Does the intensity of prudential regulation affect banks? Evidence from the 2007-2009 crises

(Draft 20 December 2011)

Isabel Argimon *
Gerard Arqué Castells
Francesc Rodríguez Tous

Banco de España, Financial Stability Department.
C/ Alcalá 48, CP 28014, Madrid.

ABSTRACT

The main objective of this research is to gather empirical evidence on the effects of more or less stringency and more or less risk sensitivity in regulatory capital requirements on European banks' observed behaviour during the crisis. To do so, we use the indices built in Argimón and Ruiz (2010), which capture such characteristics of capital regulation. We test their incidence using changes in yearly data for individual banks for 25 countries of the European Union covering the period 2007-2009. Our results show that more stringency and risk sensitivity in capital regulation resulted in higher capital increases, with limited effect on risk taking. However, for well capitalized banks, higher risk sensitivity resulted in higher capital and higher risk, thus requiring striking the right balance, so as to lead to increased stability.

Key Words: capital ratios, credit risk, financial crisis, prudential regulation.

JEL codes: G15, G21, G28,

* Tel 91 338 58 78 / Fax 91 338 61 02
e-mail: isabel.argimon@bde.es

1. Introduction

The recent financial turmoil has brought into question many features of the financial system. In their meeting in Washington in November 2008, two months after the Lehman Brothers failure and the subsequent panic, the leaders of the G20 argued that policy-makers, regulators and supervisors had not addressed the risks building up in financial markets in time[1]. In order to improve the performance of the financial sector, they committed to implementing policies consistent with common principles for reform. "*Enhancing Sound Regulation*" was among those principles. Two years later, the Basel Committee on Banking Supervision (BCBS) had developed a new international regulatory agreement, known as Basel III, as a response to the G20 call. Among other changes, the new agreement proposed increases in the minimum capital ratios, increases in the quality of capital and improvements in the calculation of risk of certain exposures (BCBS (2010)). Thus, the proposed reforms make capital regulation more stringent and more risk sensitive.

The empirical literature that has addressed which dimensions of banking prudential regulation have worked well and which have not is still rather scarce. As a matter of fact, it was not until a decade ago that an extensive database on characteristics of financial regulation and supervision from different countries was assembled by Barth et al. (2001). Such database and its following updates made possible different works (Barth et al. (2001, 2004, 2006, 2008), Beltratti and Stulz, (2010)) that look at the issue of the relevance of regulatory and institutional characteristics for banking development. Moreover, the information gathered within the context of the IMF-WB Financial Sector Assessment Program (FSAP), conducted since 1999 in most countries, has also prompted a number of empirical works, the more extensive one being Demirgüç-Kunt et al. (2008).

The results of this literature suggest that, in general, capital regulation does not have a significant impact on banks' behavior, although there have been some exceptions, such as Podpiera (2006), which finds a positive effect between compliance with Basel Core Principles and banking sector performance.

It must be taken into account that EU Member States are subject to a common regulation on capital requirements. In particular, by the end of 2007, all Member States

[1] http://www.g20.org/Documents/g20_summit_declaration.pdf.

had transposed the capital Requirements Directive, which, in turn, is the European version of the Basel II Agreement, and, therefore, European banks were operating under the new regulatory framework by that year. Heterogeneity in the regulatory framework results from the so called National Discretions, which are choices that Member States can make as regards specific areas within the Directive, and that they can apply at national level. Some of these choices can be classified as reflecting either higher or lower regulatory capital stringency or higher or lower risk sensitivity in capital requirements. These decisions provide country-specific variation in regulation that can be used to estimate the impact of more stringency and more risk sensitivity on the behavior of individual banks, while keeping an overall common regulatory framework.

Our paper tries to assess the effects of prudential capital regulation stance on the European Union (EU) banks' risk and capital during the initial years of the financial crisis, following the approach in Argimón and Ruiz (2011). Our paper presents a direct contrast of the role of specific characteristics of capital regulation on EU banks' capital and risk, using a dataset of individual banks observed between 2007 and 2009. We want to test whether regulation may explain the observed variations in risk and capital in those years. We want to test specifically if the differences in the evolution of capital and risk observed during the initial years of the financial crisis can be explained by the capital regulatory stance, which is proxied by indices constructed following the approach in Barth et al. (2001) and detailed in Argimón and Ruiz (2011).

This paper is organized as follows. Section 2 presents some stylized facts in relation to the evolution of bank's capital and risk during the crisis in EU Member States and their policy frameworks as far as regulatory stance and their decisions on rescue plans. In Section 3, we review the theoretical and empirical literature on banks' capital and risk behavior, with a special emphasis on the works relating regulation and banking performance. In Section 4 we present the data with an overview of the construction of the regulatory stance indices. Section 5 sets the econometric approach while Section 6 presents the results and Section 7 the summary and conclusions.

2. Some stylized facts

The financial crisis has brought a recession never seen since the Second World War, which has heavily hit the European Union. From 2007 to 2009, the real GDP annual growth rate in the EU went from 3% to -4.3%, and that drop in real GDP happened in a

context of very low inflation (1% in 2009). Governments tried to stimulate the economies, but that came with a price: government deficit went from 0.9% of GDP in 2007 to 6.8% of GDP in 2009, well above the limit established by the Maastricht Treaty. Building on that, government debt also suffered a significant increase: it went from 59% of GDP (in the EU27) to 74.4% at the end of 2009. These numbers show the extreme magnitude of the financial crisis, aggravated in some countries with the burst of housing bubbles or a high initial level of debt.

