
FEES	−0.009*	—	−0.384**	−0.013*		0.768**
ROAA	—	2.266**	—	—	3.277**	—
COIRC	0.000	0.045*	−0.003	0.001	0.049*	−0.009
OEPOAC	0.122**	−0.475	−0.543**	0.202**	0.655*	−0.144
GDP	0.026**	−0.438**	−0.198**	0.036**	−0.414**	−0.041
HERFINDAHL	−0.156**	0.038	−0.753**	−0.136**	1.283**	0.529**
DEPOSIT	−0.014	0.717**	0.350**	−0.023	0.689**	−0.022
RS	−0.099**	3.712**	0.799**	−0.140**	3.275**	0.234*
ST	−0.076**	−0.343	−0.146	−0.077**	−0.295	−0.200**
_CONS	1.894**	52.167**	41.210**	−0.364**	10.585**	6.351**
Observations	2089	2089	2089	2108	2108	2108
R^2	0.138	0.477	0.374	0.164	0.446	0.613

*Significant at 10 per cent, **Significant at 5 per cent.

Table C2: Estimation of risk, capital and efficiency equations with all areas of ND

	INEFT as the efficiency variable			*AC as the efficiency variable*		
	LOLPTA	*ETA*	*INEFT*	*LOLPTA*	*ETA*	*AC*
ETA	−0.009**	—	−0.190**	0.002	—	−0.062**
INEFT	−0.050**	−1.105**	—	—	—	—
AC	—	—	—	0.037**	0.107*	—
LOLPTA	—	—	−1.369**	—	0.758**	0.345**
TNLTA	−0.004**	−0.096**	−0.021**	−0.003	−0.087**	−0.019**
$SIZE^2$	−0.005**	−0.030*	−0.036**	−0.002*	0.029	−0.006
LIQUID	−0.002**	−0.029**	−0.019**	0.002**	0.019**	−0.012**
OFFBARL	0.008**	0.081**	−0.019**	0.013**	0.138**	−0.003
FEES	−0.008	—	−0.371**	−0.022**	—	0.751**
COIRC	0.003	0.114**	−0.000	0.005	0.166**	−0.011
OEPOAC	0.030	−1.473*	−0.383	−0.022	−1.378	1.636**
GDP	0.026	0.324	−0.075	0.048**	0.421	−0.316**
HERFINDAHL	−0.102	−1.837**	−1.248**	0.014	−0.458	−1.129**
ROAA	—	2.112**	—	—	3.151**	—
DEPOSIT	0.040	0.647*	0.428**	0.027	0.473	−0.008
OF	0.082	−2.793**	−1.023**	0.203**	−1.821	−1.507**
S	0.036	2.648**	0.763**	0.002	2.348**	0.161
CRSA_ST	−0.074*	1.194**	0.479**	−0.141**	0.586	0.541**
CPR_ST	0.169**	4.140**	1.715**	0.106	2.385**	−0.398*
IRB_ST	−0.005	1.715**	0.451	0.059	1.431	−1.718**
OR	−0.083	−4.723**	−1.579**	−0.003	−4.040**	−0.720**
CRSA_RS	−0.045	2.336**	0.322	−0.091	2.648**	1.094**
CPR_RS	−0.109	−1.542	−1.041*	0.001	−0.387	−1.403**
IRB_RS	−0.227**	0.334	−0.329	−0.299**	1.160	1.983**
_CONS	2.037**	44.708**	40.385	−0.391	−1.201	6.854**
Observations	2089	2089	2089	2108	2108	2108
R^2	0.145	0.493	0.378	0.171	0.464	0.647

*Significant at 10 per cent, **Significant at 5 per cent.

Table C3: Estimation of risk, capital and efficiency equations with aggregated ND indices (no principal components)

	1. INEFT as the efficiency variable			*2. AC as the efficiency variable*		
	LOLPTA	*ETA*	*INEFT*	*LOLPTA*	*ETA*	*AC*
ETA	−0.009**	—	−0.171**	0.002	—	−0.072**
INEFT	−0.050**	−1.049**	—	—	—	—
AC	—	—	—	0.029**	0.002	—
LOLPTA	—	−1.101**	−1.389**	—	0.834**	0.289**
TNLTA	−0.004**	−0.102**	−0.020**	−0.003*	−0.097**	−0.018**
SIZE	0.058**	−0.735**	0.200*	0.040*	−1.411**	−0.037
$SIZE^2$	−0.005**	−0.021	−0.033**	−0.002	0.032*	−0.007
LIQUID	−0.002**	−0.034**	−0.020**	0.002**	0.014**	−0.010**
OFFBARL	0.008**	0.074**	−0.023**	0.012**	0.128**	0.004
FEES	−0.008*	—	−0.383**	−0.017**	—	0.764**
ROAA	—	2.402**	—	—	3.396**	—
COIRC	0.000	−0.019	−0.029**	0.001	0.015	0.018**
OEPOAC	0.120**	0.354	−0.289**	0.196**	1.273**	−0.257**
GDP	0.016	−0.701**	−0.318**	0.027**	−0.544**	0.086**
HERFINDAHL	−0.189**	−0.062	−0.712**	−0.165**	1.103*	0.145
DEPOSIT	−0.018	0.934**	0.444**	−0.030	0.722**	−0.196**
RS	−0.047**	0.525**	−0.054	−0.058**	0.777**	0.445**
ST	−0.011**	0.084*	0.354	−0.013**	0.036	−0.047**
_CONS	2.289**	50.347**	42.275**	0.016	7.448**	3.198**
Observations	2089	2089	2089	2108	2108	2108
R^2	0.136	0.471	0.374	0.162	0.439	0.619

*Significant at 10 per cent, **Significant at 5 per cent.