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Ex Ante Capital Position, Changes in the Different Components of Regulatory Capital and Bank Risk

Boubacar Camara*,Laetitia Lepetit**, Amine Tarazi**

* Autorité de Contrôle Prudentiel, 61 rue Taitbout, 75009 Paris
**Université de Limoges, LAPE, 5 rue Félix Eboué, 87031 Limoges Cedex, France Corresponding author e-mail : laetitia.lepetit@unilim.fr

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Abstract:

We investigate the impact of changes in capital of European banks on their risk-taking behavior from 1992 to 2006, a time period covering the Basel I capital requirements. We specifically focus on the initial level and type of regulatory capital banks hold. First, we assume that risk changes depend on banks' ex ante regulatory capital position. Second, we consider the impact of an increase in each component of regulatory capital on banks' risk changes. We find that, for highly capitalized, adequately capitalized and strongly undercapitalized banks, an increase in equity or in subordinated debt positively affects risk. Moderately undercapitalized banks tend to invest in less risky assets when their equity ratio increases but not when they improve their capital position by extending hybrid capital or subordinated debt. On the whole, our conclusions support the need to implement more explicit thresholds to classify European banks according to their capital ratios but also to clearly distinguish pure equity from hybrid and subordinated instruments.

Keywords: Bank Risk, Bank Capital, Capital regulation, European banks
JEL Classification: G21; G28

Capital Initial, Changements par Composantes du Capital Réglementaire et Risques Bancaires

Boubacar CAMARA, Laetitia LEPETIT et Amine TARAZI

Résumé:

Dans cet article, nous étudions l'impact des variations de capital sur la prise de risque des banques européennes sur la période 1992-2006. Nous posons d'abord l'hypothèse selon laquelle la prise de risque dépend du niveau de capital réglementaire détenu ex ante par les banques. Nous isolons ensuite les principales composantes du capital réglementaire pour évaluer leur impact sur la prise de risque. Nos résultats montrent que les variations des fonds propres de base et de la dette subordonnée exercent un impact positif sur les variations de risque pour les banques fortement capitalisées et adéquatement capitalisées. Les banques sévèrement sous capitalisées qui ont très peu à perdre en cas de faillite adoptent un comportement risqué. Par contre, les établissements modérément sous capitalisés adoptent un comportement prudent consistant à réduire leur prise de risque à la suite d'une augmentation des fonds propres de base afin de respecter les exigences réglementaires. Ainsi, la définition plus stricte des fonds propres réglementaires par les autorités de régulation au niveau européen et international devrait contribuer à une plus grande solidité des établissements bancaires. Par ailleurs, une intervention graduée du superviseur basée sur davantage de seuils explicites - déterminés en fonction du niveau des ratios de fonds propres réglementaires - contribuerait à éviter les comportements risqués des banques en grande difficulté financière

Mots clés : risque bancaire, capital bancaire, réglementation du capital, banques européennes
Classification JEL: G21; G28

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1. Introduction

Bank capital regulation throughout the world is expected to play a major role to ensure financial stability. The regulatory frameworks known as Basel II, implemented in Europe in 2008, and Basel III which will be progressively enforced by 2019[1], are based on 3 pillars in which capital adequacy rules have been further tightened. The global financial crisis that started in 2007 challenges the effectiveness of these mandatory capital requirements and has led banking regulators to reshape the entire prudential regulatory framework. Under Basel III, banks have to comply with higher capital requirements based on a narrower definition of regulatory capital restricted to common equity also called core Tier 1 capital. The aim is to emphasize both the quantity and the quality of capital that banks hold. Ordinary (common) shares and retained earnings are also becoming the predominant form of Tier 1 capital and hybrid capital instruments qualifying for prudential purposes will be progressively restricted.

The theoretical literature on the impact of capital requirements on banks' risk-taking behavior has revealed mixed results. Furlong and Keeley 1989, Keeley and Furlong 1990 and Jeitschko and Jeung 2005 find that capital requirements can reduce the total volume of risky assets and thereby contribute to the stability of the banking system. However, capital regulation is likely to encourage banks to select riskier assets to offset its negative effect on leverage and on profitability (see Koehn and Santomero 1980, Kim and Santomero 1988, Rochet 1992, Blum 1999) or introduce indirect incentive effects affecting the effort to screen and monitor projects and lending behavior (see Gennote and Pyle 1991, Boot and Greenbaum 1993, Gianmarino et al. 1993, Besanko and Kanatas 1996). A more stringent capital rule could therefore, under some conditions, lead to an increase in banks' default risk. Calem and Rob (1999) also show that because the bank's portfolio choice depends on its ex ante regulatory capital position, it may either decrease or increase its portfolio risk as it moves towards compliance with a minimum capital requirement. Several empirical papers have analyzed whether banks take higher or lower risk when they are forced to hold more capital and also find contradictory results (Shrieves and Dahl 1992, Berger 1995, Jacques and Nigro 1997, Aggarwal and Jacques 2001, Rime 2001, Heid et al. 2004, Van Roy 2008, Altunbas et al. 2007).

While these papers have investigated the effect of capital regulation on bank risk taking, other papers have shown that banks hold buffers of capital indicating that capital standards are in general not binding (see Allen and Rai, 1996, Peura and Jokivuolle 2004, Barth et al. 2006, Berger and al. 2008). Rather than strictly complying with capital regulation, banks are shown to have their own target levels of capital and risk. Depending on the extent of their capital buffer, banks will adjust their capital and risk taking to reach their target levels (Milne and Whalley 2001, Ayuso et al. 2004, Lindquist 2004, VanHoose 2007, Jokipii and Milne 2008, Jokipii and Milne 2011, Stolz and Wedow 2011).

[1] For details on Basel II and Basel III, see Basel Committee on Banking Supervision: "International Convergence of Capital Standard, a Revised Framework, Comprehensive Version", Bank for International Settlements, June 2006, and Basel Committee on Banking Supervision: "Basel III: A global regulatory framework for more resilient banks and banking systems", Bank for International Settlements, June 2011.

These two strands of the literature either focus on the risk impact of an increase in capital or on the relationship between capital buffers, i.e. the amount of capital held in excess of regulatory requirements, and risk. As a whole, the question of how changes in capital impact risk-taking incentives for banks that do not initially comply with regulatory capital standards remains unresolved. Furthermore, banks can use various instruments such as equity, hybrid capital, and subordinated debt to adjust their regulatory capital levels. Whether or not changes in different forms of regulatory capital will affect risk-taking incentives differently remains an open question. In this paper we jointly consider these two dimensions in an empirical setting.

We first investigate if changes in capital will lead to the same risk-taking behavior for banks with different ex ante regulatory capital ratios. Our aim is to specifically focus on initially undercapitalized banks but for comprehensiveness we also consider the case of banks that hold capital buffers. We therefore differentiate five sub-samples of banks on the basis of their capital ratios: (i) highly capitalized when their regulatory risk-based capital ratio (*TCR*) is above 10%; (ii) adequately capitalized when their *TCR* is between 8 and 10%; (ii) undercapitalized when their *TCR* is strictly below the regulatory threshold of 8%; (iv) moderately undercapitalized when they do not meet the total capital requirement but comply with the minimum 4% capital requirement on the *TIER1* risk-based capital ratio; (v) strongly undercapitalized when they comply with neither of these two requirements. Strongly undercapitalized banks have little to lose in case of default and might take very high risk to meet capital requirements (Calem and Rob 1999, Rochet 1999). But highly capitalized banks might also invest in risky assets associated with higher expected returns (Calem and Rob 1999) although it could also be argued that such banks, holding large capital buffers, might be targeting prudent strategies. In between, adequately and moderately undercapitalized banks are expected to take lower risk to comply with regulation. While previous empirical work has already looked at the relationship between capital ratios and risk for banks with different levels of capital ratios and /or capital buffers, our aim is to further investigate the case of undercapitalized banks.

We also examine, within each of our five capitalization categories, if bank risk taking is influenced by adjustments in the different components of capital defined by regulators. We therefore disaggregate bank capital into equity capital, subordinated debt and hybrid capital, i.e. the different components of regulatory capital. Subordinated debt holders are expected to be very sensitive to individual bank risk exposure since they are the first to bear any loss in excess of the bank's equity without benefitting from upside risk. If market discipline is effective, such investors will require higher rates expecting to curb banks' incentives to take on higher risk (Flannery 2001). However, when banks face severe distress, the incentives of subordinated debt holders are aligned with those of shareholders (Gorton and Santomero 1990) and they will prefer riskier strategies to increase the probability of recovering their funds. Under such circumstances, in the absence of regulatory prompt corrective action, troubled banks may 'gamble for resurrection' (Calem and Rob 1999, Rochet 1992) under the pressure of both shareholders and subordinated debt holders. Finally, hybrid capital presents the characteristics of both equity and debt. Their holders might also behave differently, in some cases more as shareholders or more as debt holders. From this perspective, our approach is expected to help supervisors to better monitor banks with different regulatory capital structures.

We work on a panel of commercial, cooperative & mutual and savings banks from 17 European countries over the 1992-2006 period. We find that banks' risk-taking behavior depends on the amount of regulatory capital they initially hold and also on the type of capital they choose to increase. We find that, for highly as well as adequately capitalized banks but also for strongly undercapitalized banks, an increase in equity or in subordinated debt positively affects risk. Moderately undercapitalized banks

tend to invest in less risky assets when their equity ratio increases but not when they improve their capital position by extending subordinated debt or hybrid capital.

The paper is organized as follows. Section 2 describes the data, provides some preliminary statistics and presents the econometric framework. Section 3 presents our estimation results. Section 4 discusses further issues and reports robustness checks. Section 5 concludes the paper.

2. Data description and empirical framework

Our sample covers commercial, mutual & cooperative and savings banks from 17 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom) from 1992 to 2006. Our sample period is restricted to the Basel I regulatory environment introduced in January 1993; after 2006 banks have to comply with a different method to compute their risk-weighted assets (Basel II).
The data are taken from BankScope Fitch IBCA, which provides annual accounting data for 6304 commercial, cooperative & mutual and savings European banks during this period. Because BankScope CDs only report data for the last 8 years, we use three BankScope CDs to gather data for our period of study (September 2000, February 2006 and June 2008). We consider consolidated data but also use unconsolidated data when consolidated balance sheets are not available. All the banks in our sample publish their annual financial statements at the end of the calendar year. For accuracy, we only retain banks providing information for at least five consecutive years of time series observations as we estimate a dynamic panel data model including dependent and explanatory variables in first order differences (annual changes)[2]. Out of the initial 6304 banks, we are left with 1451 commercial, mutual & cooperative and savings European banks after data cleaning and imposing data availability for risk-based capital ratios (596 commercial banks, 574 mutual & cooperative banks and 281 savings banks, see Table A1 in appendix for a breakdown by country[3]). We end up with a smaller sample of 1142 banks when we require information on non-performing loans.

On average, our sample covers 64% of the total assets reported in Bankscope in 2006 but it is relatively smaller for some countries such as Denmark, Germany, Ireland, Luxembourg, Norway and the United Kingdom (see Table A1 in the appendix). We check that the major European banks are included in our sample. Our sample is dominated by Italian and French banks (respectively 677 and 226 banks). Both countries, along with Germany, have the banking systems with the largest number of banks in Europe.