TABLE 1. ANNUAL VARIATION IN CAPITAL-TO-ASSET RATIO 2007-2009

Country	Mean	Max	Min	Sd	Cv*	# of banks
Austria	-0.20	2.37	-2.79	1.08	5.40	14
Belgium	0.08	1.66	-1.83	1.27	15.88	3
Bulgaria	1.30	1.92	-0.35	1.10	0.85	2
Cyprus	-0.91	0.51	-2.22	1.24	1.36	2
Czech Republic	0.54	1.36	-0.15	0.53	0.98	3
Dennmark	-1.02	-0.55	-1.49	0.67	0.66	1
Finland	-0.43	1.33	-2.16	1.75	4.07	2
France	-0.49	2.42	-4.43	1.96	4.00	54
Germany	0.01	1.71	-2.18	0.69	69.00	14
Greece	-0.11	4.09	-3.00	2.14	19.45	12
Hungary	0.12	2.48	-2.48	1.19	9.92	8
Ireland	0.41	3.76	-0.65	1.28	3.12	5
Italy	-0.10	5.24	-2.61	1.11	11.10	36
Latvia	0.16	0.88	-0.66	0.63	3.94	3
Lithuania	-0.18	0.41	-1.94	0.89	4.94	3
Luxembourg	1.26	4.36	-0.33	2.01	1.60	3
Netherlands	-0.23	1.63	-6.59	1.91	8.30	8
Poland	0.42	2.66	-2.00	1.49	3.55	5
Portugal	0.66	4.86	-1.73	1.64	2.48	7
Romania	0.74	1.86	-0.29	0.82	1.11	4
Slovakia	0.62	2.68	-0.88	1.61	2.60	3
Slovenia	-0.14	1.16	-1.37	0.77	5.50	5
Spain	-0.27	2.94	-3.59	1.01	3.74	55
Sweden	0.98	7.33	-0.77	2.67	2.72	4
United Kingdom	0.06	4.80	-2.22	1.45	24.17	20
TOTAL	-0.10	7.33	-6.59	1.47	14.70	276

*Cv= Coefficient of Variation=Sd/mean

The financial sector has also suffered a huge decline in profits and even some big banks have been rescued by the public sector. When we take a look at the behaviour of banks,

we observe during the initial years of the crisis (2007-09) both large yearly increases in capital ratios (k), that reached over 7 percentage points, and large yearly declines, even over 6 percentage points, in EU banks (Table 1)[2]. Moreover, we also observe that country heterogeneity in capital changes was rather large when comparing country average changes: while 11 MS experienced on average reductions in their capital ratios in the first two years of the crisis, the rest experienced on average increases. On the other hand, the dispersion within each MS, as computed by the coefficient of variation was much smaller than across all MS, suggesting that there might be some national idiosyncratic characteristics that could homogenise behaviour.

TABLE 2. ANNUAL VARIATION IN RISK RATIO 2007-2009

Country	Mean	Max	Min	Sd	Cv*	# of banks
Austria	0.11	1.54	-1.15	0.42	3.82	14
Belgium	0.19	0.44	-0.03	0.17	0.89	3
Bulgaria	0.37	1.20	-0.30	0.69	1.86	2
Cyprus	0.22	0.33	0.01	0.14	0.64	2
Czech Republic	0.25	0.60	0.12	0.19	0.76	3
Dennmark	2.22	3.23	1.20	1.44	0.65	1
Finland	0.14	0.28	0.06	0.10	0.71	2
France	0.12	1.78	-0.27	0.23	1.92	54
Germany	0.01	0.61	-0.49	0.22	22.00	14
Greece	0.40	1.82	-0.10	0.48	1.20	12
Hungary	0.75	1.99	-0.15	0.64	0.85	8
Ireland	2.12	12.85	0.08	3.83	1.81	5
Italy	0.20	1.72	-1.19	0.38	1.90	36
Latvia	3.90	8.73	0.63	3.55	0.91	3
Lithuania	2.19	5.55	0.54	2.34	1.07	3
Luxembourg	0.12	0.59	-0.16	0.26	2.17	3
Netherlands	0.19	0.83	-0.02	0.20	1.05	8
Poland	0.51	1.22	0.06	0.39	0.76	5
Portugal	0.14	0.66	-0.10	0.19	1.36	7
Romania	0.86	2.27	0.09	0.75	0.87	4
Slovakia	0.32	0.69	0.10	0.23	0.72	3
Slovenia	0.30	0.74	0.00	0.26	0.87	5
Spain	0.21	2.00	-1.08	0.42	2.00	55
Sweden	0.44	2.53	-0.02	0.87	1.98	4
United Kingdom	0.65	4.80	-0.49	0.98	1.51	20
TOTAL	0.35	12.85	-1.19	0.94	2.69	276

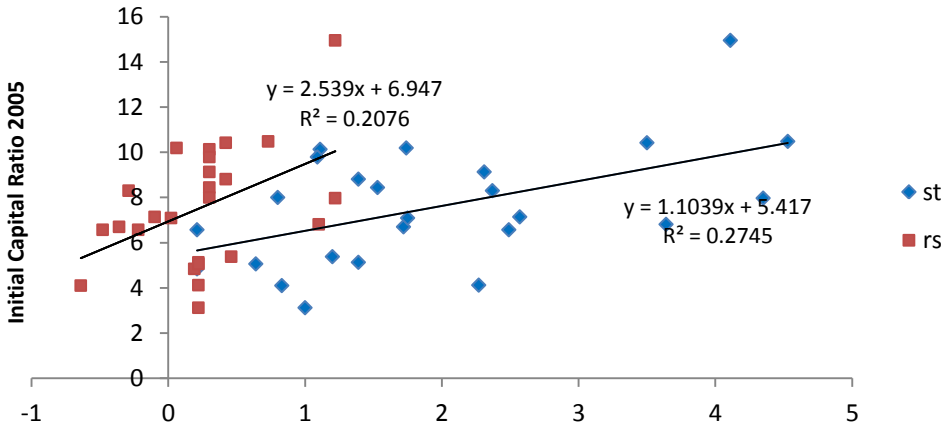
*Cv= Coefficient of Variation=Sd/mean

[2] Malta and Estonia are not included as the sample has only banks with assets higher than 2000million €

A rather different pattern emerged for credit risk (Table 2), as computed by the ratio of loan loss provisions over total assets (risk). In general, the heterogeneity in risk behaviour among countries was not so large, as all countries showed on average small increases in risk. In fact, in eleven EU countries, no bank experienced a decline in risk, as measured by the chosen indicator, all of them experiencing increases. In fact, the coefficient of variation for the annual changes in risk was higher than the corresponding for capital changes only in Bulgaria. So, the heterogeneity in risk behaviour was less pronounced than the one in capital ratios within each country.

It is also worth looking at the characteristics of the capital regulatory framework and their relationship with long-term or initial capital and risk ratios. The level of capital and the level of risk which were observed before the crisis could reflect the preferences for these two variables.

FIGURE 1. INITIAL CAPITAL RATIOS AND REGULATORY VARIABLES

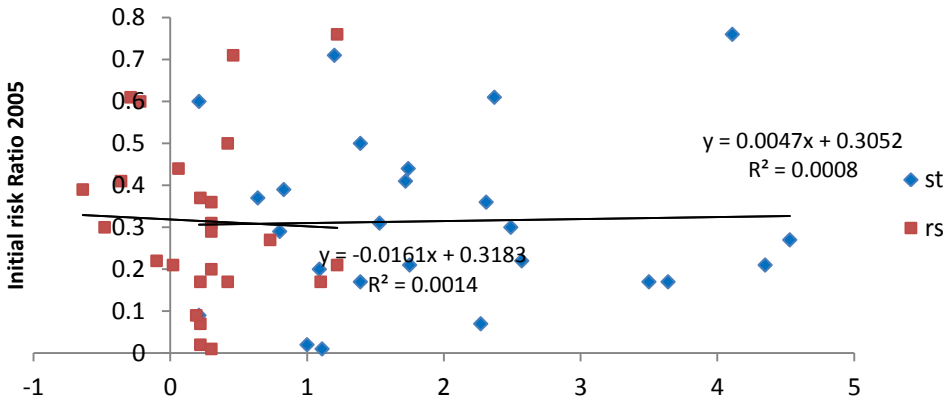


We observe that countries with preference for high capital ratios tended to choose both higher stringency (rs) and higher risk sensitivity (st) capital requirements, than countries with lower capital ratios. In particular, when we take the non-weighted average capital ratio observed in 2005 as a proxy of idiosyncratic country preference for capital, we find a positive relationship between such capital ratios and both risk sensitivity and stringency (Figure 1), which is statistically significant. Therefore, we find that bank solvency is positively associated with stringency and risk sensitivity.

On the other hand, the preference for risk does not seem to be associated with stringency or risk sensitivity in capital regulation. When we take the non-weighted

average risk ratio observed in 2005 as a proxy of idiosyncratic country preference for risk, we cannot find any statistically significant relationship between such risk ratios and neither risk sensitivity nor stringency. Higher average initial risk ratios are not associated with neither higher (nor lower) stringency and risk sensitivity in capital regulation, as reflected by the low value of the R^2 of the regression of such characteristics of capital requirements on average initial risk ratios (Figure 2) and on the low t value of the estimated coefficient.

FIGURE 2. INITIAL RISK RATIOS AND REGULATORY VARIABLES



Finally, we look at the relationship between the country specific banking rescue plans and characteristics of capital regulation, using simple correlations of average country values. We proxy rescue plans with annual contingent liabilities over GDP (cliab), which include changes in debt of other special purpose entities, other guarantees provided and asset swaps or lending. The amount of rescue plans could proxy the reliance that governments showed in relation to a market solution to the financial crisis. As Table 3 shows, we observe that there is a negative relationship between the amount devoted to rescue plans and risk sensitivity and stringency, suggesting that those countries which relied less in a market solution, also tend to have a more lenient approach to capital regulation. It could be the case that stringency and risk-sensitive regulation may have played a partial substitution role for contingent liabilities during the crisis.

TABLE 3. CORRELATIONS			
	cliab	**st**	**rs**
cliab	1.00		
st	-0.0166	1	
rs	-0.0387	0.5868	1

3. Literature Review

Bank capital regulation is at the core of banking regulation. Capital requirements, in particular, aim at making banks hold more capital than they would like to, so as to have more of their funds at risk (see Van Hoose (2007), Stolz (2002) and Santos (2001) for a survey of theories of bank behaviour under capital regulation).

The available theoretical literature produces mixed results regarding the effects of bank capital regulation on banks' risk-taking behaviour and the overall performance and soundness of the financial system (Dewatripont and Tirole (1994)). In particular, theoretical contributions do not agree on the impact of more risk sensitive and more stringent capital requirements on portfolio choices and on efficiency. Although the effects of capital adequacy requirements are usually to decrease risk taking, the reverse has also been shown to be possible (Rochet (1992), Besanko and Kanatas (1996)) [3].

Capital requirements may have an impact on banks beyond the minimum capital level as they may factor in the probability and the consequences of falling below such minimum. Some of the empirical research carried out to determine whether this is the case seems to support the view that regulatory capital has an impact on the capital held by banks (Ediz et al. (1998), Alfon et al. (2011), Francis and Osborne (2009a)). As a matter of fact, a number of empirical works have shown that, although most banks already hold capital in excess of the regulatory minimum (that is, banks hold capital buffers), changes in that minimum have an impact on banks' capital ratios. This feature is obtained for the UK in the papers by Alfon et al. (2011) and Francis and Osborne

[3] For example, using the mean-variance framework, Kahane (1977), Koehn and Santomero (1980) and Kim and Santomero (1988) have shown that increased regulatory capital standards may have the unintended effect of causing utility-maximizing banks to increase portfolio risk. On the other hand, the results in Furlong and Keeley (1989) and Keeley and Furlong (1991) suggest that higher capital standards will not cause banks to increase portfolio risk, because an increase in capital reduces the value of the deposit insurance put option.

(2009a, 2009b), the ones in Van Roy (2008) with data for six G-10 countries (Canada, France, Italy, Japan, the United Kingdom, and the United States) or the findings in Rime (2001) for Switzerland. However, Ashcraft (2001) finds little evidence that capital regulation during the 1980s materially influenced bank capital ratios. In the same vein, Barrios and Blanco (2003) find that for Spanish banks, a market-based model better fits the data, indicating that banks were not at all constrained by capital regulation but by market pressure during the period of study.

Empirical evidence is provided for the irrelevance of stringency in capital regulation for bank development and stability (Barth et al. (2004, 2006)). In a more recent paper, Beltratti and Stulz (2010), using individual data covering 386 banks in 30 countries from July 2007 to the end of 2008, analyse why some banks have performed better during the crisis than others, finding no association at all between more stringent regulation and stock returns. However, the evidence on the impact of capital adequacy requirements on financial stability has been usually obtained under an event-based approach, which identifies crisis only when they are severe enough to trigger market events[4].