We investigate, using standard measures of risk, whether the sign of the relationship between changes in capital and changes in risk is conditional on Banks' ex ante regulatory capital positions and on the type of capital they use to adjust their capitalization. We use the ratio of risk-weighted assets to total

[2] We check if this restriction leads us to exclude banks that are classified as “in bankruptcy” or “in liquidation” or “dissolved” or “dissolved for mergers” by BankScope over our period of analysis. Out of the 73 banks that are classified as “in bankruptcy” or “in liquidation”, 11 are present in our final sample. Our sample includes 311 banks that were dissolved out of the 1744 listed by BankScope. 1422 banks are not included in our final sample because BankScope does not report information on their total risk-based capital ratio and their risk-weighted assets.

[3] As BankScope provides few information on total capital ratio and risk-weighted assets for German banks, we end up with only 27 banks for this country. All these German banks have been established before 1989, so the capital requirement required by the regulator over our period of analysis is 8% (and not 12.5% as it holds for new established banks).

assets (*RWA*) based on the Basel Accord risk-based capital guidelines[4]; it reflects the allocation of assets among the four weighting categories (0, 20, 50 and 100%) but not necessarily their actual riskiness. However, using such a measure allows us to assess the impact of capital changes on banks' portfolio reallocations among different weighting categories. We also use the ratio of non-performing loans to net loans (*NPL*), which is a good predictor of future performance problems (Berger et al. 1991). As additional risk indicators, we also compute a 3-year rolling window standard deviation of the return on assets (*SD_ROA*) and the logarithm of a 3-year rolling window Z-score measure defined as $LOG\_Z = ln((100 + MROE)/SD\_ROE)$, where *MROE* is the 3-year rolling window average return on equity and *SD_ROE* is the 3-year rolling standard deviation of the return on equity (all in percentages)[5]. A higher value of *LOG_Z* implies a lower probability of default.

We further need to measure the level of regulatory capital that banks hold at the beginning of each period. We consider the value of the regulatory risk-based capital ratio (*TCR*) measured at the end of the previous period[6] to classify banks in different categories. The risk-based capital ratio is defined as total regulatory capital (*TIER 1* and *TIER 2*) divided by risk-weighted assets. We use the minimum capital requirement imposed by the Basel accords to identify banks that are undercapitalized. We further use the thresholds of the Prompt Corrective Action (PCA)[7] implemented in the US in 1991 to differentiate banks that are well capitalized from those that are adequately capitalized. Banks that exhibit a *TCR* strictly lower than 8% are classified as undercapitalized banks (*UNDER*). Banks with a *TCR* ranging from 8 to 10% are regarded as adequately capitalized (*AD*), and banks with a *TCR* above 10% as highly capitalized (*HIGH*). We further define as moderately undercapitalized (*UNDERMODER*), banks that do not meet the total capital requirement ($TCR < 8$) but do comply with the narrower capital ratio, i.e. the *TIER1* risk-based capital ratio ($TIER1\ ratio \geq 4\%$). Banks that do not comply with these two requirements ($TCR < 8$ and $TIER1\ ratio < 4\%$) are considered as strongly undercapitalized (*UNDERSTRONG).* These two categories of undercapitalized banks might react differently in adjusting their capital positions. Strongly undercapitalized banks need to increase equity capital (*TIER1*) to comply with capital requirements whereas moderately undercapitalized banks can either increase equity capital *(TIER1)* or subordinated debt and hybrid capital (*TIER2*). Therefore the impact on risk taking can be different. We consider five dummy variables, one for each capitalization category (*D_HIGH, D_AD, D_UNDER, D_UNDERMODER* and *D_UNDERSTRONG)*. A bank can be classified in different capitalization categories throughout our sample period.

Tables 1 and 2 provide statistics on our sample by differentiating banks according to their level of capitalization. During our sample period, 1384 banks are highly capitalized and 431 banks are adequately capitalized corresponding to respectively 8851 and 1199 observations (see Tables 1 and A2

[4] Throughout our sample period which ranges from 1992 to 2006, the ratio of risk-weighted assets to total assets we use is computed on a homogeneous basis. European banks have introduced the new methods allowed under Basel II after this period.

[5] It could be argued that the Z-score indicator might be inappropriate to investigate the relationship between capitalization and bank default risk because it is positively related to the capitalization variable by construction. However, the correlation between the Z-score measure and the ratio of capital to total assets is very low (0.125) in our sample. Its correlation with the annual changes in capital is also insignificant (-0.045). Because the Z-score variable is highly skewed, we use the natural logarithm of the Z-score as in Laeven and Levine (2009) and Houston et al. (2010).

[6] Our approach is based on discrete time. At time t, we consider the value taken by *TCR* at time t-1 to assign a bank in a given category. This is because we consider capital changes from t-1 to t and risk changes from t-1 to t.

[7] The PCA involves that banks are classified into one of five categories (well capitalized, adequately capitalized, undercapitalized, significantly undercapitalized and critically undercapitalized) depending on their total risk-based capital ratio, Tier 1 risk-based capital ratio, and Tier 1 leverage ratio. Because a formal corrective action has not been implemented in Europe we simply use the thresholds defined by PCA in the US to classify banks according to the level of their regulatory risk-based capital ratio. The minimum capital requirement in Europe is 8% as in the US, except in Germany where the minimum TCR is equal to 12.5% for newly established banks in the first three years of business. We do not have to deal with such regulatory differences as we do not have in our final sample German banks that are newly established. The Financial Services Authority in the United Kingdom sets additional unpublished capital requirements called "trigger" and "higher target" ratios for each bank; the FSA considers that the basic 8% regulatory minimum capital requirement is only appropriate for a well-diversified bank. This implies that some banks have to comply with a higher capital ratio. However, as this information is not publicly available, we use the same thresholds of 8% and 10% for UK banks. We test the robustness of our results by using other thresholds (see Section 4 on robustness checks).

in the appendix). A smaller number of banks are, at some stage, undercapitalized (101 banks for 178 observations). Among these undercapitalized banks, 33 are strongly undercapitalized and 57 are moderately undercapitalized (respectively 44 and 99 observations)[8]. Among undercapitalized banks, around 60 % are undercapitalized during 1 year only, 20% during 2 years and 13% during 3 years (see Table A2 in the appendix). The same proportions hold for moderately undercapitalized banks whereas strongly undercapitalized mostly experience such a situation during only 1 year. A closer look at our data shows that among the undercapitalized banks, around 30% remain undercapitalized during several consecutive years. We further observe that, on average, undercapitalized banks exhibit significantly higher risk (*NPL*, *SD_ROA* and *LOG_Z*)[9] and that the total risk-based capital ratio of strongly undercapitalized banks is very low (below 2.50% on average).

Insert Tables 1 and 2 here

We use the following specifications to determine if the ex ante regulatory capital position of the bank (highly capitalized, adequately capitalized, undercapitalized, moderately undercapitalized or strongly undercapitalized) conditions risk adjustment induced by a change in capital:

$$\Delta Risk_{i,t} = \alpha_{0,i} + \alpha_1 Risk_{i,t-1} + \alpha_2 D\_AD_{i,t-1} + \alpha_3 D\_UNDER_{i,t-1} + \alpha_4 \Delta CAP_{i,t} + \alpha_5 \Delta CAP_{i,t} * D\_AD_{i,t-1} + \alpha_6 \Delta CAP_{i,t} * D\_UNDER_{i,t-1} + \sum_{j=7}^{8} \alpha_j CONTROL_{i,t} + \gamma_c + \delta_t + \varepsilon_{i,t} \quad (1.a)$$

$$\Delta Risk_{i,t} = \alpha_{0,i} + \alpha_1 Risk_{i,t-1} + \alpha_2 D\_AD_{i,t-1} + \alpha_3 D\_UNDERMODER_{i,t-1} + \alpha_4 \Delta CAP_{i,t} + \alpha_5 \Delta CAP_{i,t} * D\_AD_{i,t-1} + \alpha_6 \Delta CAP_{i,t} * D\_UNDERMODER_{i,t-1} + \sum_{j=7}^{8} \alpha_j CONTROL_{i,t} + \gamma_c \quad (1.b)$$

$$\Delta Risk_{i,t} = \alpha_{0,i} + \alpha_1 Risk_{i,t-1} + \alpha_2 D\_AD_{i,t-1} + \alpha_3 D\_UNDERSTRONG_{i,t-1} + \alpha_4 \Delta CAP_{i,t} + \alpha_5 \Delta CAP_{i,t} * D\_AD_{i,t-1} + \alpha_6 \Delta CAP_{i,t} * D\_UNDERSTRONG_{i,t-1} + \sum_{j=7}^{8} \alpha_j CONTROL_{i,t} + \gamma \quad (1.c)$$

The dependent variable ($\Delta RISK$) is either the annual change in the ratio of risk-weighted assets to total assets *ΔRWA*, the annual change in the ratio of non-performing loans to net loans *ΔNPL*, the 3-year rolling window standard deviation of the return on assets *SD_ROA*, or the logarithm of the 3-year rolling window Z-score *LOG_Z*[10]. We consider a dynamic adjustment by including the one year lagged value of the risk variable (in level) as our measures of risk could exhibit time dependency ($RISK_{t-1}$). Changes in capital are measured by the variable *ΔCAP* defined as the annual change in the ratio of total capital to total assets ($\Delta CAP = CAP_t - CAP_{t-1}$).

[8] Among the 11 banks listed as "in bankruptcy" or "in liquidation" by BankScope in our sample, only 1 bank appears as undercapitalized (and more precisely as strongly undercapitalized); similarly, among the 311 banks listed as "dissolved", 28 are undercapitalized (of which 9 are strongly undercapitalized).

[9] Mean tests are available from the authors on request.

[10] Two of our measures, *SD_ROA* and *LOG_Z*, are computed using a 3-year rolling window making first order differencing problematic. We do not therefore consider the annual changes for these variables. However, we also perform our estimations using the changes in these variables as robustness checks.

We first consider in specification (1.a) three categories of banks according to the level of their regulatory capital at *t-1:* highly capitalized (*D_HIGH*), adequately capitalized (*D_AD*) and undercapitalized (*D_UNDER*). We further use two alternative specifications, (1.b) and (1.c), to examine if the sign of the relationship for undercapitalized banks depends on whether they are undercapitalized in terms of both the total risk-based capital ratio and the TIER1 risk-based capital ratio (strongly undercapitalized, *D_UNDERSTRONG*) or only in terms of the total risk-based capital ratio (moderately undercapitalized, *D_UNDERMODER*). We ignore in the three specifications the dummy variable *D_HIGH* representing highly capitalized banks to avoid singularity. Highly capitalized banks are therefore the reference banks. To measure the impact of changes in capital on risk changes conditional on the level of regulatory capital, we interact *ΔCAP* with the dummy variables *D_AD* and *D_UNDER* (or alternatively *D_UNDERMODER* or *D_UNDERSTRONG).* α_4 captures the relationship between changes in capital and changes in risk for highly capitalized banks. α_5 and α_6 indicate whether adequately and undercapitalized banks behave differently than highly capitalized banks (α_5 and/or α_6 significant) or not (α_5 and/or α_6 not significant) respectively. In our investigation, we also test the significance of the sum of the coefficients associated to changes in capital and the appropriate interaction term ($\alpha_4+\alpha_5$ and $\alpha_4+\alpha_6$) to focus more closely on the relationship between changes in capital and changes in risk for each category of banks.