On the other hand, evidence has been found that more stringent capital regulations or higher compliance with the Basel Core Principles are negatively linked with non-performing loans (Barth et al. (2008), Podpiera (2006)), suggesting a negative link between stringency and risk-taking behaviour (Argimón and Ruiz (2011). However, Demirgüç-Kunt and Detragiache (2009) do not find any relationship between compliance with the Basel Core Principles and banks' risk-taking, using z-score as its proxy, in their analysis of 86 countries. The authors suggest that the results may reflect the difficulty of capturing bank risk using accounting measures, but they nevertheless raise doubts on the relevance of the Basel Core Principles. A similar result of lack of association between more stringency in regulation and the evolution of risk is found in Beltratti and Stulz (2010) with individual bank data from 2007 to 2008. Editz et al. (1998) find no evidence that an increase in the minimum bank-specific capital ratio prevalent in the UK causes a bank to shift into less risky asset risk buckets, while Rime (2001) shows that regulatory pressure does not affect the level of risk in Swiss banks. On the other hand, Leaven and Levine (2009), with individual data covering the largest banks in 48 countries, find that stronger capital stringency tends to increase bank risk-

[4] In contrast, crises successfully contained by corrective policies are neglected, so that estimation suffers from selection bias (von Hagen and Ho (2007))

taking for those banks that have highly concentrated shareholders, in accordance with the theoretical results by Koehn and Santomero (1980) and Buser et al. (1981) as regards the positive relationship between capital regulation and risk-taking incentives of owners. In their study of the relationship between bank's risk-taking, governance structures and regulation, they show that such positive relationship cannot be found in those banks with a low ownership concentration. In the same vein, González (2005) 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 the one found by Shrieves and Dahl (1992).

The empirical evidence gathered as far as the impact of risk sensitivity in capital regulation on capital and on risk-taking is very limited. It points at a negative relationship between risk sensitivity and risk taking (Thakor (1996), Jacques et Nigro (1997)), and to significant increases in capital ratios (Jacques et Nigro (1997)) in relation to a non risk-sensitivity baseline.

Therefore, the gathered empirical evidence produces rather mixed results as far as the effects of capital regulation on bank's behaviour.

4. Data

In order to carry out the empirical analysis we use different sources. Our sample consists of 276 banks with assets above 2,000 million €, including commercial, savings and cooperative banks from 25 countries of the European Union[5], for which we have yearly consolidated data for the period 2005-2009[6] obtained from the BankScope database, property of Fitch Ratings and Bureau Van Dijk. We also use annual GDP growth data and data on the ratio of capital injections and contingent liabilities obtained from the European System of Central Banks, and the regulatory indices for capital regulatory stance, whose construction we broadly describe below.

4.1. Regulatory stance indices

The Capital Requirements Directive (CRD), comprising Directive 2006/48/EC and Directive 2006/49/EC is the common framework for the implementation of the Basel II accord in the European Union (EU), which came into force on 1 January 2007. The

[5] We do not have any observation from neither Estonia nor Malta.
[6] Although we study the period 2007-2009, we need data from previous periods to carry out the analysis.

Directive sets up minimum capital standards and other rules concerning credit institutions and their prudential supervision, which have to be transposed into the law of all EU Member States.

The CRD gave EU Member States (MS) a choice of more than 150 so-called national discretions and options (ND), as regards specific regulatory measures, which allow for differences in regulation. Such arrangement implies that there is a basic common regulatory and supervisory framework in EU economies, but with specific heterogeneity resulting from national preferences. In particular, such national discretions may be applied on the basis of national circumstances and cover a rather wide scope of specific areas within the Directive[7]. MS are asked to decide between taking the option that the Directive proposes or sticking to the baseline rule, which is common to all. The MS's choices are then reflected in their yes/no answer to each one of the possibilities that they are offered.

To carry out the empirical analysis, we picked up 53 of these national discretions for which we could clearly identify whether its adoption implied more or less stringency in regulation or more or less risk sensitive than the benchmark given by the Directive[8].

For the empirical analysis presented in this paper, we group the responses provided by the MS into two aggregate indexes, the first one reflecting overall stringency (st) and the other one reflecting overall risk sensitivity (rs). Following Barth et al. (2004), we calculate the principal components of the underlying choices[9], with mean zero and standard deviation one and pick up the first principal component to be used as a regressor in the estimation of the equations.

5. Specification

The empirical exercise we perform in this paper is to test whether the regulator's preference for more or less stringent and risk-sensitive capital regulation has contributed to the evolution of individual banks' capital and risk during the financial crisis. In order to assess the existence of this impact, we postulate that the evolution of individual bank's capital and risk may be modelled as a function of different determinants, among

[7] The information on the choices made by Member States can be found in the European Banking Authority website http://www.eba.europa.eu/Publications/Consultation-Papers/All-consultations/CP11-CP20/CP18.aspx

[8] For a more detailed description of the National Discretions, see Argimon and Ruiz (2010)

[9] A simple aggregation gives equal weight to each of the national discretions, while they may really have a rather different incidence.

which the regulatory environment. Such an approach allows us to assess the resilience of individual banks in terms of capital and risk, conditioned on their desired level of these two variables, under a different regulatory stance. In particular, the equations to be estimated are the following ones:

$$\Delta k_{ijt} = \alpha + \beta_1 \Delta size_{ijt} + \beta_2 \Delta roa_{ijt} + \beta_3 \Delta liq_{ijt} + \beta_4 \Delta risk_{ijt} + \beta_5 gdp_{jt} + \beta_6 k05_{ijt} + \beta_7 risk05_{ijt} + \pi_1 rs_j + \pi_2 st_j + d09_t + \beta_8 cliab_{jt} + \varepsilon_{ijt} \quad (1)$$

$$\Delta risk_{ijt} = \delta + \mu_1 \Delta size_{ijt} + \mu_2 \Delta nlta_{ijt} + \mu_3 \Delta liq_{ijt} + \mu_4 \Delta k_{ijt} + \mu_5 gdp_{jt} + \mu_6 k05_{ijt} + \mu_7 risk05_{ijt} + \omega_1 rs_j + \omega_2 st_j + d09_t + \mu_8 cliab_{jt} + v_{ijt} \quad (2)$$

where *i* stands for bank, *j* for country, *t* for time and Δ for change.

5.1. Variables to be explained (in differences)

Capital (k_{ijt}): ratio of total capital over total assets, as defined in most empirical work.

Risk ($risk_{ijt}$): ratio of loan-loss provisions over total assets as a proxy of bank's risk-taking. As in the case of the capital-to-asset ratio, it is extensively used in the empirical literature.

5.2. Bank-specific variables

Bank size ($size_{ijt}$): As a measure of size we use the natural log of total assets. As pointed out by McAllister and McManus (1993), larger banks have better risk diversification opportunities and thus lower cost of funding than smaller ones, so that we could expect a positive relation between capital and size. On the other hand, the "too-big-to-fail" argument suggests that larger banks would benefit from an implicit guarantee that, other things equal, decreases their cost of funding and allows them to invest in riskier assets, so that we could expect a positive relationship between size and risk. Available empirical evidence on this issue provides ambiguous results, although recently a negative relationship between capital ratios and size seems to dominate. We can expect that when we consider changes the same results could hold.