For highly capitalized banks that hold large buffers, the expected relationship between changes in capital and changes in risk is undetermined. Banks holding large capital buffers might be targeting prudent investment strategies but they also might favor riskier investments (secured by important buffers). The net impact on their default probability will depend on the extent of the change in risk relatively to that in capital. Adequately capitalized banks are expected to adopt a prudent behavior but the sign of the relationship between changes in capital and changes in risk is ambiguous for undercapitalized banks. Banks that are moderately undercapitalized at the beginning of the period might reduce risk to avoid supervisory as well as market sanctions. On the other hand, strongly undercapitalized banks might be tempted to take higher risk. Such behavior might increase their default probability.

We further analyze the impact on risk of a change in a specific component of capital (change in the ratio of equity to total assets (*ΔEQ*) or change in the ratio of subordinated debt to total assets (*ΔSUB*) or change in the ratio of hybrid capital to total assets (*ΔHYB*)) using a disaggregated version of specifications (1.a), (1.b) and (1.c) as follows[11]:

[11] Note that the sum of the coefficients of *ΔEQ*, *ΔSUB* and *ΔHYB* ($\beta_4+\beta_7+\beta_{10}$) in specifications (2) equals, for a given sample, the coefficient associated with *ΔCAP* (α_4) in specifications (1). It is therefore possible to find the results of specifications (1) using specifications (2). However, to facilitate the interpretation of the results, we present the results obtained for both specifications (1) and (2).

$$\Delta Risk_{i,t} = \beta_{0,i} + \beta_1 Risk_{i,t-1} + \beta_2 D\_AD_{i,t-1} + \beta_3 D\_UNDER_{i,t-1} + \beta_4 \Delta EQ_{i,t} + \beta_5 \Delta EQ_{i,t} * D\_AD_{i,t-1} + \beta_6 \Delta EQ_{i,t} * D\_UNDER_{i,t-1} + \beta_7 \Delta SUB_{i,t} + \beta_8 \Delta SUB_{i,t} * D\_AD_{i,t-1} + \beta_9 \Delta SUB_{i,t} * D\_UNDER_{i,t-1} + \beta_{10} \Delta HYB_{i,t} + \beta_{11} \Delta HYB_{i,t} * D\_AD_{i,t-1} + \beta_{12} \Delta HYB_{i,t} * D\_UNDER_{i,t-1} + \sum_{j=13}^{14} \beta_j CONTROL_{i,t} + \gamma_c + \delta_t + \varepsilon_{i,t} \quad (2.a)$$

$$\Delta Risk_{i,t} = \beta_{0,i} + \beta_1 Risk_{i,t-1} + \beta_2 D\_AD_{i,t-1} + \beta_3 D\_UNDERMODER_{i,t-1} + \beta_4 \Delta EQ_{i,t} + \beta_5 \Delta EQ_{i,t} * D\_AD_{i,t-1} + \beta_6 \Delta EQ_{i,t} * D\_UNDERMODER_{i,t-1} + \beta_7 \Delta SUB_{i,t} + \beta_8 \Delta SUB_{i,t} * D\_AD_{i,t-1} + \beta_9 \Delta SUB_{i,t} * D\_UNDERMODER_{i,t-1} + \beta_{10} \Delta HYB_{i,t} + \beta_{11} \Delta HYB_{i,t} * D\_AD_{i,t-1} + \beta_{12} \Delta HYB_{i,t} * D\_UNDERMODER_{i,t-1} + \sum_{j=13}^{14} \beta_j CONTROL_{i,t} + \gamma_c + \delta_t + \varepsilon_{i,t} \quad (2.b)$$

$$\Delta Risk_{i,t} = \beta_{0,i} + \beta_1 Risk_{i,t-1} + \beta_2 D\_AD_{i,t-1} + \beta_3 D\_UNDERSTRONG_{i,t-1} + \beta_4 \Delta EQ_{i,t} + \beta_5 \Delta EQ_{i,t} * D\_AD_{i,t-1} + \beta_6 \Delta EQ_{i,t} * D\_UNDERSTRONG_{i,t-1} + \beta_7 \Delta SUB_{i,t} + \beta_8 \Delta SUB_{i,t} * D\_AD_{i,t-1} + \beta_9 \Delta SUB_{i,t} * D\_UNDERSTRONG_{i,t-1} + \beta_{10} \Delta HYB_{i,t} + \beta_{11} \Delta HYB_{i,t} * D\_AD_{i,t-1} + \beta_{12} \Delta HYB_{i,t} * D\_UNDERSTRONG_{i,t-1} + \sum_{j=13}^{14} \beta_j CONTROL_{i,t} + \gamma_c + \delta_t + \varepsilon_{i,t} \quad (2.c)$$

For severely undercapitalized banks, a change in equity capital is expected to positively affect risk but if market participants expect support or forbearance from regulators the same result will hold for changes in subordinated debt and hybrid capital which would behave as pure equity. At higher levels of capitalization (moderately undercapitalized and adequately capitalized banks), an increase in any of the three components of capital will moderate risk, but the effect should be stronger for subordinated debt and to a lesser extent for hybrid capital which is a mixture of equity and debt. For banks with large capital buffers, as argued above, the impact of an increase in capital in general is undetermined because banks might be either following riskier or more prudent strategies. However, subordinated debt and, to a lesser extent hybrid capital holders are always expected to curb potential higher risk taking (exclusively or essentially) benefitting pure equity holders. If banks that accumulate large buffers do so because they target higher risk, an increase in subordinated debt or, to a lesser extent, in hybrid capital will cause a lower increase in risk than would a change in pure equity. Furthermore, strong pressures from subordinated debt holders could possibly lead to a decrease in risk. If banks with important buffers adopt a more prudent behavior, an increase in any of the three components of regulatory capital will not generate higher risk.

We introduce a set of control variables in all our specifications. We control for bank size measured as the natural logarithm of total assets (*SIZE*). Large banks are expected to better diversify and manage

risk. However, large banks could also benefit from safety net and too-big-to-fail policies (systemic risk concerns) and increase the riskiness of their assets. We also account for bank efficiency by considering the cost-to-income ratio defined as the ratio of total costs to total income before provisions and taxes (*EFF*). Less efficient firms may be tempted to take on higher risk to offset the lost returns incurred by a more stringent capital regulation. However, regulators may allow more room for leverage for efficient firms with better management (Altunbas et al. 2007). Finally, we include country and time dummies. Descriptive statistics of all the variables are provided in tables 1 and 2.

3. Estimation results

We test for the presence of endogeneity by using the Hausman test. For specification (1), endogeneity is presumably a problem for the two variables representing changes in capital (*ΔCAP*) and the level of efficiency[12] (*EFF*). We use as instruments the lagged value (in level) of the capital ratio CAP_{t-1} for ΔCAP_t and the lagged value in first difference ΔEFF_{t-1} for EFF_t [13]. We find endogeneity for *ΔCAP* when the dependent variable is *ΔRWA* or *SD_ROA* and for *EFF* when *ΔRWA* is the dependent variable. We run the same tests for the different components of capital based on specification (2) and find that only the variable measuring changes in equity (*ΔEQ*) is endogenous when the dependent variable is either *ΔRWA, SD_ROA* or *LOG_Z*.

To deal with endogeneity, we can either use 2SLS/3SLS or the generalized method of moments (GMM). The first approach is used in most of the previous studies which analyze the effectiveness of capital adequacy regulations and the relationship between an increase in bank capital and risk (Shrieves and Dahl 1992; Jacques and Nigro 1997; Aggarwal and Jacques 2001; Rime 2001; Altunbas et al. 2007). However, GMM estimators provide more efficient estimators in the presence of individual specific heteroscedascticity, as it is the case with our data. We therefore use GMM but, as a robustness check, also consider a simultaneous equations approach for specification (1) (see section 4).

We use the Blundell and Bond (1998) system GMM estimator by considering lagged values (in level) of the capital ratio and the equity ratio as instruments for, respectively, the variables ΔCAP_t and ΔEQ_t, the lagged values in first difference for the efficiency variable EFF_t. We apply the forward orthogonal deviations transformation of the original equation as suggested by Arellano and Bover (1995) and use the two-step estimator including the Windmeijer (2005) finite-sample correction. In order to limit the number of instruments, we restrict the lag range used in generating them to four and the instrument matrix is collapsed as suggested by Roodman (2009). We check the validity of our instruments with the AR(2) test and the Hansen test. The AR(2) test corresponds to the Arellano-Bond test which tests for absence of second-order serial correlation in the first-differenced residuals. The Hansen test allows for checking the validity, i.e. the exogeneity, of the entire set of instruments as a group. We also ensure the absence of multicollinearity problems.

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[12] Efficiency could be affected by changes in bank risk. If a manager is not very good at assessing and monitoring loans, she/he will presumably not reach a high level of operating efficiency. Moreover, a bank which wants to maximize its long-run performance can reduce the funds devoted to underwriting and monitoring loans. Such a behavior will boost efficiency in the short-run but will also increase bank risk. See Berger and DeYoung (1997) for more details.

[13] We first regress, using OLS, each presumably endogenous variable on the instrumental variables and a set of exogenous variables not suspected to be endogenous. We then obtain the fitted values (*ΔCAP_FIT* and *EFF_FIT*) and the residuals (*ΔCAP_RES* and *EFF_RES*) for the two variables suspected to be endogenous that we substitute for *ΔCAP* and *EFF* in specification (1). An endogeneity problem potentially exists if *ΔCAP_RES* and/or *EFF_RES* are significantly different from zero. We finally run a join test to confirm that we have an endogeneity problem. These estimations are available from the authors on request.

Changes in capital and risk for banks with different initial regulatory capital positions

The estimation results regarding specifications (1a-c) are presented in Tables 3a-b for our three different measures of asset risk and for our measure of default risk; similarly, the results for specifications (2a-c) are given in Tables 4a-b.

The results show that the ex ante regulatory capital positions of banks influence their risk-taking behavior differently when they adjust their capital (see Tables 3a-b). For highly capitalized banks, we find a positive relationship between changes in capital and changes in asset and loan risk (*ΔRWA*, *ΔNPL* and *SD_ROA*). These results indicate that highly capitalized banks invest in riskier assets when they increase their capital ratio. We also find that such a behavior increases their default probability (*LOG_Z*) indicating that the increase in asset risk more than offsets the reduction in default risk attributable to higher capitalization. Regarding adequately capitalized banks, we find that they do not behave differently than highly capitalized banks.

For undercapitalized banks (equation (1.a), we find a significant negative relationship between changes in capital and changes in asset risk (*ΔRWA*, *ΔNPL* and *SD_ROA*). Undercapitalized banks seem to adopt a prudent behavior when they improve their capital standards to catch up with regulatory requirements. Such banks might want to avoid regulatory and/or market sanctions when rebuilding their capital ratio. However, when we further separate undercapitalized banks into two sub-categories, we note that the reduction in asset risk only holds for banks that are simply undercapitalized in terms of the total risk-based capital ratio, i.e. for moderately undercapitalized banks (equation (1.b)). These banks also display a lower default probability (*LOG_Z*). The opposite result holds for institutions that neither meet the *TCR* nor the *TIER 1* requirement (equation (1.c)). For such strongly undercapitalized banks, we highlight the same behavior as highly capitalized banks, i.e. a positive relationship between changes in capital and changes in asset risk. These banks, which exhibit a very low mean value of *TCR* and *TIER 1*, respectively of 2.48 and 1.59% (see Table 1) might be suffering from the persistence of negative outcomes from past investments in poor quality projects. They might also be aiming for a higher expected return on equity by reallocating their asset portfolio and by selecting riskier and more profitable assets. We also find that a change in capital is associated with a higher default risk for strongly undercapitalized banks. Therefore, similarly to highly capitalized banks, the increase in asset risk for such banks more than offsets the reduction in default risk initially driven by a higher capitalization. The net impact is a higher default probability. These institutions seem therefore to be less prudent than banks which are simply undercapitalized in terms of *TCR* and which are close to the minimum regulatory requirement since the mean value of *TCR* for such institutions is equal to 7.10% (see Table 1). However, these results have to be considered with caution since, in our sample, the number of strongly undercapitalized banks is relatively low (33 banks for a total of 44 observations).

Insert Tables 3a-b here

Changes in different components of capital and risk, for banks with different initial regulatory capital positions

We further decompose bank total capital into equity, subordinated debt and hybrid capital and we measure the impact of a change in each component of capital on changes in bank risk. Tables 4a-b give the estimation results and show that both the type of capital used by a bank and its capital position impacts its risk-taking behavior. We find a positive relationship between changes in the equity ratio (*ΔEQ)* and changes in the risk-weighted assets ratio (*ΔRWA*) for adequately and highly capitalized banks. However, no significant link is found for these two categories of banks between changes in equity and the standard deviation of ROA *(SD_ROA)*. Our results also show that a change in the equity

ratio implies an increase in the probability of default (*LOG_Z*) for highly and adequately capitalized banks. Conversely, and consistently with our previous results, we also find a negative and significant relationship between changes in equity and changes in the risk-weighted assets ratio (*ΔRWA*) for undercapitalized banks. We still observe the same differences for our two groups of undercapitalized banks. Our results show a negative relationship between changes in the equity ratio and changes in the ratio of risk-weighted assets to total assets for moderately undercapitalized banks. However, strongly undercapitalized banks do not behave differently from highly capitalized banks. Strongly undercapitalized banks have little to lose in the event of insolvency and seem to take higher risk to meet capital requirements by investing in riskier assets to increase their expected return. Similarly to highly capitalized banks, this reallocation towards riskier assets increases the default risk of strongly undercapitalized banks whereas we do not find a significant impact of a change in the equity ratio on default risk for the more prudent moderately undercapitalized banks.

Our results further highlight a significant positive relationship between a change in the ratio of subordinated debt (*ΔSUB)* and a change in the risk-weighted assets ratio (*ΔRWA)* for any initial level of bank capitalization. On the whole, market discipline exerted by subordinated debt holders does not seem to curb banks' incentives to adopt riskier strategies.

Regarding changes in the ratio of hybrid capital (*ΔHYB)*, there is no significant impact for highly capitalized banks whereas we find a positive relationship with the risk-weighted assets ratio (*ΔRWA)* for adequately and undercapitalized banks. At lower levels of capital buffer, hybrid capital appears to impact bank asset reallocation (*ΔRWA)* similarly to pure equity. For such banks hybrid capital contributes to increase the share of risky assets (*ΔRWA)*. This finding is consistent with Basel III's focus on a narrower definition of regulatory capital separating hybrid capital from bank core capital. However, no significant link is found with the standard deviation of ROA *(SD_ROA)* and default risk (*LOG_Z*).

Insert Tables 4a-b here

4. Deeper investigation and robustness checks

In order to further examine issues related to the influence of capital changes on the risk-taking behavior of banks, we carry out a deeper investigation of our sample[14].

Isolating the impact of increases and decreases in capital ratios

We consider in our regressions both positive and negative capital changes. To go deeper in our investigation, we estimate specifications (1a-c) on two separate samples, including respectively positive and negative changes in capital[15]. We are more concerned about increases in capital than decreases in capital since we focus on changes in risk when banks are forced to improve their capital ratios, namely undercapitalized banks. Around 40% of capital changes in our sample are positive changes (increase in capital). The results of the estimations on the whole sample (including both increases and decreases in capital) are consistent with those of the sample restricted to increases in

[14] Some of the estimation results discussed in this section are not presented in the paper but are available from the authors on request.

[15] We are not able to run our specifications (2a-c) when we differentiate positive and negative equity, subordinated debt and hybrid capital changes due to lack of sufficient observations.

capital which is the sample consistent with our investigation (see Tables A3 a-b and A4 a-b in Appendix).

Ownership type

We consider in our sample three types of banks with different ownership. Shareholder wealth maximization is the traditional objective of commercial banks. However, mutual & cooperative banks are owned by their customers and might thus put their interests first (O'Hara 1981, Altunbas et al. 2001). Savings banks, on the other hand, are generally held by stakeholders such as employees and local or regional authorities and aim to boost savings, develop the local economy and support social work (Gardener et al. 1997). These characteristics may lead to different business strategies regarding bank lending and investment, which can result in differences in profitability and risk (Goddard et al. 2007, Iannotta et al. 2007). Moreover, mutual & cooperative and savings banks might experience difficulties in raising as much capital as they would like. We therefore run our econometric specifications on each type of banks separately. The number of observations for moderately and strongly undercapitalized banks does not allow us to run regressions (1.b) and (1.c) separately for the three types of banks. The main results presented in Section 3 hold for commercial banks and savings banks. For cooperative & mutual banks we find a significant positive relationship between changes in capital and changes in the asset risk (*ΔRWA* and *SD_ROA)* and a significant negative relationship with the default probability (*LOG_Z*) for any initial level of bank capitalization.

Market discipline

Banks that are closely monitored by market participants might behave differently than institutions heavily reliant on explicitly or implicitly insured deposits and that do not issue large amounts of market debt. We therefore run our regressions on two sub-samples. The first sub-sample includes banks with a ratio of deposits to total assets below the sample median (54.95%). The second sub-sample is restricted to banks that are strongly reliant on deposits i.e. institutions with a ratio of deposits to total assets above the median. Highly and adequately capitalized banks that are relatively more reliant on market debt do not behave differently than banks that are more dependent on deposits (see Tables A5a-b and A6a-b). We also observe that strongly undercapitalized banks adopt riskier behavior even when they are more reliant on market debt. But moderately undercapitalized banks behave differently when their liability structure is different. Our results show a negative relationship between changes in capital and changes in risk for moderately undercapitalized banks that are relatively more reliant on market debt. Conversely, we find that moderately undercapitalized banks that are more deposit-oriented do not behave differently than highly capitalized banks. For such banks that are presumed to be less closely monitored by uninsured market debt holders, our findings highlight that an increase in capital positively affects risk, similarly to strongly undercapitalized banks. Market discipline is therefore only effective to temper risk-taking behavior, following changes in capital, for moderately undercapitalized banks, but not for strongly undercapitalized banks or well capitalized and adequately capitalized banks.

Robustness checks

Several robustness checks are also performed. First, we estimate specification (1.a) by using a simultaneous equations approach for the two measures of risk (*ΔRWA* and *SD_ROA)* for which we identified endogeneity issues with *ΔCAP*[16].We introduce the same set of control variables used in equation (1.a) with, in addition, the return on assets (*ROA*). We use the three stage least square method by using instruments to tackle endogeneity issues. Our main results are unaltered (see Tables A7a-b in

[16] We are not able to run our specifications (1b-c) when we use simultaneous equations due to an insufficient number of observations.

Appendix). Second, we include the annual changes in the risk-weighted assets to total assets *ΔRWA* in specifications where *ΔNPL* is the dependent variable, as in Shrieves and Dahl (1992). Third, we use another threshold to classify highly and adequately capitalized banks. We define banks with a *TCR* ranging from 8 to 12% as adequately capitalized, and banks with a *TCR* above 12% as highly capitalized. Our results also remain unchanged for both specifications (1.a-c) and (2.a-c). We also perform our estimations by interacting *ΔCAP* with the lagged value of the total capital ratio (*TCR*) instead of the dummy variables (*D_AD* and *D_UNDER*). We find a significant positive relationship between changes in capital and changes in the risk-weighted assets ratio (*ΔRWA*); but for higher values of the total capital ratio we find lower coefficients associated to changes in capital. Furthermore, to be consistent with the other risk proxies we use, we run our regressions using the changes in the standard deviation of *ROA* and the Z-score instead of their levels. Again, our findings are unaltered. Finally, we check the stability of our results by carrying out estimations on two sub-periods, 1992-1998 and 1999-2006. On the whole for our sample of commercial, cooperative and savings banks, capital ratios exhibit an upward trend until 1998 and remain relatively stable after this period. We can assume that after their implementation in January 1993, capital rules were initially binding for at least some banks that were catching up with the new standards. However, our main results hold for all the sub-periods.

5. Conclusions

The purpose of this paper is to investigate whether the impact of changes in capital on bank risk taking is conditional on the ex ante regulatory capital positions of banks and on the type of capital they use to adjust their capital positions. We distinguish different categories of banks based on the initial level of their risk-weighted capital ratio (highly capitalized, adequately capitalized, undercapitalized, moderately undercapitalized and strongly undercapitalized banks). First, we find that banks react differently in terms of risk taking to capital changes. Highly capitalized banks increase their risk while undercapitalized banks tend to reduce it. However, when we separate undercapitalized banks into two sub-categories, we find that only moderately undercapitalized banks lower their risk exposure. Conversely, strongly undercapitalized banks take higher risk. Moreover, an increase in capital in highly, adequately and strongly undercapitalized banks is associated with higher default risk while default risk is lower for moderately undercapitalized banks.

Sensitivity analysis shows that strongly undercapitalized banks, but also highly capitalized and adequately capitalized banks, do not behave differently when they are heavily reliant on market debt, i.e. when they are presumed to be more closely monitored by uninsured market debt holders. However, for moderately undercapitalized banks, the negative relationship between changes in capital and changes in risk only holds when they are more reliant on market debt.

We also disaggregate bank capital into equity, subordinated debt and hybrid capital and find that for highly capitalized, adequately capitalized and strongly undercapitalized banks, an increase in the ratio of equity or in subordinated debt systematically increases their riskiness. We also find that for moderately undercapitalized banks, an increase in the ratio of equity negatively affects risk whereas an increase in the ratio of subordinated debt or hybrid capital positively affects risk. The positive relationship between an increase in the ratio of hybrid capital and change in risk also holds for strongly undercapitalized banks.

Our results support the need to implement explicit thresholds to classify European banks according to their capital ratios. This would help to clearly specify the conditions for supervisory intervention in

troubled banks. Our results are also in favor of a clearer distinction between hybrid instruments, subordinated debt and pure equity capital in regulatory capital standards.

Table 1. General descriptive statistics, on average over the 1992-2006 period

	DEP_TA	NL_TA	ROA	ROE	Net_margin	EFF	TCR	TIER1	TA
Full sample of commercial, mutual & cooperative and savings banks available in BankScope (6304 banks)									
Mean	78.05	56.23	0.53	6.36	3.06	68.11	16.72	15.16	6149.8
Std. Dev.	17.23	21.83	1.92	10.98	2.11	18.18	8.34	8,93	43171
Our sample									
All banks (1451 banks)									
Mean	66.57	58.07	0.80	8.57	3.34	67.66	16.28	14.71	18800
Std. Dev.	15.71	19.01	0.93	9.88	1.57	16.25	7.51	8.09	79104
Highly capitalized banks (1384 banks)									
Mean	66.83	57.37	0.85	8.73	3.41	67.51	17.45	15.92	17469
Std. Dev.	15.60	18.95	0.95	8.91	1.59	15.96	7.39	8.01	81527
Adequately capitalized banks (431 banks)									
Mean	65.16	63.13	0.49	8.34	2.83	67.98	9.14	7.27	29056
Std. Dev.	16.43	18.37	0.61	12.15	1.35	16.94	0.55	1.51	63220
Undercapitalized banks (101 banks)									
Mean	63.08	58.92	0.32	1.88	3.07	72.81	5.80	4.77	15902
Std. Dev.	15.63	20.75	1.23	25.55	1.29	23.46	2.54	2.44	36826
Moderately undercapitalized banks (57 banks)[a]									
Mean	61.19	59.95	0.34	5.45	2.85	71.77	7.10	6.18	22065
Std. Dev.	16.26	21.45	1.02	19.77	1.38	22.17	0.77	1.06	45566
Strongly undercapitalized banks (33 banks)[a]									
Mean	63.69	50.59	0.31	-7.77	3.21	73.34	2.48	1.59	12008
Std. Dev.	14.17	22.02	1.77	37.76	1.13	29.30	2.46	1.45	24552

Variable definitions (all variables are expressed in percentages, except *TA* which is in millions of Euros): *DEP_TA* = deposits/total assets; *NL_TA* = net loans/total assets; *ROA* = return on assets; *ROE*= return on equity; *Net_margin*= net interest income/total earning assets; *EFF* = total costs/total income before provisions and taxes; *TCR* = total capital/ risk-weighted assets; *TIER1*= tier 1 capital/ risk-weighted assets; *TA*= total assets (millions of Euros).