Return on assets (roa_{ijt}). In the capital equation we also include a proxy of bank profits, which is the return on average assets that is provided by the Bankscope dataset.

The intuition is that retained earnings are the cheapest way to increase the capital-to-asset ratio. We would then expect a positive relationship.

Bank loans (nlta$_{ijt}$): We use the ratio of net loans to total assets as the measure of bank's lending activity and include it as a determinant of risk. Loans might be more profitable than other types of assets such as securities, but might be more costly to produce being associated with higher risk.

Bank liquidity (liq$_{ijt}$): the banks' ratio of liquid assets to total assets is used as a proxy of bank liquidity. We could expect that banks with a high level of liquid assets will receive lower interest income than banks with less liquid assets, so will have lower profits and thus lower capital. On the other hand, higher liquidity could be associated with higher risk in the credit area to compensate for the forgone income.

Bank recurring earning power (rep$_{ijt}$): in the risk equation we include a measure of sustainability of income, which is proxied by the ratio of profit before tax, minus other, plus loan loss provisions over average total assets. This ratio is effectively a return on assets performance measurement without deducting provisions. We could expect that banks with high recurring earning power are more able to engage in higher risk.

Initial capital ratio (kta05$_{ij}$): the bank's capital ratio at t=2005. It tries to capture the fact that banks with higher initial capital ratios may experience higher declines, without hitting the minimum requirement.

Initial risk ratio (risk05$_{ij}$): the bank's risk ratio at t=2005. It tries to capture the fact that banks with lower initial risk ratios may experience higher increases in the rate to reach equivalent levels of risk.

5.3. Country-specific variables

GDP growth (gdp$_{jt}$): The national GDP growth rate should account for the impact of the economic cycle on bank performance.

Rescue programs (cliab$_{jt}$): contingent liabilities committed by public authorities as a percentage of GDP (in levels).

Stringency (st$_j$): It is the index of the intensity of stringency in capital regulation that we have constructed.

Risk Sensitivity (rs$_j$): It is the index of risk sensitivity in capital regulation that we have constructed.

We also use a dummy variable for the year 2009 (**d09**$_t$): it takes value 1 for the observations corresponding to year 2009 and 0 otherwise.

6. Empirical results

We estimate equations 1 and 2 applied to the annual change observed in risk and capital ratios between 2007 and 2009, the first two crisis years. In order to take into account the unobserved heterogeneity of the data, we estimate equations (1) and (2), by OLS with standard errors clustered by country and including dummy variables for each one of the countries, so as to condition on other unobserved country characteristics that may affect banks. Moreover, we provide the results for three different samples of countries: the entire one consisting of 276 banks with total assets above 2.000 million €, the sample with banks from countries with rescue plans (248)[10], so that their government either has contingent liabilities to face the banking crisis or has engaged in share acquisitions and, finally, the sample of banks from euro countries (223). The results are presented in columns 1 to 3 of Table 4 for the capital equation and in columns 4 to 6 for the risk equation.

[10] All banks with the exception of those from Slovakia, Czech Republic, Hungary, Lithuania, Poland and Romania.

TABLE 4. CAPITAL AND RISK CHANGES DURING 2007-2009

	Capital			Risk		
	Δk	Δk	Δk	Δrisk	Δrisk	Δrisk
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Total	Rescue	Euro	Total	Rescue	Euro
Δsize	-1.717**	-1.825**	-1.686	-1.677**	-2.086**	-2.298
	(0.723)	*(0.756)*	*(1.454)*	*(0.621)*	*(0.846)*	*(1.437)*
Δroa	0.458***	0.489***	0.441***			
	(0.074)	*(0.077)*	*(0.085)*			
Δnlta				-0.045	-0.054	-0.067
				(0.037)	*(0.044)*	*(0.058)*
Δrep				0.097	-0.044	-0.042
				(0.083)	*(0.111)*	*(0.117)*
Δliq	-0.026***	-0.023**	-0.027*	-0.014	-0.020	-0.024
	(0.008)	*(0.008)*	*(0.013)*	*(0.017)*	*(0.019)*	*(0.024)*
Δrisk	0.358***	0.431***	0.316***			
	(0.075)	*(0.083)*	*(0.087)*			
Δk				-0.000	0.017	-0.017
				(0.027)	*(0.031)*	*(0.029)*
gdp	0.220***	0.336**	0.288*	-0.151**	-0.210	-0.012
	(0.075)	*(0.121)*	*(0.147)*	*(0.070)*	*(0.149)*	*(0.045)*
rs	1.536***	1.619**	1.341	0.333	0.238	-0.239
	(0.544)	*(0.576)*	*(0.800)*	*(0.539)*	*(0.559)*	*(0.169)*
st	0.765*	0.986**	0.687*	-0.386	-0.437	0.103
	(0.381)	*(0.415)*	*(0.355)*	*(0.422)*	*(0.454)*	*(0.154)*
k05	-0.030	-0.033	-0.055*	0.012	0.012	0.007
	(0.038)	*(0.038)*	*(0.028)*	*(0.009)*	*(0.008)*	*(0.008)*
risk05	0.523**	0.477*	0.342	0.537***	0.583**	0.216
	(0.227)	*(0.239)*	*(0.236)*	*(0.189)*	*(0.205)*	*(0.165)*
cliab	0.019	0.033	0.021	-0.016	-0.021	-0.060***
	(0.026)	*(0.027)*	*(0.047)*	*(0.031)*	*(0.033)*	*(0.017)*
d09	2.378***	2.763***	2.654**	-0.624*	-0.826	0.035
	(0.677)	*(0.783)*	*(0.924)*	*(0.335)*	*(0.593)*	*(0.199)*
c	-1.942**	-2.408**	-1.722**	0.950	1.060	0.109
	(0.815)	*(0.865)*	*(0.630)*	*(1.085)*	*(1.188)*	*(0.231)*
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	552	496	446	552	496	446
R2	0.495	0.496	0.490	0.512	0.507	0.379

Standard errors clusterd by country in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results obtained for the capital equation show that higher stringency in capital regulation is positively associated to yearly changes in capital ratios. The evidence gathered suggests that more stringency has contributed to either reinforcing capital ratios or containing its decline during the crisis.