We classify banks in different categories of capitalization: highly capitalized when $TCR \geq 10$; adequately capitalized when $8 \leq TCR < 10$; undercapitalized when *TCR* < 8%; moderately undercapitalized when *TCR*<8% and $TIER1 \geq 4$; strongly undercapitalized when *TCR*<8% and *TIER1*<4.

[a] The sum of banks classified as moderately and strongly undercapitalized (90 banks) does not perfectly match with the number of undercapitalized banks (101 banks) because some of these banks do not provide information on *TIER1*.

Table 2. Descriptive statistics of risk measures and capitalization variables, on average over the 1992-2006 period

	RWA	ΔRWA	NPL	ΔNPL	SD_ROA	LOG_Z	CAP	ΔCAP	EQ	SUB	HYB
Highly capitalized banks (1384 banks)											
Mean	66.967	1.082	6.739	-0.366	0.314	4.142	11.318	-0.034	10.428	1.293	0.098
Std. Dev.	16.761	7.281	6.845	3.072	0.567	1.083	4.573	1.884	4.829	1.379	0.344
Adequately capitalized banks (431 banks)											
Mean	73.042	2.183	6.228	-0.192	0.218	4.033	7.394	-0.101	5.956	1.567	0.254
Std. Dev.	17.685	9.218	5.305	2.26	0.326	1.109	2.516	1.172	2.54	1.129	0.532
Undercapitalized banks (101 banks)											
Mean	72.59	5.308	9.975	0.376	0.424	3.647	7.776	-0.027	6.689	1.342	0.145
Std. Dev.	18.245	13.328	10.189	4.286	0.661	1.243	4.713	1.831	4.918	1.159	0.363
Moderately undercapitalized (57 banks)											
Mean	72.124	5.281	9.884	0.397	0.435	3.656	6.841	-0.217	6.117	1.011	0.048
Std. Dev.	18.663	12.306	10.104	4.892	0.683	1.289	3.805	1.357	3.972	0.89	0.145
Strongly undercapitalized banks (33 banks)											
Mean	75.476	4.974	10.100	0.566	0.551	3.586	10.914	0.17	9.564	1.571	0.053
Std. Dev.	17.417	19.794	11.667	3.012	0.791	1.376	6.125	2.502	6.765	1.256	0.127

Variable definitions (all variables are expressed in percentages): *RWA* = risk-weighted assets to total assets; *ΔRWA* = annual changes of *RWA*; *NPL* = non performing loans/net loans; *ΔNPL* = annual changes of *NPL*; *SD_ROA* = 3-year rolling standard deviation of the return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *CAP* = total capital /total assets =(Equity capital+Subordinated debt+Hybrid capital)/total assets; *ΔCAP*= annual changes of *CAP*; *EQ*=equity capital/Total assets; *SUB*=subordinated debt/total assets; *HYB*=hybrid capital/total assets.

We classify banks in different categories of capitalization: highly capitalized when $TCR \geq 10$; adequately capitalized when $8 \leq TCR < 10$; undercapitalized when *TCR* < 8%; moderately undercapitalized when *TCR*<8% and $TIER1 \geq 4$; strongly undercapitalized when *TCR*<8% and *TIER1*<4.

[a] The sum of banks classified as moderately and strongly undercapitalized (90 banks) does not perfectly match with the number of undercapitalized banks (101 banks) because some of these banks do not provide information on *TIER1*.

Table 3a. Ex ante regulatory capital position of European banks and risk-taking behavior over the period 1992-2006, specification (1) (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-0.756	-0.886*	-0.839*	0.00949	-0.00761	0.000755
	(0.103)	(0.053)	(0.071)	(0.914)	(0.904)	(0.991)
D_UNDER (α_3)	-0.949			0.533**		
	(0.444)			(0.043)		
D_UNDERMODER (α_3)		-0.258			0.405	
		(0.837)			(0.103)	
D_UNDERSTRONG (α_3)			-11.34***			0.332
			(0.001)			(0.217)
ΔCAP (α_4)	0.779***	0.799***	0.776***	0.0674***	0.0600***	0.0519***
	(0.000)	(0.000)	(0.000)	(0.006)	(0.001)	(0.006)
ΔCAP*D_AD (α_5)	0.104	0.113	0.119	0.0627	-0.00723	0.0152
	(0.719)	(0.699)	(0.685)	(0.308)	(0.902)	(0.804)
ΔCAP*D_UNDER (α_6)	-2.151***			-0.409***		
	(0.004)			(0.004)		
ΔCAP*D_UNDERMODER (α_6)		-2.323***			-0.412***	
		(0.004)			(0.000)	
ΔCAP*D_UNDERSTRONG (α_6)			0.306			-0.233
			(0.850)			(0.314)
RWA_{t-1}	-0.155***	-0.143***	-0.151***			
	(0.000)	(0.000)	(0.000)			
NPL_{t-1}				-0.240***	-0.252***	-0.196***
				(0.000)	(0.000)	(0.000)
EFF	-0.136***	-0.145***	-0.151***	0.0741***	0.00517**	0.00427*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.019)	(0.065)
SIZE	-0.284***	-0.287***	-0.307***	0.0206	-0.0579***	-0.0314
	(0.002)	(0.003)	(0.002)	(0.484)	(0.005)	(0.114)
Const.	24.95***	24.79***	25.99***	-3.850***	1.679***	0.942**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.022)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$	-1.373**	-1.524**		-0.342**	-0.352***	
	(0.062)	(0.052)		(0.01)	(0.000)	
AR(2) test	0.756	0.993	0.800	0.435	0.799	0.65
Hansen test	0.896	0.812	0.807	0.251	0.822	0.301
Observations	5754	5401	5357	4481	3506	3473

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; EFF = cost to income ratio; *SIZE* = logarithm of total assets.; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL*.

Table 3b. Ex ante regulatory capital position of European banks and risk-taking behavior over the period 1992-2006, specification (1) (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	0.009	0.001	0.007	-0.087***	-0.037	-0.044*
	(0.273)	(0.806)	(0.519)	(0.000)	(0.142)	(0.080)
D_UNDER (α_3)	0.0865*			-0.0525		
	(0.066)			(0.393)		
D_UNDERMODER (α_3)		0.011			-0.005	
		(0.595)			(0.955)	
D_UNDERSTRONG (α_3)			0.110			-0.185
			(0.106)			(0.231)
ΔCAP (α_4)	0.006**	0.004**	0.008**	-0.019***	-0.025***	-0.026***
	(0.044)	(0.036)	(0.044)	(0.000)	(0.000)	(0.000)
ΔCAP*D_AD (α_5)	-0.020**	-0.002	-0.018	0.010	0.039*	0.041*
	(0.028)	(0.731)	(0.112)	(0.532)	(0.094)	(0.073)
ΔCAP*D_UNDER (α_6)	-0.115**			0.0426**		
	(0.016)			(0.019)		
ΔCAP*D_UNDERMODER (α_6)		-0.020**			0.062***	
		(0.042)			(0.003)	
ΔCAP*D_UNDERSTRONG (α_6)			0.012			-0.131
			(0.755)			(0.336)
SD_ROA_{t-1}	0.761***	0.854***	0.821***			
	(0.000)	(0.000)	(0.000)			
LOG_Z_{t-1}				0.735***	0.770***	0.765***
				(0.000)	(0.000)	(0.000)
EFF	0.0033**	0.003***	0.003**	-0.001***	-0.003***	-0.003***
	(0.043)	(0.001)	(0.049)	(0.000)	(0.000)	(0.000)
SIZE	-0.003	0.003	-0.002	-0.016***	-0.020***	-0.018***
	(0.258)	(0.113)	(0.544)	(0.000)	(0.000)	(0.000)
Const.	-0.136	-0.213**	-0.172	1.414***	1.356***	1.354***
	(0.320)	(0.016)	(0.267)	(0.000)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{5=0}$	-0.0138				0.0137	0.015
	(0.113)				(0.552)	(0.491)
α_{4+} $\alpha_{6=0}$	-0.108**	-0.016*		0.061***	0.037**	
	(0.0233)	(0.092)		(0.000)	(0.042)	
AR(2) test	0.246	0.445	0.554	0.426	0.185	0.539
Hansen test	0.944	0.850	0.380	0.223	0.157	0.353
Observations	6245	4518	5018	3684	4402	4371

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP*= annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year *SD_ROA*; ; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets;.

Table 4a. Impact of changes in equity, subordinated debt and hybrid instrument on European banks' risk changes over the period 1992-2006, specification (2) (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(2.a)	(2.b)	(2.c)	(2.a)	(2.b)	(2.c)
ΔEQ (β_4)	1.498***	1.567***	1.187***	0.00833	0.0305	-0.0180
	(0.000)	(0.000)	(0.000)	(0.894)	(0.597)	(0.789)
ΔEQ*D_AD (β_5)	0.124	0.200	1.088	0.0348	0.00183	-0.0498
	(0.819)	(0.680)	(0.108)	(0.833)	(0.991)	(0.780)
ΔEQ*D_UNDER (β_6)	-5.431***			-0.322		
	(0.000)			(0.113)		
ΔEQ*D_UNDERMODER (β_6)		-5.864***			-0.441**	
		(0.000)			(0.019)	
ΔEQ*D_UNDERSTRONG (β_6)			0.0700			-0.399
			(0.969)			(0.367)
F-test $\beta_4+\beta_6=0$	-3.934***	-4.297***			-0.411**	
	(0.000)	(0.000)			(0.0103)	
ΔSUB (β_7)	0.920***	0.980***	0.848***	-0.104	-0.0636	-0.0797
	(0.000)	(0.000)	(0.005)	(0.155)	(0.340)	(0.340)
ΔSUB*D_AD (β_8)	-0.673	-0.578	-0.453	0.373	0.360*	0.265
	(0.158)	(0.212)	(0.513)	(0.110)	(0.082)	(0.296)
ΔSUB*D_UNDER (β_9)	0.658			-0.113		
	(0.750)			(0.789)		
ΔSUB*D_UNDERMODER (β_9)		-0.616			-0.383	
		(0.753)			(0.474)	
ΔSUB*D_UNDERSTRONG (β_9)			1.313			1.494
			(0.750)			(0.454)
ΔHYB (β_{10})	0.205	0.587	0.565	0.209	0.171	0.172
	(0.723)	(0.308)	(0.373)	(0.175)	(0.169)	(0.321)
ΔHYB*D_AD (β_{11})	1.866**	1.238	2.812**	0.0429	0.350	0.416
	(0.023)	(0.157)	(0.013)	(0.901)	(0.280)	(0.262)
ΔHYB*D_UNDER (β_{12})	54.16***			-0.326		
	(0.000)			(0.928)		
ΔHYB*D_UNDERMODER (β_{12})		244.9***			26.90***	
		(0.000)			(0.000)	
ΔHYB*D_UNDERSTRONG (β_{12})			NA			12.74*
						(0.083)
F-test $\beta_{10}+\beta_{11}=0$	2.071***		1.825***			
	(0.000)		(0.004)			
$\beta_{10}+\beta_{12}=0$	54.37***	245.5***			27.07***	12.57*
	(0.000)	(0.000)			(0.000)	(0.086)
D_AD	-0.560	-0.850*	-0.431	0.0451	-0.0435	0.0555
	(0.234)	(0.057)	(0.567)	(0.828)	(0.830)	(0.812)
D_UNDER	-0.260			2.098***		
	(0.846)			(0.000)		
D_UNDERMODR		-0.816			1.400**	
		(0.448)			(0.022)	
D_UNDERSTRONG			-11.11			2.568**
			(0.115)			(0.021)

Table 4a (continue) Impact of changes in equity, subordinated debt and hybrid instrument on European banks' risk changes over the period 1992-2006, specification (2) (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(2.a)	(2.b)	(2.c)	(2.a)	(2.b)	(2.c)
RWA_{t-1}	-0.0809**	-0.0703**	-0.157***			
	(0.010)	(0.037)	(0.001)			
NPL_{t-1}				-0.922***	-0.889***	-0.930***
				(0.000)	(0.000)	(0.000)
EFF	0.145*	0.150**	0.115	-0.0140	0.0154	-0.0183
	(0.097)	(0.016)	(0.215)	(0.557)	(0.594)	(0.471)
SIZE	-0.0713	-0.0100	-0.101	-0.0906	-0.0685	-0.122*
	(0.544)	(0.922)	(0.507)	(0.151)	(0.266)	(0.087)
Constant	-1.767	-3.506	4.831	6.492***	4.189*	7.160***
	(0.807)	(0.555)	(0.537)	(0.002)	(0.094)	(0.002)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) test	0.381	0.218	0.125	0.311	0.314	0.958
Hansen test	0.990	0.995	0.862	0.555	0.268	0.326
Observations	1994	1787	1939	1642	1493	1485

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD*=1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔEQ* = annual changes in the ratio of equity capital to total assets; *ΔSUB* = annual changes in the ratio of subordinated debt to total assets; *ΔHYB* = annual changes in the ratio of hybrid capital to total assets; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL; EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

Table 4b. Impact of changes in equity, subordinated debt and hybrid instrument on European banks' risk changes over the period 1992-2006, specification (2) (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(2.a)	(2.b)	(2.c)	(2.a)	(2.b)	(2.c)
ΔEQ (β_4)	-0.0443	0.087	0.161*	-0.367*	-0.043**	-0.039**
	(0.373)	(0.312)	(0.071)	(0.100)	(0.021)	(0.034)
ΔEQ*D_AD (β_5)	0.042	-0.087	-0.159*	0.312	0.017	0.024
	(0.410)	(0.288)	(0.072)	(0.158)	(0.854)	(0.791)
ΔEQ*D_UNDER (β_6)	0.066			0.460*		
	(0.323)			(0.075)		
ΔEQ*D_UNDERMODER (β_6)		-0.137			0.145**	
		(0.170)			(0.032)	
ΔEQ*D_UNDERSTRONG (β_6)			-0.053			0.022
			(0.558)			(0.782)
F-test $\beta_4 + \beta_5 = 0$			0.002			
			(0.890)			
$\beta_4 + \beta_6 = 0$				0.092	0.102	
				(0.164)	(0.124)	
ΔSUB (β_7)	-0.007	0.009	0.024	-0.026	0.046	0.048
	(0.467)	(0.608)	(0.205)	(0.667)	(0.218)	(0.196)
ΔSUB*D_AD (β_8)	-0.005	-0.025	-0.033	0.036	-0.014	-0.015
	(0.747)	(0.244)	(0.173)	(0.713)	(0.861)	(0.852)
ΔSUB*D_UNDER (β_9)	0.036			-0.374		
	(0.269)			(0.167)		
ΔSUB*D_UNDERMODER (β_9)		0.0231			-0.342	
		(0.694)			(0.237)	
ΔSUB*D_UNDERSTRONG (β_9)			-0.413***			-0.710
			(0.000)			(0.216)
F-test $\beta_7 + \beta_9 = 0$			-0.389			
			(0.585)			
ΔHYB (β_{10})	-0.0205	0.00242	0.0219	-0.0964	-0.0429	-0.0381
	(0.357)	(0.924)	(0.425)	(0.365)	(0.685)	(0.717)
ΔHYB*D_AD (β_{11})	0.0714**	0.0216	0.00299	0.0135	-0.0334	-0.0411
	(0.024)	(0.595)	(0.944)	(0.959)	(0.911)	(0.890)
ΔHYB*D_UNDER (β_{12})	0.0744			-1.805		
	(0.198)			(0.236)		
ΔHYB*D_UNDERMODER (β_{12})		0.354			-0.430	
		(0.454)			(0.669)	
ΔHYB*D_UNDERSTRONG (β_{12})			1.259*			-2.898
			(0.067)			(0.182)
F-test $\beta_{10} + \beta_{11} = 0$	0.024					
	(0.382)					
$\beta_{10} + \beta_{12} = 0$			1.281**			
			(0.063)			
D_AD	0.00275	-0.0196	-0.0312	-0.00111	0.0114	0.0112
	(0.767)	(0.302)	(0.110)	(0.987)	(0.861)	(0.863)
D_UNDER	0.000379			0.0798		
	(0.989)			(0.622)		
D_UNDERMODR		-0.00620			-0.00663	
		(0.897)			(0.974)	
D_UNDERSTRONG			-0.0279			0.204
			(0.786)			(0.473)

Table 4b (continue). Impact of changes in equity, subordinated debt and hybrid instrument on European banks' risk changes over the period 1992-2006, specification (2) (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(2.a)	(2.b)	(2.c)	(2.a)	(2.b)	(2.c)
SD_ROA_{t-1}	0.914***	0.907***	0.886***			
	(0.000)	(0.000)	(0.000)			
LOG_Z_{t-1}				0.703***	0.743***	0.726***
				(0.000)	(0.000)	(0.000)
EFF	-0.00427	0.00773**	0.00648**	-0.0222*	-0.0230**	-0.0228**
	(0.605)	(0.040)	(0.036)	(0.054)	(0.050)	(0.049)
SIZE	-0.00210	0.00750	0.0106**	-0.0580***	-0.0516***	-0.0506***
	(0.680)	(0.161)	(0.022)	(0.003)	(0.001)	(0.001)
Constant	0.320	-0.631**	-0.569**	3.514***	3.409***	3.458***
	(0.617)	(0.034)	(0.011)	(0.001)	(0.001)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) test	0.335	0.598	0.330	0.432	0.452	0.480
Hansen test	0.105	0.106	0.131	0.666	0.202	0.274
Observations	2116	1854	1857	2353	1956	1946

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *D_UNDER* =1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; ΔEQ = annual changes in the ratio of equity capital to total assets; ΔSUB = annual changes in the ratio of subordinated debt to total assets; ΔHYB = annual changes in the ratio of hybrid capital to total assets; SD_ROA_{t-1} = previous year ratio *SD_ROA*; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

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Appendix

Table A1. Distribution of banks by country and type

Country	Number of banks	% Total assets[a]	Commercial banks	Savings banks	Mutual & cooperative banks
Austria	9	62.88	5	2	2
Belgium	26	92	18	5	3
Denmark	91	36.14	57	34	0
Finland	10	96.8	8	1	1
France	226	51.52	130	18	78
Germany	27	30.71	16	2	9
Greece	13	91.25	13	0	0
Ireland	11	47.79	9	2	0
Italy	677	71.18	139	65	473
Luxembourg	33	40.63	32	1	0
Netherlands	30	61.56	29	1	0
Norway	51	36.73	15	36	0
Portugal	22	86.48	18	3	1
Spain	77	91.21	26	46	5
Sweden	84	74.12	21	63	0
Switzerland	19	84.15	16	1	2
United Kingdom	45	31.48	44	1	0
Total	**1451**	**63.92**	**596**	**281**	**574**

[a] % Total assets represents total assets of commercial, savings and mutual & cooperative banks we consider in our sample divided by total assets of commercial, savings and mutual & cooperative banks of the largest sample of banks provided by BankScope Fitch IBCA for the year 2006.

Table A2. Frequency of banks capitalization status, over the 1992-2006 period

	Highly capitalized	Adequately capitalized	Undercapitalized	Moderately undercapitalized	Strongly undercapitalized
1 year	83	155	62	33	26
2 years	100	97	19	12	5
3 years	86	52	13	9	2
4 years	104	46	3	1	0
5 years	165	25	2	1	0
6 years	195	35	1	1	0
7 years	194	7	1	0	0
8 years	191	4	0	0	0
9 years	69	8	0	0	0
10 years	37	2	0	0	0
11 years	43	0	0	0	0
12 years	42	0	0	0	0
13 years	29	0	0	0	0
14 years	22	0	0	0	0
15 years	24	0	0	0	0
Total	**1384**	**431**	**101**	**57**	**33**

We classify banks in different categories of capitalization: highly capitalized when $TCR \geq 10$; adequately capitalized when $8 \leq TCR < 10$; undercapitalized when $TCR < 8\%$; moderately undercapitalized when $TCR<8\%$ and $TIER1 \geq 4$; strongly undercapitalized when $TCR<8\%$ and $TIER1<4$. The sum of banks classified as moderately and strongly undercapitalized does not perfectly match with the number of undercapitalized banks because some of these banks do not provide information on *TIER1*. *TCR* = total capital/ risk-weighted assets; *TIER1*= tier 1 capital/ risk-weighted assets.

Table A3a. Increase in capital (ΔCAP>0) and risk-taking behavior over the period 1992-2006 (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-2.213***	-2.081**	-1.686*	0.244	0.0971	0.112
	(0.009)	(0.014)	(0.056)	(0.140)	(0.418)	(0.347)
D_UNDER (α_3)	1.236			1.340**		
	(0.403)			(0.014)		
D_UNDERMODER (α_3)		-2.304***			-0.467***	
		(0.001)			(0.000)	
D_UNDERSTRONG (α_3)			0.624			-0.102
			(0.799)			(0.774)
ΔCAP (α_4)	0.835***	0.812***	0.866***	-0.0415	-0.00163	-0.0430
	(0.000)	(0.000)	(0.000)	(0.409)	(0.957)	(0.233)
ΔCAP*D_AD (α_5)	0.786*	0.769	0.673	0.128	-0.0630	0.0189
	(0.091)	(0.111)	(0.177)	(0.369)	(0.437)	(0.844)
ΔCAP*D_UNDER (α_6)	-2.094***			-0.445***		
	(0.003)			(0.000)		
ΔCAP*D_UNDERMODER (α_6)		-2.304***			-0.467***	
		(0.001)			(0.000)	
ΔCAP*D_UNDERSTRONG (α_6)			0.624			-0.102
			(0.799)			(0.774)
RWA_{t-1}	-0.0868	-0.0898	-0.139**			
	(0.118)	(0.125)	(0.033)			
NPL_{t-1}				-0.332***	-0.400***	-0.249***
				(0.000)	(0.000)	(0.001)
EFF	-0.0777	-0.0792	-0.109	0.0293	0.00633*	0.00377
	(0.198)	(0.269)	(0.169)	(0.266)	(0.086)	(0.315)
SIZE	-0.146	-0.165	-0.218*	-0.161**	-0.123***	-0.0728*
	(0.178)	(0.180)	(0.095)	(0.014)	(0.001)	(0.088)
Const.	14.55**	15.24**	21.26***	2.319	3.459***	1.938**
	(0.012)	(0.024)	(0.005)	(0.327)	(0.000)	(0.041)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$	1.259*	-1.492**		-0.487***	-0.469***	
	(0.067)	(0.028)		(0.000)	(0.000)	
AR(2) test	0.716	0.927	0.774	0.205	0.690	0.653
Hansen test	0.664	0.580	0.427	0.978	0.723	0.376
Observations	2580	2411	2383	2060	1480	1554

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL;* EFF = cost to income ratio; *SIZE* = logarithm of total assets.