We also find that the amount of government contingent liabilities has not had a statistically significant impact on the evolution of capital ratios, not even when we consider only those countries with rescue plans. Therefore, higher funds devoted to rescuing the banking sector, have not resulted in higher observed increases in capital. The lack of statistical significance of this variable shows that even if government rescue plans have positively contributed to the solvency of banks, they have not shown in larger increases in capital.

Moreover, risk sensitivity in capital regulation has also positively affected the evolution of capital ratios in EU banks during the first two years of the crisis. The higher the risk sensitivity chosen to implement Basel II, the higher the increase in capital ratios that we have observed during the first crisis years. However, when we consider only the banks in euro countries, such relationship is no statistically significant. So, in general, both higher risk sensitivity and stringency have resulted in higher increases in capital ratios, leading to the conclusion that the stance of capital regulation has had an impact on the evolution of banks'capital.

The results also show that there is a strong inverse relationship between size and capital variations, so that banks that increased their balance, also reduced their capital ratios. We also find that increases in bank risk result in increases in capital, a relationship which is statistically significant. Namely, banks that increased their risk, as recorded by a positive change in the ratio of loan loss provisions over total assets, tended to also increase their capital ratios. We also find that capital changes are strongly positively related to changes in profitability, so that higher returns on assets also resulted in higher capital increases.

Liquidity appears to have played a compensating role on capital, as shown by a negative and statistically significant coefficient. Increases in liquidity have been accompanied by declines in capital.

We also find evidence that the initial capital ratio has had a negative impact on capital changes, so that we observe larger positive changes for those banks that had lower initial ratios, although it is only statistically significant for euro countries. It would

suggest that banks which have a preference for lower capital ratios are either willing to see them rise when there is a stressful situation or not to let them fall as much as those that initially had a higher ratio. On the other hand, the initial risk level had a positive impact on capital changes, so that the higher the preference for risk, the higher the increase in capital ratios observed during the crisis.

Finally, the economic cycle, as captured by real GDP growth, has had a positive effect on the yearly changes in capital, thus reinforcing the cycle: the economic recession has been accompanied by a decline in capital. On the other hand, the coefficient for the 2009 dummy variable is positive and statistically significant, indicating that in the second year of the crisis banks capital ratios evolved differently than in the first year, in the sense that they either increased more or declined less than in the first year. In fact, while in 2008, 75% of the banks in the sample experienced a decline in their capital ratio, the same percentage experienced an increase a year after.

As for the risk equation (cols 4 to 6 in Table 4), we observe that none of the two measures of regulatory stance are statistically significant and, in fact, they do not seem to have a clear impact on changes in risk. In particular, stringency appears to have had a negative impact on risk, except when the euro area is considered, which is not statistically significant. Moreover, the risk sensitivity of the regulatory capital framework does not seem to have affected the changes in risk that were taken during the crisis, showing a positive sign for the whole sample and for those countries with rescue plans and a negative sign if we only consider euro area countries. Therefore, neither stringency nor risk sensitivity in capital regulation seems to have had, in general, an impact on bank's changes in credit risk.

The results also show a strong negative association between changes in bank size and changes in risk, so that the larger the size increases, the lower the increase in risk, which is not statistically significant in the euro area. Therefore, reductions in size are accompanied by increases in both risk and capital. We also find that increases in the ratio of loans over total assets and in liquidity lead to lower variations in risk, but such relationships are not statistically significant. The incidence of the recurring earning power is not statistically significant either and its sign is not so clear cut: it is positive only for the whole sample, but it becomes negative in the samples that have countries with rescue plans or euro countries only. Variations in capital do not seem to have influenced decisions on changes in risk, either.

We find that the initial levels of risk affected the observed changes in risk during the financial crisis. In particular, higher initial levels of risk resulted in higher positive changes in this variable, thus reinforcing the initial shown preferences. On the other hand, initial capital ratios have a positive impact on risk, implying that the higher the capital level the higher the change in risk, but the coefficient is not statistically significant.

Contingent liabilities to address the financial crisis have had a negative impact on risk variations, only statistically significant when we consider the euro area, suggesting that banks in countries that have decided to invest more in public rescue plans for the banking sector have also tended to reduce risk. Finally, both the 2009 and the cycle variable show a negative sign, when the sample is not restricted to the euro area, which is statistically significant for the whole sample. Therefore, the increased deterioration in the economic environment resulted in reductions in risk.

6.1. Alternative definitions of capital and risk

We propose analysing different definitions for the capital and the risk variable. In particular, we estimate the equations using **eta**, the ratio of own funds over total assets and **tceta**, the ratio of tangible common equity over tangible assets. As for risk, we use **lolnl** the ratio of loan-loss reserves over net loans and **lolgl** the ratio of loan-loss reserves over gross loans. The results regarding the impact of the different characteristics of capital regulation on these different definitions of capital and risk are presented in Table 5.

TABLE 5. ALTERNATIVE DEFINITIONS OF CAPITAL AND RISK (1)

	Capital			Risk		
	Δk	**Δeta**	**Δtceta**	**Δrisk**	**Δlolgl**	**Δlolnl**
	(1)	(2)	(3)	(4)	(5)	(6)
rs	1.536*	1.380**	1.817***	0.333	-0.067	0.677
	(0.818)	*(0.531)*	*(0.446)*	*(0.370)*	*(0.560)*	*(1.118)*
st	0.765*	0.696**	0.552*	-0.386	-0.299	-0.741
	(0.462)	*(0.315)*	*(0.273)*	*(0.251)*	*(0.487)*	*(0.925)*
Obs.	552	459	552	552	501	552
R2	0.495	0.456	0.486	0.512	0.560	0.391

(1) Coefficient and standard errors clustered by country from the estimation of specifications in column 1 and 4 in Table 4

We obtain the same qualitative results as those presented in Table 4 for the capital equations: both stringency and risk sensitivity have a positive effect on capital variations that is statistically significant. We also observe that stringency has had a negative effect on risk variations whether we proxy risk with the ratio of loan loss reserves over net or over gross loans, but this effect is not statistically significant. We also find that the impact of more risk sensitivity over risk is not statistically significant.

6.2. Different types of banks

We have also tested for the possible different response to the regulatory stance depending on the type of banks that we are analysing. In Table 6 we present the results for specific groups of financial institutions. The first group we are considering includes a wider number of banks than in the previous section, as we also take into account the response of banks that submit unconsolidated statement with no consolidated companion (conso). The regulation of capital requirements is defined at a consolidated level, so that for the institutions that do not present consolidated accounts, we can use their unconsolidated statement as a proxy. Heterogeneity will therefore be larger. The results are qualitatively the same as those obtained beforehand for the capital equation (col (1)): both stringency and risk sensitivity have a positive effect on capital variations, suggesting that more risk sensitivity and more stringency lead to higher increases in capital. As for the risk equation (col (4)), again we cannot find a statistically significant impact of stringency or risk sensitivity neither on capital nor on risk variations.

TABLE 6. DIFFERENT TYPES OF FIRMS (1)

	Capital			Risk		
	Δk	**Δk**	**Δk**	**Δrisk**	**Δrisk**	**Δrisk**
	(1)	(2)	(3)	(4)	(5)	(6)
	all	high_capi	high_risk	all	high_capi	high_risk
rs	1.109*	6.133***	4.844***	0.333	1.788*	-0.272
	(0.623)	*(1.936)*	*(0.990)*	*(0.539)*	*(0.914)*	*(1.032)*
st	1.080**	3.401	2.359**	-0.386	-0.739	0.005
	(0.445)	*(2.095)*	*(0.947)*	*(0.422)*	*(0.800)*	*(0.542)*
Obs.	1104	178	170	1104	178	170
R2	0.360	0.754	0.563	0.424	0.697	0.626

(1) Coefficients and standard errors clustered by country from the estimation of specifications in column 1 and 4 in Table 4

Another group of banks that we have looked at includes those that have a clear preference for capital, so that they were well capitalized before the crisis, with capital ratios above 8.5% of total assets. We obtain similar qualitative results for the capital equation (col. (2)) than in Table 4: more risk sensitivity resulted in higher increases in capital. However, more stringency did not result in statistically significant higher increases in capital in these well capitalized banks. On the other hand, more risk sensitivity resulted in higher risk for well capitalized banks, while there is no statistically significant effect from stringency on risk changes (col. (5)). In columns (3) and (6) we present the results obtained for the last group of banks: those with a preference for high risk, before the crisis, i.e. with a ratio of loan-loss provisions over total assets above 0.35%. For risky banks' response in terms of changes in capital ratios, we observe the same qualitative results we presented before: stringency and risk sensitivity seems to have had a saying on the changes in capital observed during the crisis, resulting in a positive impact on capital. Risky banks, on the other hand, do not seem to have been affected by the regulatory stance in their decisions to modify risk.

7. **Summary and conclusions**

With the onset of the financial crisis, both national and international authorities engaged in regulatory reform. Regulation was regarded as not having played its expected role and as even having contributed to the development of what was then termed "financial turmoil". The Basel Committee on Banking Supervision, in particular, agreed on a new

set of capital requirements rules, known as Basel III, which implied a strengthening of capital regulation in relation to the current agreement, in place in EU countries, and in a calendar for future implementation. Basel III represents, in general, a move towards a more stringent and more risk sensitivity capital regulatory framework than the one currently being applied.

In this paper, we have presented an empirical analysis of the relation between more stringency and more risk-sensitivity under the current Basel II capital regulation and EU banks' capital and risk behaviour during the initial crisis years. We have made use of the regulatory indices developed in Argimon and Ruiz (2010) and have estimated the impact of such regulatory characteristics on observed changes in individual bank's capital and risk, taking into account, among other variables, national rescue plans.

Our results suggest that differences in regulatory stance have affected mainly capital decisions during the crisis, and, in some instances, also risk decisions. In particular, stringency in capital regulation has been positively associated to changes in capital, and has not affected risk decisions. Therefore, higher stringency has resulted in higher increases in capital, which is not an undesired effect from the supervisor's perspective, as higher capital reinforces bank's solvency. On the other hand, we have found that risk sensitivity has been also positively related to changes in capital, a relationship which is also, in principle, desirable, as higher risk sensitivity in capital regulation also results in higher capital increases. However, higher risk sensitivity also resulted in higher risk for those banks which had a preference for high capital, a result that supervisors would not be after. Therefore, as higher risk sensitivity in capital regulation seems to result in both higher capital and higher risk, there is a balance that needs to be struck in the design of the regulatory framework, so as to lead to increased financial stability.

We have not found evidence that governmental plans designed to rescue the financial system have had a significant impact on the behavior of banks' capital. They have certainly contributed to the recapitalization process, but they have not influenced the observed changes in capital. On the other hand, we have found evidence that they may have contributed to reductions in risk at least when we consider banks in the euro area.

Therefore, our results point at the effectiveness of stringency and risk sensitivity in generating increases in capital during stressful situations, thus supporting the reinforcement of such characteristics of the capital regulatory framework, as proposed

under Basel III. However, while it is clear that higher capital may result in higher individual financial resilience, it may also result in higher inefficiency, a trade-off that needs to be properly addressed in the design of regulation. The possibility that increased risk sensitivity in capital regulation could result in more risk being taken needs also to be factored in.

Moreover, the impact on the banking system as a whole cannot be obtained as a simple addition of individual effects, as the ones analyzed here. To obtain conclusions in relation to overall financial stability we would need to take into account the correlations among the different market players. Such analysis would require a completely different approach.

We believe that this work contributes to the empirical literature on the effects of bank capital regulation on banks' behaviour. The approach that has been followed benefits from the fact that the banks that have been analysed enjoy a homogenous basic regulatory framework, in spite of the fact that they operate in different countries. On the other hand, they experience a source of heterogeneity in relation to the dimensions of stringency and risk sensitivity in capital requirements, that can be isolated and their effects tested. Moreover, the analysis of bank performance during the crisis should help understand the role of regulatory stance in stressful periods.