Table A3b. Increase in capital (ΔCAP>0) and risk-taking behavior over the period 1992-2006 (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	0.00996	-0.0027	0.0123	-0.0785**	-0.0875*	-0.103**
	(0.449)	(0.873)	(0.452)	(0.026)	(0.056)	(0.021)
D_UNDER (α_3)	0.0298			-0.0315		
	(0.417)			(0.632)		
D_UNDERMODER (α_3)		0.00577			-0.0340*	
		(0.731)			(0.094)	
D_UNDERSTRONG (α_3)			-0.0135			-0.0758
			(0.900)			(0.827)
ΔCAP (α_4)	0.0158***	0.0105*	0.016***	-0.029***	-0.0518***	-0.051***
	(0.006)	(0.089)	(0.002)	(0.000)	(0.000)	(0.000)
ΔCAP*D_AD (α_5)	-0.0182	-0.0057	-0.0227*	-0.00005	0.0566	0.0658*
	(0.104)	(0.685)	(0.063)	(0.999)	(0.162)	(0.096)
ΔCAP*D_UNDER (α_6)	0.00577			-0.0340*		
	(0.731)			(0.094)		
ΔCAP*D_UNDERMODER (α_6)		-0.054**			-0.0181**	
		(0.012)			(0.046)	
ΔCAP*D_UNDERSTRONG (α_6)			0.0239			-0.0798
			(0.656)			(0.715)
SD_ROA_{t-1}	0.783***	0.924***	0.747***			
	(0.000)	(0.000)	(0.000)			
LOG_Z_{t-1}				0.746***	0.738***	0.731***
				(0.000)	(0.000)	(0.000)
EFF	-0.00385	-0.008*	0.000368	0.00015	-0.00218**	-0.00165
	(0.147)	(0.081)	(0.903)	(0.820)	(0.044)	(0.134)
SIZE	-0.00247	-0.0058	-0.0076*	-0.013***	-0.0180***	-0.0125*
	(0.341)	(0.166)	(0.080)	(0.001)	(0.009)	(0.070)
Const.	0.337*	0.662*	0.136	1.198***	1.440***	1.359***
	(0.073)	(0.063)	(0.583)	(0.000)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$		-0.044**		-0.063	-0.033	
		(0.033)		(0.123)	(0.126)	
AR(2) test	0.350	0.439	0.486	0.455	0.116	0.112
Hansen test	0.190	0.373	0.211	0.188	0.151	0.329
Observations	2938	2092	2322	1751	2071	2050

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP*= annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year *SD_ROA*; ; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

Table A4a. Increase in capital (ΔCAP<0) and risk-taking behavior over the period 1992-2006 (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-0.728	-0.813	-1.087	0.0738	-0.0562	-0.0428
	(0.277)	(0.242)	(0.113)	(0.606)	(0.566)	(0.646)
D_UNDER (α_3)	-7.543***			0.331		
	(0.001)			(0.388)		
D_UNDERMODER (α_3)		-7.359***			0.0588	
		(0.003)			(0.846)	
D_UNDERSTRONG (α_3)			-11.48**			0.903
			(0.014)			(0.317)
ΔCAP (α_4)	0.844**	0.777**	0.901**	0.0916	0.0932**	0.0834*
	(0.015)	(0.033)	(0.011)	(0.153)	(0.042)	(0.071)
ΔCAP*D_AD (α_5)	-0.645	-0.653	-0.711	0.0435	0.00353	0.00545
	(0.362)	(0.352)	(0.312)	(0.697)	(0.968)	(0.952)
ΔCAP*D_UNDER (α_6)	-3.331**			-0.337		
	(0.033)			(0.187)		
ΔCAP*D_UNDERMODER (α_6)		-3.823***			-0.141	
		(0.009)			(0.511)	
ΔCAP*D_UNDERSTRONG (α_6)			-2.236			0.435
			(0.441)			(0.491)
RWA_{t-1}	-0.220***	-0.211***	-0.174***			
	(0.000)	(0.000)	(0.001)			
NPL_{t-1}				-0.177***	-0.331***	-0.271***
				(0.010)	(0.000)	(0.000)
EFF	-0.0589	-0.0733	-0.0648	0.0581***	0.00842***	0.00667***
	(0.309)	(0.212)	(0.293)	(0.002)	(0.003)	(0.007)
SIZE	-0.169	-0.197	-0.193	-0.0194	-0.0913***	-0.0755***
	(0.281)	(0.216)	(0.232)	(0.716)	(0.001)	(0.002)
Const.	22.97***	23.71***	20.46***	-2.508	2.343***	1.900***
	(0.001)	(0.001)	(0.005)	(0.198)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$	-3.046**	-1.334				
	(0.021)	(0.642)				
AR(2) test	0.601	0.795	0.701	0.319	0.771	0.832
Hansen test	0.264	0.363	0.166	0.316	0.858	0.886
Observations	3192	3006	2995	2667	2048	2041

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL;* EFF = cost to income ratio; *SIZE* = logarithm of total assets.

Table A4b. Increase in capital (ΔCAP<0) and risk-taking behavior over the period 1992-2006 (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	0.0109	0.00731	0.00332	-0.0679**	0.00393	0.000708
	(0.256)	(0.436)	(0.793)	(0.025)	(0.924)	(0.986)
D_UNDER (α_3)	-0.0544			-0.191**		
	(0.180)			(0.016)		
D_UNDERMODER (α_3)		-0.0269			0.0131	
		(0.354)			(0.918)	
D_UNDERSTRONG (α_3)			0.331*			-0.476***
			(0.080)			(0.005)
ΔCAP (α_4)	-0.00009	0.00162	0.00348	0.00144	0.00194	0.00552
	(0.979)	(0.642)	(0.508)	(0.828)	(0.855)	(0.620)
ΔCAP*D_AD (α_5)	0.0136	0.0184	0.00973	-0.00797	0.0180	0.0147
	(0.206)	(0.151)	(0.553)	(0.777)	(0.618)	(0.683)
ΔCAP*D_UNDER (α_6)	-0.00571			-0.0548		
	(0.804)			(0.325)		
ΔCAP*D_UNDERMODER (α_6)		-0.026**			-0.0975*	
		(0.014)			(0.085)	
ΔCAP*D_UNDERSTRONG (α_6)			0.163			-0.386***
			(0.221)			(0.000)
SD_ROA_{t-1}	0.908***	0.904***	0.888***			
	(0.000)	(0.000)	(0.000)			
LOG_Z_{t-1}				0.775***	0.803***	0.801***
				(0.000)	(0.000)	(0.000)
EFF	0.0044***	0.005***	0.007***	-0.003***	-0.0048***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SIZE	0.0045**	0.006***	0.006**	-0.023***	-0.023***	-0.023***
	(0.026)	(0.006)	(0.047)	(0.000)	(0.000)	(0.000)
Const.	-0.32***	-0.40***	-0.526***	1.411***	1.321***	1.348***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$		-0.02***			-0.095*	-0.380***
		(0.009)			(0.083)	(0.000)
AR(2) test	0.265	0.512	0.611	0.287	0.292	0.282
Hansen test	0.198	0.149	0.106	0.324	0.449	0.343
Observations	3112	2466	2646	1933	2332	2329

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; ; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD*=1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year *SD_ROA*; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

Table A5a. Impact of changes in capital on risk changes for European banks with a relatively low ratio of deposits to total assets over the period 1992-2006 (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-0.901	-1.033*	-1.039*	0.219**	0.0936	0.106
	(0.110)	(0.062)	(0.063)	(0.040)	(0.210)	(0.134)
D_UNDER (α_3)	-1.504			0.780***		
	(0.291)			(0.004)		
D_UNDERMODER (α_3)		-0.712			0.472**	
		(0.617)			(0.044)	
D_UNDERSTRONG (α_3)			-12.23***			-0.226
			(0.001)			(0.517)
ΔCAP (α_4)	0.749***	0.763***	0.726***	0.0642**	0.0779***	0.0760***
	(0.000)	(0.000)	(0.000)	(0.027)	(0.000)	(0.000)
ΔCAP*D_AD (α_5)	0.0916	0.0636	0.0999	0.0951	0.0159	0.000720
	(0.773)	(0.843)	(0.754)	(0.157)	(0.805)	(0.991)
ΔCAP*D_UNDER (α_6)	-2.074***			-0.467***		
	(0.007)			(0.001)		
ΔCAP*D_UNDERMODER (α_6)		-2.203***			-0.301***	
		(0.007)			(0.008)	
ΔCAP*D_UNDERSTRONG (α_6)			-0.779			0.195
			(0.751)			(0.426)
RWA_{t-1}	-0.150***	-0.142***	-0.146***			
	(0.001)	(0.001)	(0.001)			
NPL_{t-1}				-0.211***	-0.280***	-0.251***
				(0.000)	(0.000)	(0.000)
EFF	-0.166***	-0.169***	-0.175***	0.0827***	0.00863***	0.00707***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)
SIZE	-0.331***	-0.312***	-0.326***	-0.00287	-0.0805***	-0.0770***
	(0.001)	(0.003)	(0.003)	(0.944)	(0.000)	(0.000)
Const.	27.23***	26.64***	27.50***	-4.270***	1.876***	1.757***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$	-1.440**	-0.053		-0.403***	-0.223**	
	(0.067)	(0.983)		(0.004)	(0.046)	
AR(2) test	0.784	0.998	0.790	0.349	0.887	0.534
Hansen test	0.838	0.755	0.744	0.641	0.830	0.675
Observations	4875	4689	4650	4051	3101	3065

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL* EFF = cost to income ratio; *SIZE* = logarithm of total assets.