Bibliography

- Alfon, I., Argimon, I. and Bascuñana-Ambros, P. (2011): "The Determinants of Capital Held by UK Banks and Building Societies and the Role of Individual Capital Requirements" in K. Alexander (ed.) "Research Handbook on International Financial Regulation", Edward Elgar, UK.
- Argimón, I., Ruiz, J. (2010): "The effects of National Discretions on banks," Banco de España Working Paper 1029.
- Argimón, I., Ruiz, J. (2011): "The effects of regulatory stringency and risk sensitivity on banks". *Journal of Banking Regulation* **12**, 144-166 (April 2011)
- Ashcraft, A. (2001): "Do Tougher Bank Capital Requirements Matter? New Evidence from the Eighties," Mimeo.
- Barrios, V., Blanco, J. (2003): "The effectiveness of bank capital adequacy regulation: A theoretical and empirical approach," *Journal of Banking and Finance*, 27, p. 1935–1958.
- Barth, J., Caprio, G., Levine, R. (2001): "Banking systems around the globe: Do regulations and ownership affect performance and stability?" in Mishkin, F.S. (Ed.), Prudential Supervision: What Works and What Doesn't. Univ. of Chicago Press, p. 31–88.
- Barth, J., Caprio, G., Levine, R. (2004). "Bank regulation and supervision: what works best?" *Journal of Financial Intermediation*, 13, pp.205-248.
- Barth, J., Caprio, G., Levine, R. (2006): "Rethinking Bank Regulation: Till angels govern," Cambridge University Press.
- Barth, J., Caprio, G., Levine, R. (2008): "Bank regulations are changing: for better or worse?" *Comparative Economic Studies*, 50, p. 537-563; Symposium Paper.
- Basel Committee on Banking Supervision, 2010: "Basel III: A global regulatory framework for more resilient banks and banking systems" BIS.
- Beltratti , A., Stulz, R. (2010): "The Credit Crisis Around the Globe: Why Did Some Banks Perform Better?," Charles A. Dice Center Working Paper No. 2010-5
- Berger, A. N. (1995): "The relationship between capital and earnings in banking," *Journal of Money, Credit and Banking*, 27, p. 432-56.
- Besanko, D. and G. Kanatas, (1996): "The Regulation of Bank Capital: Do Capital Standards Promote Bank Safety?" *Journal of Financial Intermediation*, 5(2).
- Buser, S. Chen, A., Kane, (1981): "Federal Deposit Insurance, Regulatory Policy, and Optimal Bank Capital," *Journal of Finance*, 36, p. 51 – 60.
- Demirgüç-Kunt, A., Laeven, L., Levine, R. (2004): "Regulations, market structure, institutions, and the cost of financial intermediation," *Journal of Money, Credit and Banking*, 36, p. 593-622.

- Demirgüç-Kunt, A., Detragiache, E., Tressel, T. (2008): "Banking on the principles: Compliance with Basel Core Principles and bank soundness," *Journal of Financial Intermediation*, 17(4), p. 511-542.
- Demirguc-Kunt, A., Detragiache, E. (2009): "Basel core principles and bank soundness: does compliance matter?" Policy Research Working Paper Series 5129, The World Bank.
- Dewatripont M., Tirole, J. (1994): "The Prudential Regulation of Banks," MIT Press, Cambridge, MA.
- Ediz, T., Michael, I., Perraudin, W. (1998): "The impact of capital requirements on UK bank behaviour," FRBNY Economic Policy Review, p.15-22.
- Francis, W., Osborne, M. (2009a) "On the behaviour and determinants of risk-based capital requirements: revisiting the evidence from UK banking institutions," Financial Services Authority Occasional Paper num. 31. UK.
- Francis, W., Osborne, M. (2009b) "Bank regulation, capital and credit supply: measuring the impact of Prudential Standards," Financial Services Authority Occasional Paper num. 36. UK.
- Furlong F., Keeley, M. (1989): "Capital regulation and bank risk taking: A note" *Journal of Banking and Finance*, 13, p. 883-891.
- González, F. (2005): "Bank regulation and risk-taking incentives: an international comparison of bank risk," *Journal of Banking and Finance*, 29, p. 1153-1184.
- Jackson, P., Furfine, C., Groeneveld, H., Hancock, D., Jones, D., Perraudin, W. (1999): "Capital requirements and bank behavior: The impact of the Basel accord," Basel Committee on Banking Supervision, Working Paper No. 1.
- Jacques, K., Nigro, P. (1997): Risk-based capital, portfolio risk, and bank capital: A simultaneous equations approach," *Journal of Economics and Business*, 49, p. 533-547.
- Kahane, Y (1977): "Capital adequacy and the regulation of financial intermediaries," *Journal of Banking and Finance*, 1(2), p. 207-217.
- Keeley, M., Furlong, F. (1991): "A reexamination of mean–variance analysis of bank capital regulation," Federal Reserve of San Francisco Economic Review 0 (3), p. 40–48.
- Kim, D. and A. M. Santomero (1988): "Risk in Banking and Capital Regulation," *Journal of Finance*, 43(5), p. 1219-1233.
- Koehn, M., Santomero, A.M. (1980): "Regulation of bank capital and portfolio risk," *Journal of Finance*, 35(5), p. 1235–1244.
- Laeven, L., Levine, R. (2009): "Bank governance, regulation and risk taking," *Journal of Financial Economics*, 93(2), p. 259-275.
- McAllister, P.H., McManus, D.A. (1993): "Resolving the scale efficiency puzzle in banking," *Journal of Banking and Finance*, 17, p. 389–405.
- Podpiera, R. (2006): "Does compliance with Basel Core Principles bring any measurable benefits?", IMF Staff Papers**,** Vol. 53, No. 2.

- Rime, B. (2001): “Capital requirements and bank behaviour: empirical evidence for Switzerland,” *Journal of Banking and Finance*, 25, p. 789-805.
- Rochet, J. (1992): “Capital requirements and the behaviour of commercial banks,” *European Economic Review*, 36, p. 1137-1178
- Santos, J. (2001): “Bank capital regulation in contemporary banking theory: a review of the literature,” *Financial Markets, Institutions and Instruments*, 10(2), p. 41-84.
- Shrieves, R., Dahl, D. (1992): “The relationship between risk and capital in commercial banks,” *Journal of Banking and Finance*, 16, p. 439-457.
- Stolz, S. (2002) “The relationship between bank capital, risk-taking, and capital regulation: a review of the literature” Kiel Working Paper No. 1105
- Thakor, A. V. (1996): “Capital requirements, monetary policy and aggregate bank lending: theory and empirical evidence,” *Journal of Finance*, 51(1), p. 279-324.
- VanHoose, D. (2007): “Theories of bank behaviour under capital regulation,” *Journal of Banking and Finance*, 31, p. 3680-3697.
- Van Roy, P. (2008): "Capital Requirements and Bank Behaviour in the Early 1990: Cross-Country Evidence," *International Journal of Central Banking*, 4(3), pages 29-60.
- Von Hagen, J., Ho, T. (2007): “Money Market Pressure and the Determinants of Banking Crises,” *Journal of Money, Credit and Banking*, 39(5), p. 1037 - 1066.