Table A5b. Impact of changes in capital on risk changes for European banks with a relatively low ratio of deposits to total assets over the period 1992-2006 (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	0.00566	0.00243	0.00539	-0.071***	-0.0355	-0.0422
	(0.561)	(0.671)	(0.650)	(0.000)	(0.205)	(0.127)
D_UNDER (α_3)	0.0697			-0.0138		
	(0.167)			(0.831)		
D_UNDERMODER (α_3)		0.00867			0.0221	
		(0.561)			(0.811)	
D_UNDERSTRONG (α_3)			0.0986			-0.0358
			(0.141)			(0.821)
ΔCAP (α_4)	0.0015**	0.005***	0.0040**	-0.020***	-0.0241***	-0.024***
	(0.055)	(0.004)	(0.056)	(0.000)	(0.000)	(0.000)
ΔCAP*D_AD (α_5)	-0.0151	-0.0005	-0.0106	0.0111	0.0315	0.0321
	(0.161)	(0.937)	(0.353)	(0.546)	(0.199)	(0.183)
ΔCAP*D_UNDER (α_6)	-0.122**			0.0491		
	(0.027)			(0.522)		
ΔCAP*D_UNDERMODER (α_6)		-0.02***			0.0348	
		(0.000)			(0.178)	
ΔCAP*D_UNDERSTRONG (α_6)			0.000631			-0.166
			(0.989)			(0.210)
SD_ROA_{t-1}	0.894***	0.884***	0.878***			
	(0.000)	(0.000)	(0.000)			
LOG_Z_{t-1}				0.764***	0.799***	0.782***
				(0.000)	(0.000)	(0.000)
EFF	0.00343*	0.003***	0.0042**	-0.001***	-0.00328***	-0.003***
	(0.061)	(0.000)	(0.015)	(0.001)	(0.000)	(0.000)
SIZE	0.00371	0.003**	0.00323	-0.018***	-0.0233***	-0.020***
	(0.208)	(0.023)	(0.361)	(0.000)	(0.000)	(0.000)
Const.	-0.237	-0.22***	-0.272*	1.297***	1.260***	1.308***
	(0.122)	(0.003)	(0.060)	(0.000)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$	-0.120**	-0.020***				
	(0.028)	(0.000)				
AR(2) test	0.552	0.441	0.546	0.178	0.686	0.510
Hansen test	0.329	0.441	0.677	0.266	0.104	0.113
Observations	5027	3760	4311	2998	3778	3757

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank-risk based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD*=1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *ΔCAP* = annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year *SD_ROA*; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total asset.

Table A6a. Impact of changes in capital on risk changes for European banks with a relatively high ratio of deposits to total assets over the period 1992-2006 (two-step system GMM estimator)

	ΔRWA			ΔNPL		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-1.068	-0.354	-0.329	-0.348	0.0271	0.00267
	(0.237)	(0.767)	(0.774)	(0.352)	(0.887)	(0.989)
D_UNDER (α_3)	-1.325			1.357		
	(0.570)			(0.418)		
D_UNDERMODER (α_3)		0.164			0.462	
		(0.962)			(0.580)	
D_UNDERSTRONG (α_3)			-4.103*			2.027***
			(0.052)			(0.000)
ΔCAP (α_4)	1.184***	1.317***	1.301***	0.109	0.0868*	0.0855*
	(0.001)	(0.000)	(0.000)	(0.329)	(0.070)	(0.080)
ΔCAP*D_AD (α_5)	0.0599	-0.00685	-0.0485	0.0899	-0.00754	0.0239
	(0.954)	(0.995)	(0.963)	(0.784)	(0.966)	(0.898)
ΔCAP*D_UNDER (α_6)	-0.600			-0.935**		
	(0.382)			(0.045)		
ΔCAP*D_UNDERMODER (α_6)		-1.495			-0.212	
		(0.143)			(0.386)	
ΔCAP*D_UNDERSTRONG (α_6)			-0.141			1.063***
			(0.722)			(0.000)
RWA_{t-1}	-0.214***	-0.218**	-0.212**			
	(0.003)	(0.030)	(0.032)			
NPL_{t-1}				0.109	-0.300***	-0.309***
				(0.635)	(0.000)	(0.000)
EFF	0.0423	0.0251	0.0282	0.0279	-0.00283	-0.00245
	(0.356)	(0.687)	(0.654)	(0.591)	(0.472)	(0.522)
SIZE	-0.406*	-0.597*	-0.573*	-0.0523	-0.0354	-0.0385
	(0.091)	(0.069)	(0.076)	(0.577)	(0.217)	(0.203)
Const.	13.79**	18.30**	17.37*	-2.233	1.034	1.210*
	(0.035)	(0.049)	(0.056)	(0.616)	(0.127)	(0.098)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$				-1.043**		1.148***
				(0.032)		(0.000)
AR(2) test	0.569	0.418	0.337	0.266	0.655	0.672
Hansen test	0.998	0.649	0.627	0.190	0.423	0.344
Observations	879	710	705	551	427	426

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *ΔNPL* = annual changes in the ratio of non-performing loans to net loans; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; RWA_{t-1} = previous year *RWA* ; NPL_{t-1} = previous year *NPL* EFF = cost to income ratio; *SIZE* = logarithm of total assets.

Table A6b. Impact of changes in capital on risk changes for European banks with a relatively high ratio of deposits to total assets over the period 1992-2006 (two-step system GMM estimator)

	SD_ROA			LOG_Z		
	(1.a)	(1.b)	(1.c)	(1.a)	(1.b)	(1.c)
D_AD (α_2)	-0.0115	0.0267	0.0358	-0.0997	-0.0294	0.0109
	(0.748)	(0.420)	(0.642)	(0.167)	(0.768)	(0.913)
D_UNDER (α_3)	0.0644			-0.106		
	(0.564)			(0.684)		
D_UNDERMODER (α_3)		-0.567			-0.484	
		(0.142)			(0.107)	
D_UNDERSTRONG (α_3)			0.146			-0.310***
			(0.226)			(0.002)
ΔCAP (α_4)	0.017*	0.012**	0.0083**	-0.0113*	-0.0337**	-0.0313**
	(0.070)	(0.054)	(0.039)	(0.087)	(0.051)	(0.055)
ΔCAP*D_AD (α_5)	-0.0172	-0.0300	-0.0521	-0.0182	0.0333	0.0731
	(0.676)	(0.237)	(0.568)	(0.753)	(0.730)	(0.404)
ΔCAP*D_UNDER (α_6)	-0.0607			0.315		
	(0.309)			(0.139)		
ΔCAP*D_UNDERMODER (α_6)		-0.618			0.635	
		(0.349)			(0.144)	
ΔCAP*D_UNDERSTRONG (α_6)			0.256			0.058
			(0.958)			(0.246)
SD_ROA_{t-1}	0.493***	0.656***	0.417***			
	(0.000)	(0.000)	(0.007)			
LOG_Z_{t-1}				0.629***	0.563***	0.555***
				(0.000)	(0.000)	(0.000)
EFF	0.000530	-0.009*	-0.0114	-0.00141	-0.00408**	-0.0043**
	(0.867)	(0.072)	(0.356)	(0.200)	(0.032)	(0.024)
SIZE	-0.0251**	-0.0126	-0.045***	0.0281***	0.0271	0.0271
	(0.022)	(0.108)	(0.010)	(0.009)	(0.112)	(0.116)
Const.	0.331	0.922**	1.487	0.915***	1.538***	1.637***
	(0.378)	(0.049)	(0.212)	(0.000)	(0.000)	(0.000)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-test: α_{4+} $\alpha_{6=0}$		-0.606**				
		(0.051)				
AR(2) test	0.362	0.421	0.891	0.898	0.193	0.139
Hansen test	0.144	0.739	0.156	0.310	0.321	0.374
Observations	1214	610	704	918	665	662

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *LOG_Z* = logarithm of 3-year rolling Z-score; *D_UNDER* = 1 when bank-risk based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD*=1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year *SD_ROA*; LOG_Z_{t-1} = previous year *LOG_Z*; *EFF* = cost to income ratio; *SIZE* = logarithm of total asset.

Table A7a Simultaneous equations (1992-2006)

	ΔRWA	ΔCAP
ΔCAP (α_3)	2.672***	
	(0.000)	
ΔCAP*D_AD (α_4)	-2.092***	
	(0.000)	
ΔCAP*D_UNDER (α_5)	-0.981**	
	(0.050)	
ΔRWA (α_3)		0.146***
		(0.000)
ΔRWA*D_AD (α_4)		-0.123***
		(0.000)
ΔRWA*D_UNDER (α_5)		-0.328***
		(0.000)
RWA_{t-1}	-0.120***	
	(0.004)	
CAP_{t-1}		-0.022***
		(0.000)
D_AD	-0.446**	0.570***
	(0.024)	(0.000)
D_UNDER	-0.490	0.732***
	(0.387)	(0.004)
EFF	0.0207***	-0.007***
	(0.004)	(0.000)
SIZE	0.232**	-0.018
	(0.029)	(0.143)
Country fixed effects	Yes	Yes
Period fixed effects	Yes	Yes
Khi^2 test : α_{3+} $\alpha_{4=0}$	0.580***	0.023
	(0.000)	(0.291)
α_{3+} $\alpha_{5=0}$	0.981***	-0.168***
	(0.000)	(0.002)
R^2	0.048	0.134
Observations	3130	3130

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *ΔRWA* = annual changes in the ratio of risk-weighted assets to total assets; *D_UNDER* = 1 when bank risk-based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP* = annual changes in the ratio of total capital to total assets; RWA_{t-1} = Previous year ratio of risk-weighted assets to total assets; CAP_{t-1} = Previous year ratio of total capital to total assets; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

Table A7b Simultaneous equations (1992-2006)

	SD_ROA	ΔCAP
ΔCAP (α_3)	0.144***	
	(0.000)	
ΔCAP*D_AD (α_4)	0.005	
	(0.788)	
ΔCAP*D_UNDER (α_5)	-0.128***	
	(0.000)	
SD_ROA (α_3)		0.126
		(0.162)
SD_ROA*D_AD (α_4)		-1.885***
		(0.000)
SD_ROA*D_UNDER (α_5)		-3.496***
		(0.000)
SD_ROA_{t-1}	0.672***	
	(0.000)	
CAP_{t-1}		-0.022***
		(0.000)
D_AD	0.055***	0.618***
	(0.000)	(0.000)
D_UNDER	0.242***	1.709***
	(0.000)	(0.000)
EFF	-0.001	-0.003***
	(0.284)	(0.000)
SIZE	-0.015***	-0.003***
	(0.000)	(0.000)
Country fixed effects	Yes	Yes
Period fixed effects	Yes	Yes
Khi^2 test : α_{3+} $\alpha_{4=0}$		-1.759***
		(0.000)
α_{3+} $\alpha_{5=0}$	0.016	-3.37***
	(0.540)	(0.000)
R^2	0.307	0.053
Observations	2869	2869

***, **, * indicate statistical significance respectively at the 1%, 5% and 10% level; figures in brackets represent the P-value. *SD_ROA* = 3-year rolling standard deviation of return on assets; *D_UNDER* = 1 when bank risk -based capital ratio<8% in the previous year, 0 otherwise; *D_UNDERMODER* = 1 when bank risk-based capital ratio<8% and tier1 ratio ≥4 in the previous year, 0 otherwise; *D_UNDERSTRONG* = 1 when bank risk-based capital ratio<8% and tier1 ratio<4 in the previous year, 0 otherwise; *D_AD* = 1 when bank risk-based capital ratio between 8% and 10% in the previous year, 0 otherwise; *ΔCAP*= annual changes in the ratio of total capital to total assets; SD_ROA_{t-1} = previous year standard deviation of return on assets; CAP_{t-1} = Previous year ratio of total capital to total assets; *EFF* = cost to income ratio; *SIZE* = logarithm of total assets.

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2. O. de Bandt, N. Dumontaux, V. Martin et D. Médée, « Mise en œuvre de stress tests sur les crédits aux entreprises» Mars 2013

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ACP
Autorité de Contrôle Prudentiel
Banque de France

61, rue Taitbout
75009 Paris
Téléphone : 01 49 95 40 00
Télécopie : 01 49 95 40 48
Site internet : www.acp.banque-france.fr